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16. Abstract

Highway relief routes around small- or medium-size communities are an important element of the Texas Trunk System. These routes provide for the safe and efficient movement of through traffic and contribute to the growth of the Texas economy. For small- and medium-size communities, however, highway relief routes potentially bring both positive and negative impacts by reducing the flow of traffic through the center of town. While a relief route often means quieter, safer streets for the residents of the community, it can also lead to changes in the local economy that may or may not benefit local residents. Residents and business leaders in communities for which the Texas Department of Transportation (TxDOT) is proposing relief routes are understandably concerned about potential negative impacts.

The purpose of this project is to provide TxDOT planners and engineers with reliable information they can use to address the questions and concerns of local residents and business leaders. This information will be based on experiences with previous relief route projects, including a quantitative analysis of the impacts of these routes on local economies, as well as in-depth case studies of the nature of these impacts in selected communities. This report summarizes the first phase of the research: the identification of key issues from the affected communities' perspective and from TxDOT's perspective, a review of the literature on highway relief routes pertaining to theory and methodologies, and a summary of the findings of previous research on this topic. This report provides the basis for the work that follows by pointing to variables to include in the quantitative analysis, by identifying the questions to ask in the case studies, and by providing guidance regarding appropriate methodologies.

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by

S. L. Handy, S. Kubly, J. Jarrett, and S. Srinivasan

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"Economic Effects of Highway Relief Routes on Small and Medium-Size Communities"

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Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

April 2000

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Research Supervisor

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CHAPTER 1. INTRODUCTION

Highway relief routes around small- or medium-size communities are an important element of the Texas Trunk System. These routes provide for the safe and efficient movement of through traffic and contribute to the growth of the Texas economy. For small- and medium-size communities, however, highway relief routes potentially bring both positive and negative impacts by reducing the flow of traffic through the center of town. While a relief route often means quieter, safer streets for the residents of the community, it can also lead to changes in the local economy that may or may not benefit local residents. Residents and business leaders in communities for which the Texas Department of Transportation (TxDOT) is proposing relief routes are understandably concerned about potential negative impacts.

The kinds of changes small- and medium-size communities experience when a highway relief route is built around town are perhaps more easily observed than quantified: a blossoming of new businesses along the new highway coupled with a withering of old businesses along the old highway. To some extent, this kind of change is inevitable, since most retail and service businesses depend at least partly, if not largely, on drive-by traffic — customers that come in because they were driving by and not because they set out for that particular business. As traffic volumes shift from the old highway to the new, business activity generally shifts to some degree as well. What this shift means for local residents — economically and otherwise — is less certain and may depend on local circumstances. Questions from local leaders might include the overall impact of the relief route on the local economy, the possible shift from local businesses to national chains, and the potential for tourism- and truck-based economic development.

Although the impacts of a relief route depend on the particular circumstances of the community served by the route, those circumstances are partly under the control of local officials. Local leaders may wonder what steps they can take to ensure that a highway relief route has a positive impact on the local economy and on the quality of life in their community. Strategies to mitigate the negative impacts of the relief route and bolster the positive impacts may include zoning policies, tax incentives, signage programs, and advertising campaigns, among others. Foreknowledge of the potential impacts of relief routes and of strategies used successfully in other communities is an essential first step in adequately planning for highway relief routes for both TxDOT and the local communities themselves.

The purpose of this project is to provide TxDOT planners and engineers with reliable information they can use to address the questions and concerns of local residents and business leaders. This information will be based on experiences with previous relief route projects, including a quantitative analysis of the impacts of these routes on local economies, as well as in-depth case studies of the nature of these impacts in selected communities. This report summarizes the first phase of the research: the identification of key issues from the affected communities' perspective and from TxDOT's perspective, a review of the literature on highway relief routes pertaining to theory and methodologies, and a summary of the findings of previous research on this topic. This report provides the basis for the work that follows by pointing to variables to include in the quantitative analysis, by identifying the questions to ask in the case studies, and by providing guidance concerning appropriate methodologies.

CHAPTER 2. IDENTIFICATION OF ISSUES

The starting point for this research project was the identification of the issues of most concern to small- and medium-size communities when a proposed highway relief route is being considered. The research that follows, both the quantitative analysis and the case studies, must address these concerns and provide answers for community leaders as to possible impacts on their communities and the conditions that influence those impacts.

In order to identify these concerns, the researchers interviewed officials of a variety of state and local organizations that represent or work closely with small- and medium-size communities in Texas and thus have some knowledge of the kinds of concerns these communities express about highway relief routes. The TxDOT engineers who work with these communities in planning, designing, and building highway relief routes were also interviewed (Table 2.1).[1] In these interviews, the researchers asked about the kinds of benefits local residents see in relief routes, the concerns they express about possible negative impacts, the different views held by different groups within these communities, and examples of communities that have been positively or negatively affected by relief routes. In addition, TxDOT engineers were asked about their own experiences with and concerns about highway relief route projects. The engineers were also asked to identify recent relief route projects within their districts in order to create a complete statewide list of relief route communities for use in subsequent phases of this research. In the case studies to be completed in the next phase of research, local officials and TxDOT staff will be interviewed in more depth to determine their concerns about and assessment of the impacts of specific highway relief routes.

2.1 COMMUNITY CONCERNS

Several clear themes characterizing the concerns expressed by communities over highway relief routes emerged from the interviews completed. For the most part, the TxDOT perspective on community concerns is consistent with the perspective of officials from state and local organizations that represent or work closely with small- and medium-size communities. In

[1] In the discussion that follows, the names of the individuals making specific points or comments are intentionally omitted in order to protect confidentiality.

other words, the kinds of concerns that communities express to TxDOT are essentially the same as those that they express to other organizations and agencies with whom they work.

TABLE 2.1 INTERVIEWS COMPLETED

STATE AND COMMUNITY ORGANIZATIONS

Bee Development Authority
Stephenville Agricultural Research and Extension Center
Texas Economic Development Council
Texas Main Street Program
Texas-New Mexico Power
Texas Rural Development Council

TxDOT DISTRICTS

Abilene District	Joe Higgens
Amarillo District	Mark Tomlinson
Austin District	William Garbade
Beaumont District	Jackie Anderson
Beaumont District*	Jackie Anderson
Brownwood District	Bill Crumley
Bryan District	Bob Richardson
Childress District	David Casteel
Corpus Christi District	Paula Sales
Dallas District	Stan Hall
Dallas District*	Charles Tucker
El Paso District	Mary Diaz
Fort Worth District	Burt Clifton
Fort Worth District*	Burt Clifton
Houston District*	Carol Nixon
Laredo District*	Jo Ann Garcia
Lubbock District	Gerald Sturdivant
Odessa District	Lauren Garduno
Paris District	Steve Extrom
Pharr District*	Amadeo Saenz, Jr.
San Angelo District	John DeWitt
San Antonio District	Julie Brown
Tyler District	Wes McClure
Wichita Falls District	John Barton
Yoakum District	Lonnie Gregorcyck

* letter received from district in lieu of interview

2.1.1 Community Concerns Identified by State and Local Organizations

Officials from the state and local organizations interviewed (as listed in Table 2.1) agreed that different communities and different groups within communities anticipate very different impacts from highway relief routes. Some community members see a relief route as an opportunity for economic growth with new businesses locating on the relief route, if access roads are provided. Others believe it will be the deathknell for the downtown area and the small commercial businesses that often struggle to survive there. One official put it this way: Those community members who see opportunities for relocating or establishing businesses on the relief route and those who see their property values increasing are supportive, while those who will lose customer traffic or whose land will be adversely affected are against the relief route. Another argued that the predominant community position depends solely on the views of the most influential local citizens at critical times. Key groups include chambers of commerce, local economic development organizations, city councils, county judges and courts, property owners, and downtown merchants. These groups may or may not support the bypass depending on how they are affected and on what involvement they have in the planning of the proposed project.

The challenge for relief routes, according to one official, is to eliminate truck traffic from the center of town without losing the customer base for local businesses. Most community members see the advantages of eliminating truck traffic, most notably reduced traffic and noise and improved safety. These improvements may, in fact, help local businesses by improving the overall quality of the environment in the center of town. However, if local businesses, few of which have the resources to relocate to the relief route, depend on “stop and shop” traffic as a source of customers, they are likely to suffer. As another official pointed out, relief routes are less likely to hurt local businesses in communities that are already a significant draw for tourists, since tourists are specifically destined for that community. For other communities trying to build their tourism base, however, shifting through travelers to a relief route and out of sight of the charms of the historic town center might mean a loss of future tourists.

Communities are also concerned about where the relief route is located and how it is designed. In addition to impacts on businesses (both the potential loss of existing local businesses and the potential attraction of new businesses), residents may be concerned about increased noise on the periphery of town, division of properties by the right-of-way for the relief

route, the cost of extending utility infrastructure to the vicinity of the new route, and the adequacy of signage promoting local businesses along the route. One design issue in particular emerged as a primary concern: the degree and nature of access to the new relief route.

In general, communities seem to prefer uncontrolled access or access roads along the relief route if it is going to be built. Access roads are seen as an important stimulant to the development of new businesses that will offset any losses in the local tax base created by the loss of local businesses. This view reflects a belief that the highway relief route itself rather than new businesses emerging along the route is the cause of declines in local businesses. Bastrop was cited by one official as an example in which the relief route (in this case an uncontrolled-access facility) led to an increase in the overall tax base of the community, in contrast to the situation in La Grange, where the controlled-access facility proved economically detrimental to the community. However, another official cited La Grange as a case in which the controlled-access facility helped to preserve the viability of downtown businesses and pointed out the problem of development along uncontrolled relief routes that ultimately necessitates the construction of a second bypass, as was the case in Kingsville (and has been proposed for Bastrop). This difference in assessments relates in part to a difference in perspective on the community's goal in the face of a planned relief route: preservation and enhancement of the overall tax base versus preservation of traditional businesses and local character.

As one official noted, sufficient communication and coordination between local economic development organizations, chambers of commerce, and other organizations are essential to encouraging new business growth and minimizing any declines in the local tax base. But local coordination in other policy areas is also important. Policies related to the extension of infrastructure (water, sewer, and electricity) to new businesses were viewed as critical and may be partially dictated by the location of the relief route relative to the city limits. Several officials felt that more coordination is needed between the planning of the relief route, infrastructure planning, and city land use ordinances. With better coordination, small communities could take advantage of improved transportation access to promote industrial development and the recruitment of businesses for the areas served by the relief route. Land ownership is also important, according to one official:

> A bypass is a significant asset to a community, but only if the community can work for development. If the "developable" locations are in private ownership, then the whole process may never get started. I have seen examples of both. As far as I am concerned, the frontage roads for the bypass (which should be a requirement) are prime development locations.

2.1.2 Community Concerns Identified by TxDOT Districts

According to engineers in TxDOT districts, communities express a variety of concerns and have assorted expectations for a relief route in their city. Many of the concerns are multi-faceted. Different segments of the community will express different, and at times conflicting, concerns. In every interview, TxDOT engineers said that residents of the community usually welcome the diversion of through traffic. Citizens assume that a reduction in traffic along the main street will improve safety along the corridor and feel that lower traffic on the existing route will translate to better mobility and accessibility in town. Along with reduced congestion, communities feel that there will be fewer noxious impacts — such as noise and emissions — associated with the current facilities.

The business community, in contrast, is concerned with how a reduction in through traffic will affect sales. In particular, downtown business owners see themselves as increasingly irrelevant after the construction of a relief route. Several communities have expressed concern that their downtown areas would become dominated by antique shops and other tourist-oriented activities; others worry that their community will wither and die. Many merchants express concern about access to the central business district from the new route, as well as signage on the new route. If travelers on the relief route have easy access to the business district, merchants may feel more confident in their ability to compete for the through-traffic customer.

The location of the facility also arouses concerns among citizens. Communities believe that relief routes will impact property values, but different members of the community feel that such routes will affect them in different ways. Residential property owners feel that their property value will be lowered by proximity to the facility, while business owners feel that their property values will be lowered by not having access to the new relief route. In some instances several large landowners control a majority of the land adjacent to the relief route. As a result, business owners fear that they will not be able to develop along the new route and thus not be able to compete for the traffic on the bypass.

The type of traffic using the existing route or the proposed relief route may raise concerns within the community. The citizens of Clarksville requested a relief route to divert hazardous cargo, in this case munitions, which, without the relief route, were being transported through the center of town. Several relief routes in West Texas are parts of federal Waste Isolation Plant Project (WIPP) routes, on which trucks will transport radioactive waste across Texas and into New Mexico. These communities may prefer that radioactive waste travel around rather than through town but may still be concerned that the WIPP designation will have negative impacts on the community. In a compilation of research studies of WIPP routes in New Mexico, Oregon, Idaho, and Colorado, Oakes (Ref 1) determined that the primary safety concern associated with WIPP routes was traffic accidents with cargo trucks. Communities also worried about declining property values, tourism, and devalued agricultural products; however, the level of concern varied from state to state. Many cities viewed the WIPP bypasses as an opportunity for development but expressed concern about the stability of the development that would occur.

Experiences with relief routes in Texas cities have varied, according to TxDOT engineers. Some cities have become specialty retail centers, with most of these concentrating on antiques; Bastrop and Navasota are two towns cited as examples of this trend. Some towns, such as La Grange, have maintained the character of their historic downtown. Some towns, such as Honey Grove, Dodge City, and Whindam in Fannin County, seem to have experienced economic decline as a result of the relief route. In some cases, so much development has occurred around the relief route that it no longer functions as intended, and a second relief route may be needed. In Tyler, for example, development encroached on the loop built in 1958, and a new loop is under construction. The relief route in Stephenville was built too close to the city and has become a “city street.” In contrast, the relief route around La Grange exhibits very little development. The conflicting experiences may be the result of different design standards and facility placement.

2.1.3 Community Concerns Identified in Other Studies

Studies in other states also provide insights into the concerns of small- and medium-size communities both before and after the construction of a highway relief route, although conditions in Texas may be somewhat different.

A study performed by the Wisconsin Department of Transportation (Ref 2) used a case study format to examine the concerns and experiences of six communities. Nonmetropolitan

communities were concerned that a loss of traffic through town would negatively impact downtown businesses. Several towns did see declines in the vitality of central business districts. Most civic and business leaders, however, felt that the downtown decline was caused by regional shopping centers, not by the relief route. In Mt. Horeb, a town reliant on tourism, one interviewee felt the "quality" of customers had increased, since customers exiting the relief route and traveling through town were more likely to make major purchases. Several towns experienced a brief decline in through traffic followed by a return to prebypass levels. Improved safety is frequently used as a justification for relief routes, but several Wisconsin communities felt that safety was reduced. The reduction was attributed to poor interchange or intersection design.

The Iowa Department of Transportation conducted a study in 1987, revised in 1992 (Ref 3), of local experiences with highway relief routes. In general, large towns suffered less than small towns, and highway-related businesses suffered more than other sectors. Sales to through travelers before the construction of the relief route were lower than commonly assumed, and although the Iowa communities were concerned about a loss of through traffic, many people felt that the business districts were more attractive following completion of the relief route. Overall, most interviewees felt that the impacts of relief routes had been positive or inconsequential.

In an Iowa and Minnesota study (Ref 4), probit models were calibrated using data from a survey to explain factors that influenced a person's decision to favor or oppose a bypass. Similar models were developed for people's perception of the impact of the bypass on the business activity and on the community as a whole. These models generated a variety of interesting findings. In general, business owners felt that the central business district was a more attractive environment than that along the relief route, and most favored the relief route following its construction. Established merchants, those with a longer tenure in the community, were generally less concerned about the impacts. But the farther the relief route from the central business district of the town, the greater the concern over the impacts on the town.

2.2 TXDOT CONCERNS

The concerns of the communities reflect local goals and priorities regarding the construction of a relief route; TxDOT is required to take a wider view and consider local as well as regional and state-level concerns. During the interviews, TxDOT engineers were also asked what concerns or issues they address when planning a new route. By far the most common

response was statewide mobility. Many of the proposed bypasses are a part of the Texas Trunk System, which has a primary mission of improving statewide mobility by minimizing the need to reduce speeds through towns. The goal of improving mobility for through travelers may place TxDOT at odds with local communities, particularly over the issue of interchanges and access roads. As noted above, local communities often prefer greater access to increase the potential for new development. However, new development along the relief route generates additional traffic that may impede mobility for through travelers. TxDOT engineers also frequently mentioned safety as a concern, particularly for WIPP routes in West Texas.

Complying with the requirements of the National Environmental Protection Act (NEPA) is another important issue for TxDOT engineers. In Cleburne, TxDOT engineers had to address concerns about the impact of the proposed relief route on wetlands. In Dublin, a historic town center prevented widening the highway, forcing engineers to consider alternatives that included a relief route. Other aspects of complying with NEPA include ensuring environmental justice, minimizing residential and commercial displacements, and maintaining community cohesion. In a separate interview, consultants who have worked for TxDOT on several environmental impact statements for proposed relief routes in small towns expressed concern over the lack of rigorous research available for supporting their analyses of potential impacts on environmental qualities like noise, light, visual aesthetics, and community cohesion. Analyzing the cumulative and secondary impacts, as required by NEPA, is especially challenging.

Because of different concerns and priorities, the community may prefer a new route that differs from the one chosen by TxDOT. TxDOT must then work to reconcile the disagreement. As one engineer pointed out, while TxDOT engineers serve a statewide constituency, they also frequently live in these communities and share the concerns of their neighbors.

CHAPTER 3. THEORIES AND METHODOLOGIES

A second starting point for the project was a review of the theories and methodologies described in the literature relating to highway relief routes. This review, like the interviews, helps to identify the variables to be included in the quantitative analysis and the questions to explore in the case studies. In addition, the review highlights the strengths and weaknesses of different research methodologies and thus helps in the development of the methodologies used in later phases of this study. The findings of the empirical research studies will be summarized in Chapter 4.

3.1 THEORIES

A short review of traditional economic theories provides an initial understanding of the ways in which relief routes might impact the economies of small- and medium-size communities.[2] In general, these theories suggest that relief routes might impact local economies in a variety of ways by reducing travel times (and, thus, travel costs) to and through the bypassed towns. Impacts are likely to be seen not just in the bypassed town but also in other communities along the highway, which are now more easily accessed as well.

3.1.1 Central Place Theory

Central place theory describes a hierarchy of central places established over space to serve rural markets. Market size is determined by the order of the product being sold: a low-order product, such as groceries or gasoline, will have a very small market area, while a higher-order product, such as an automobile, necessarily draws from a much larger market area. The implication of this theory, which describes an ideal settlement pattern given a uniform geography, is that the smallest towns will have only the lowest-order businesses, while larger towns will have these and higher-order businesses. Residents of small communities must thus

[2] These theories are described in numerous regional economic textbooks. A particularly good overview of the implications of these theories for rural areas is provided by Marie Howland in "Applying Theory to Practice in Rural Economies," in Richard D. Bingham and Robert Mier, eds., *Theories of Local Economic Development* (Newbury Park: Sage Publications), 1993.

travel to larger communities for higher-order products and to metropolitan areas for the most specialized products and services.

Central place theory suggests that a highway relief route will affect the local economy in several ways. In general, as travel costs decrease, market areas increase: customers can reach more distant destinations in the same amount of time. A highway relief route, which reduces travel costs more for through travelers than for travelers destined for the bypassed community, may expand the service area of adjacent communities more than it expands the service area of the bypassed community. If so, the economies of the adjacent communities may grow at the expense of the economy in the bypassed community, especially if an adjacent community is larger to begin with. Relief routes also reduce the travel time to the nearest metropolitan center and the goods and services found there, increasing the attraction of the metropolitan center to residents of small- and medium-size towns and potentially decreasing patronage of local businesses. On the other hand, if the relief route in other ways brings economic growth (as the following theories suggest) and thus increased numbers of jobs and residents, then growth in the local service sectors is likely to follow. The bypassed town then moves up the hierarchy of central places and provides goods and services of an order higher than before.

3.1.2 Industrial Location Theory

Industrial location theory explains economic growth by focusing on the factors that influence the location choices of individual firms. Every firm has certain needs, whether access to markets, raw material, skilled or unskilled labor, or other resources. Every place has certain attributes it can offer, such as abundant materials, an educated workforce, inexpensive labor, or other assets. Firms will choose locations that offer the attributes that best meet their needs and thus offer the greatest potential for profits. A relief route, by lowering travel times and, consequently, transportation costs, may increase the attractiveness of the community for industrial firms in two ways: by decreasing shipping costs to and from the community and by increasing the labor pool available within a given commute time. Firms for which shipping costs and labor supply are especially important may now be more likely to locate in that community.

3.1.3 Economic Base Theory

Economic base theory differentiates between the concept of basic (or export) and nonbasic (or nonexport, local-serving) employment. The theory hypothesizes that economic growth is stimulated by increases in basic (export) employment and that an increase in basic employment will lead to an increase in nonbasic employment, an impact often called the "multiplier effect." This multiplier effect varies by city size and in general is smaller in smaller communities. In other words, for a given increase in basic employment, the subsequent increase in nonbasic employment will be smaller in smaller communities. If a highway relief route attracts new industry to the community (as industrial location theory suggests, as noted above), then additional job growth can be expected in nonbasic sectors, that is, those sectors that serve the local population. This prediction mirrors one of the predictions from central place theory. If a highway relief route attracts new highway-oriented businesses (e.g., gas stations, truck stops, motels, etc.), these businesses may largely fall into the basic category because they serve mostly travelers rather than local residents and are therefore an important form of "export" for the community. This form of growth in basic employment will also lead to a multiplier effect in nonbasic employment.

3.2 METHODOLOGIES

Researchers have used several different methodologies to assess the impacts of highway relief routes and highway investment. These methodologies range from exclusively qualitative to exclusively quantitative but frequently combine qualitative and quantitative techniques. Researchers do not always draw distinct lines between different methodologies. For example, Parolin and Garner (Ref 5) conducted a before-and-after study for one community and case studies for three communities and compiled them in one report. Many of the major studies incorporate multiple methodologies. The 1992 University of Texas study (Ref 6), for example, incorporates econometric modeling, matched-pair, projected-development, and case study methodologies. Choice of methodology is frequently dictated by time, data, and cost constraints. This section describes the different methodologies, discusses their strengths and weaknesses, and notes some of the studies that use these different methodologies (see Table A.1 in the Appendix for a summary of methodologies used by selected studies).

3.2.1 Before-and-After Approach

The before-and-after approach is a common method used for determining the impacts of specific transportation investments. In such a study, researchers measure an economic variable or set of variables before and after the completion of a transportation facility, with the difference assumed to reflect the impact of the facility in question. Bardwell et al. (Ref 7), for example, used a before-and-after methodology to examine the impacts of limited access facilities on communities, land use, and land values, using sales tax data by sector and land prices to determine the effects of a facility. The before-and-after approach has been used in numerous studies, although there are major drawbacks to this method. The central problem is that these studies do not control for a change of exogenous factors that may influence outcomes during the study period. Hence, one cannot be certain whether the changes identified after construction are due to the bypass or due to other factors. For example, does the before-and-after study control for growth that would occur with or without the new route? Does the study consider the possibility that knowledge of the facility prior to the actual construction might influence land values or other behavior beforehand? Generally, a simple before-and-after study accounts for neither the factors other than the facility that might influence the local economy nor the possible variations in the timing of the impacts.

A study of the economic impacts of highway bypasses on rural South Carolina cities and towns (Ref 8) is one of the early applications of this method for analyzing bypass impacts. Sales data, property values, and bank deposits were analyzed before and after the construction of the bypass. An economic impact study of Interstate 40 (Ref 9) examined traffic, sales, and employment data before and after the bypass to determine the impact of the bypass on the communities along the corridor. A classic example of a recent before-and-after study is one undertaken in Yass, Australia (Ref 5). Businesses were surveyed months before the bypass, a few weeks after the opening of the bypass, and for a third time about 6 months after the opening of the bypass.

These surveys were used to quantify the impacts in terms of changes in gross annual sales, employment levels, changes in business operations, and closures resulting from the bypass. Survey data obtained from the motorists who stopped and stayed in town were used to quantify the dollar value of the highway-generated trade. Pre- and post-bypass license plate surveys helped to identify changes in traffic patterns.

3.2.2 Case Study Approach

The case study approach, as used to measure impacts of highway projects, examines a small group of representative communities. Although it may be difficult to generalize the results of case studies of other communities, case studies allow for a richer and more comprehensive identification of issues and their interrelationships. Qualitative as well as quantitative evidence can be weighed, multiple perspectives can be evaluated and compared, and research questions can be more clearly specified through discussions with key informants. The information gained from case study research can aid in the construction of more useful and valid econometric models (discussed below) by reducing the risk of specification bias resulting from omitted or poorly specified explanatory variables. A thoughtful and rigorous research design can ensure the validity and usefulness of the case studies.

Prior case studies have not followed a standard methodology. Some case studies, such as those undertaken by Otto and Anderson (Ref 4), focus almost exclusively on quantitative economic data, while other studies, such as the Wisconsin study (Ref 2), examine the perceived impacts of a project. Other studies, including a 1998 study by Yeh (Ref 10), integrate the two approaches. A qualitative approach can use a standardized methodology in which the same factors are examined in each case study, or researchers may approach each case study in a unique fashion. A 1987 study by the Iowa Department of Transportation (Ref 3) represents an example of the latter format. In another permutation of case study methodology, the researcher selects several cities along a route and studies the impacts of a relief route on the communities in question. Parolin and Garner (Ref 5) used this method to study the impacts of relief routes on four communities in New South Wales. The 1992 University of Texas project (Ref 11) studied six small cities that were bypassed. Records of the cities' history and economic profile were reviewed, numbers and spatial location of highway-oriented businesses were obtained from telephone directories, and local business people were interviewed regarding the desirability of the bypass and its effects on business, land use, and downtown improvement measures. The insights gained from this study were used to structure a more general study that used econometric models to analyze the impacts of relief routes.

3.2.3 Econometric Models

Econometric models, employing multiple regression techniques, permit the researcher to isolate the effects of different highway- and non-highway-related variables on a variety of economic variables. The economic variables investigated are the dependent variables in the model, which are explained by a set of independent variables. Independent, or explanatory, variables include any number of factors, such as distance to a metropolitan area or population of the bypassed community that might influence economic impacts. In contrast to simple before-and-after studies, multiple-regression econometric models offer the advantage of analyzing the effects of a highway relief route on the dependent variables while accounting for other factors that may also influence the dependent variable.

Econometric models fall into two major categories: cross-sectional and time-series. Cross-sectional models examine several areas for a single time period. Time-series models examine a single area across several points in time. Several researchers, relying on "panel" data sets, have developed time-series cross-sectional models that examine several areas across several points in time. Econometric models can be employed to study both long- and short-term impacts and impacts at different levels of geographic aggregation, usually local, regional, or state level.

Econometric models are powerful explanatory tools, but they have several shortcomings. They require extensive databases that are expensive to compile in terms of time and money. If the results of the model are not reported with proper perspective, they may oversimplify issues related to development and give undue authority to a particular explanation. Econometric models, regardless of quality, possess a certain authority accorded to quantitative studies but might actually misrepresent reality. As is true of all methodologies, econometric models cannot identify every factor that affects the economy, although they usually help to identify the primary factors. Some of the important factors may be qualitative in nature, however, and unless proxies can be found to represent them, these factors will be omitted from the model, leading to misspecification and potentially biased estimates of the effects of the independent variables.

In addition, the equations of econometric models reflect associations among variables but not necessarily causality. In other words, they suggest that the explanatory factors and the economic impacts are related but do not prove that the explanatory factors actually cause the economic impacts. The direction of the relationship between economic impacts and transportation investments is especially difficult to resolve. Does economic development spur

transportation investment or vice versa? Most transportation investments occur in existing transportation corridors. Investment may be allocated to growing corridors, in which case it may be more accurate to say that the growth caused the investment rather than the other way around. Similarly, lack of growth in corridors without new transportation investments may itself explain lack of investment. Several researchers have used time-series models to address causality. However, significant time lags between the initial planning of a project and completion — as long as 10 to 20 years or more for major investments — complicate the analysis, as development may occur in the interim period in anticipation of project completion.

Examples of the use of this approach include work done by Lombard et al. (Ref 12) that used a cross-sectional multiple regression analysis to model the impact of highway infrastructure on economic development in Indiana. The work done by Buffington and Burke (Ref 13) discusses the use of regression models using (a) cross-sectional data, and (b) combined, or "pooled," cross-sectional and time-series data to study the economic impacts of bypasses, loops, and radials. The study analyzed sixty-seven highway improvements (forty bypasses, twenty loops, and seven radials). The numbers of manufacturing employees in the city, the total number of employees in the county, and the total wages at the county level were chosen as the indicators of economic impacts. Models were developed for each of the three indicators using both the cross-sectional and the pooled data. The study demonstrated that the pooled model was better than the 1-year cross-sectional data model and concluded that it could be reasonably inferred that the majority of the effects were due to the highway improvement.

Other researchers have taken a similar approach but with interesting variations. A comprehensive study of the impacts of bypasses undertaken in Kansas (Ref 14) examined the long- and short-term impacts at both the county and city levels. Businesses were categorized as highway-related and non-highway-related and were analyzed separately using econometric models for pooled cross-sectional and time-series data. Employment levels, sales, and number of startups and failures were used as indicators of economic activity. Estimates of local and through traffic used as explanatory variables were obtained from a specially calibrated gravity model. The impacts of several factors that affect the economy were, however, studied separately using different regression models.

A study by Stephanedes and Eagle (Ref 15) examined the link between highway investment and economic development measured in terms of employment levels and focused on

determining whether highway investments follow economic development or economic developments follow highway investments. The direction of causality was tested using econometric tools like vector autoregressive models, structural plots, and Granger-Sims-type causality tests. As the regional and national trends were largely filtered out, the impacts could be largely attributed to the explanatory variables used in the study.

The research undertaken at The University of Texas at Austin in 1992 (Ref 11) employed multiple regression analysis to study the impact of highway bypasses on total retail sales and sales in highway-oriented businesses. The database was developed for a sample of twenty-three bypass cities and twenty-three "control" cities, selected to match the bypass cities in terms of such characteristics as highway district, proximity to larger city, population, and economic characteristics (a methodology described in more detail below). An analysis of general trends for bypass and control cities was followed by statistical testing of the differences between matched pairs of bypass and control cities. Multiple regression models were then developed to analyze the relationships between the selected dependent variables and potential explanatory variables representing economic, geographic, and traffic-related characteristics. A cluster analysis uncovered important regional effects in the database, and the inclusion of regional cluster variables in the models improved their specification. The predictive accuracy of the models was then tested using cities outside the original model: The average percentage error was found to be only 23 percent, a result the researchers concluded confirmed the usefulness of the models as a predictive tool.

3.2.4 Projected Development Models

Projected development models examine existing development that occurred after the construction of a highway facility and compare it to hypothetical conditions that would have prevailed if the facility had not been built. Projected development models are not commonly used, but Holhouser (Ref 16) describes the methodology in detail in his study of two bypasses in Kentucky. In this method, the trends from before the bypass are projected to the future, assuming those trends continue. The actual situation after the highway investment is compared to the projected trend. The differences are attributed to the investment. A potential advantage of this method is that it tries to control for factors other than the bypass that influence development. However, this method requires substantial time-series data to establish trends satisfactorily, and

its accuracy depends on the validity of the assumption that prebypass trends would have continued without the construction of the bypass.

Anderson et al. (Ref 11) employed this method as a part of their study of highway bypasses in Texas. For each bypassed city, a projection of the retail sales was made on previously established trends. The observed trends were compared to the projected trends, and cities were classified into those that had higher-than-expected sales and those that had lower-than-projected sales.

3.2.5 Matched-Pairs and Survey-Control Studies

Matched-pairs, or "twin studies," is another method used to predict transportation impacts. "Twin studies" in transportation are similar to the practice of observing biological twins to predict the impacts of the environment versus genetics. In bypass studies, researchers select two similar cities matched demographically, geographically, and economically at a point prior to construction of the bypass, except that one community has a bypass and one does not. Any other differences may be attributable to the bypass. A closely related approach, used more widely for highway impact studies, is the survey-control method. In this method, a bypassed community is compared to a set of similar control cities, but the cities are not matched one-to-one. The matched-pairs method does not necessitate the massive data sets required by other methodologies and, therefore, reduces expenses and increases accuracy (Ref 17). However, finding suitable control cities may prove impossible, especially for studies of bypasses around larger communities, most of which already have a bypass. As a result, the survey-control method is somewhat easier in practice.

A matched-pairs analysis was used in the Iowa and Minnesota studies (Ref 4) to examine the changes in retail-pull factors associated with bypass construction. The pull factor was defined as the ratio of the sales per capita in the city to the sales per capita in all comparable cities. The pull factors for the bypassed and the control cities were compared as a measure of impact. The University of Texas study (Refs 6, 11) also used the matched-pairs approach to analyze the impacts of highway bypasses in small towns in Texas, as noted above. In a study of seventeen Wisconsin communities using the survey-control method (Ref 10), communities were divided into three categories and control groups were developed for each category. Holhouser (Ref 16) employed the survey-control method to study the impact of two Kentucky bypasses on the real

estate values; but instead of comparing areas defined by jurisdiction, he compared areas on the bypass to areas not on the bypass within the communities studied.

3.2.6 Input-Output Models

Input-output models predict the economic activity across the economy created by a measured amount of activity in a specific industry and can be used to generate employment and income multipliers. Multipliers can be developed for specific industries at the national level and at the regional level; while regional multipliers are usually preferable, they are also generally less accurate than national multipliers. In the case of highway investment, multipliers can be used to estimate the total impact on the economy in terms of employment or income of the highway investment. The total economic impact includes not only the direct effect of the highway investments but also indirect effects generated by linkages between industries within the regional economy and the induced effects generated by increases in household spending.

Several different input-output models are now available commercially. IMPLAN is a commonly used model, but its multipliers are generally not as accurate as those of some of the other models. Beemiller (Ref 18) describes the use of the RIMS II model in a "hybrid approach" to estimating economic impacts. The REMI model (developed and licensed by Regional Economic Modeling, Inc.) is being used in a growing number of U.S. studies on the impacts of highway and other transportation investments on local, regional, state, and national economies; most of these studies have been conducted as a part of larger project-impact analyses. As Forkenbrock (Ref 19) notes, input-output models may reflect improved competitiveness relative to other areas in the country, rather than economic development.

3.3 REPRESENTATION OF ECONOMIC IMPACTS

Choosing appropriate variables to represent economic impact is another critical element in the development of the research methodology. Studies of the economic impacts of highway relief routes have used a variety of variables to represent these impacts, depending partly on the purpose of the study and on data availability. Several important issues need to be considered in defining economic impacts and in selecting appropriate variables.

The economic impacts of highway facilities can be divided into two basic classes: user and nonuser benefits. Primary, or user, benefits consist of travel-time savings through congestion

relief, reduced operating costs owing to better gas mileage, and improved safety through design improvements. User benefits attributable to the new route include benefits to users of both the new route and the old route, who derive travel-time savings from the diversion of through traffic to the new route. Secondary, or nonuser, benefits, such as employment changes, increased wages, increased land values, and population increases, are also commonly associated with highway improvements and are derived from user benefits. The distinction between user and nonuser benefits may not always be clear, however, and different researchers have categorized benefits in different ways. Some researchers argue that all benefits are actually user benefits, while others argue that only user benefits should be considered.

An important issue regarding secondary benefits is whether they are "generative" or "redistributive" (Ref 20). Redistributive benefits are benefits that occur at the expense of another region. If a distribution facility relocates from community A to community B as a result of a transportation improvement in community B, the benefits are considered redistributive. Generative benefits are benefits created directly from the highway. For example, if there is a manufacturer located in community B and it is able to lower its costs as a result of reduced transport time, it will be able to lower the price of its product. Demand for the product will consequently increase, forcing the manufacturer to hire more employees. The increase in employees would be considered generative growth.

The distinction between generative and distributive growth is an important one. At the local level any growth is viewed as beneficial and can be used as a justification for the project. Redistributive growth becomes an issue at the state and national levels, though, where gains for one area are balanced by losses in other areas. Forkenbrock (Ref 21) discusses this issue in the context of investment efficiency and argues that in addition to determining whether the project will generate travel-time savings that exceed the cost of the project, analysts should not calculate growth resulting from relocation from other regions in the state or nation as an economic benefit of the project. However, differentiating between redistributive and generative growth may be difficult in practice.

Most commonly, user benefits are represented in studies of the economic impacts of highway relief routes by travel-time savings, other transportation cost savings (such as fuel), and accident rates (see Table 3.1 and Table A.2 in the Appendix). Nonuser benefits have been represented by a wide range of variables, including changes in employment by sector, sales by

sector, wages, land values, per capita income, and population. Sales, examined in aggregate or measured by sector, may be the most common variable used. Because bypasses are thought to impact primarily businesses relying on through traffic, the most frequently examined category is highway-related businesses, such as gas or service stations, hotels/motels, and restaurants. Other sectors, such as general retail, automobile sales, furniture sales, and apparel sales, are also frequently investigated. In terms of economic development indicators, using changes in per capita income may be clearer than using changes in jobs. Population is also frequently used to measure project impact, although a population increase may reflect negatively or positively on economic growth. For example, a large increase in population in areas adjacent to metropolitan regions may reflect increased commuting rather than an increase in the economic base of the study area. Property values and land development can also be used as indicators of the impact of transportation projects, although transportation investments affect different land uses in distinct ways, depending on the location and type of facility in question.

Table 3.1 DEPENDENT VARIABLES

USER BENEFITS
Travel-time savings
Travel-cost savings
Decreases in accidents
NON-USER BENEFITS
Employment
Sales
Wages
Income
Land values or development
Population

3.4 REPRESENTION OF CAUSAL FACTORS

The choice of independent variables to represent the factors that contribute to economic growth or decline in a community is another essential step in the development of the research methodology. Although the construction and design of the relief route are the factors of interest, other factors must also be included to isolate the economic impacts attributable to the relief route. Several factors that may contribute to decline or growth have been identified in previous studies. For example, in a study of rural interchanges on Interstate 40, Hartgen (Ref 22) identified six factors that affect growth in the interchange area:

- the average daily traffic (ADT) count of the highway in question,
- the ADT on the intersecting road,
- the location and population of communities within 10 miles of the interchange,
- the distance to the nearest major urban center,
- the amount of development prior to interchange construction, and
- the distance to the next interchange.

An exhaustive list of independent variables is not practical — some studies used in excess of ninety explanatory variables — but commonly used variables include those listed in Table 3.2.

Table 3.2 SELECTED INDEPENDENT VARIABLES

Year of completion
Length of the new route
Length of the old route
Access type: controlled versus uncontrolled
Distance of route from the city or regional center
Distance of city from nearest metro area
Dollars of transportation investment
Income of region
Tax rates
Population of study area

CHAPTER 4. IMPACTS OF TRANSPORTATION INVESTMENTS

Numerous studies over several decades have examined the impact of highway relief routes on rural communities. In 1996, the National Cooperative Highway Research Program (NCHRP) summarized this body of research (Ref 23). The purpose of the NCHRP synthesis project was to review the state of knowledge about the impacts of highway bypasses on rural communities and small urban areas and about current practices in using that knowledge to plan for bypass development. In all, the report reviewed 190 publications, although most of these had appeared more than 10 years before the synthesis was conducted. The report concludes that there is no clear consensus on appropriate methodologies for bypass studies, the impacts on businesses along the older bypassed routes seem to be limited, and, for the most part, bypasses appear to have a favorable impact on rural communities, although the evidence is weak.

A look at the findings of some of the key studies sheds more light on the range and extent of impacts of highway relief routes on congestion, safety, industrial location, employment, sales, wages, land value and development, and population. While the seemingly contradictory findings among these studies are sometimes explained by differences in methodologies, they also point to actual variations in impacts that depend on both time and place. Perhaps more than anything else, these studies highlight the complexity of the relationships between highway investments and local economies and the challenges researchers face in attempting to isolate the effects of highway investments.

4.1 CONGESTION

Relief routes are frequently built to relieve congestion on local streets or to provide through traffic with an alternative facility that avoids congested areas of town. Reduced congestion generates economic impacts by reducing travel times and thus operating costs; reduced operating costs may be passed on to consumers through lower prices. Over time, however, the improved access provided by the relief route may encourage new development that generates new traffic that offsets at least some of the initial reduction in congestion (Ref 13).

The evidence on congestion impacts is mixed. Some studies show a significant decrease in transportation costs. Orus (Ref 24), for example, found an appreciable decrease in transportation costs resulting from highway improvements owing to improved fuel consumption

and travel-time savings. In a study of twenty-one bypassed communities in Kansas, Burress (Ref 14) found an average of $1 million (1994 dollars) in travel-time savings attributable to each bypass. Other studies, however, have found little reduction in traffic on the original route after the construction of the relief route. A study of the Okehampton Bypass in England (Ref 25), for example, found that the bypass failed to attract heavy vehicles and that traffic volumes through the town center were higher than predicted. A study of Wisconsin communities (Ref 10) revealed that, despite an initial drop in traffic volume on the original route, traffic volumes returned to prebypass levels over the long term. One explanation for these seemingly inconsistent results is that the time and cost savings accrue primarily to the users of the new route rather than the old route. In addition, the fact that traffic volumes on the old route do not always decline with the construction of the relief route is good news for businesses along the old route, even if congestion does not decline.

4.2 SAFETY

Any safety improvements resulting from investments in highways or the construction of relief routes generate a positive economic impact by reducing the costs of personal injury and vehicular damage. But while safety enhancements are frequently cited as benefits of and justification for highway investments, several studies suggest that relief routes do not always improve safety. Otto and Anderson (Ref 4), for example, investigated the perceptions of Iowa and Minnesota business owners and found that most believed bypass construction had increased safety, but an investigation of official statistics revealed a slight increase in accidents (although the severity of accidents was not reported and could not be analyzed). A series of case studies in Wisconsin cities (Ref 2) revealed that in at least one instance safety had been negatively impacted by the construction of a bypass. A possible explanation for the lack of improvements in safety is that relief routes often increase travel speeds, potentially leading to more severe accidents. In a study in Great Britain (Ref 26), for example, a significant portion of residents in the communities surveyed felt traffic speeds had increased to problematic levels. Although the impacts of relief routes on safety merit further study, the available evidence suggests that improvements in safety are not a given for relief route projects.

4.3 INDUSTRIAL LOCATION

Highway expenditures generally and relief route construction specifically are thought to attract industry by reducing transportation costs. If a firm locates to maximize profits, as hypothesized by industrial location theory, it will choose a location that minimizes costs, including transportation costs. A number of studies have explored the importance of highway access in decisions about industrial location. In a 1987 business survey (Ref 27), wholesale, retail, and manufacturing employers cited existing water, sewer, and roads as the number one factor in their location decisions, followed closely by access to domestic markets. Although this survey was limited to large corporations rating major metropolitan areas, it illustrates the range of factors influencing industrial location. A study by Bowersox (Ref 28) on factors influencing site selection suggested that highway access was an important but not critical factor in the location decision. In a survey of 1,000 North Carolina manufacturers, Hartgen (Ref 29) found highway infrastructure to be a "nonprimary" factor in their location decisions. Together these studies suggest that highway access may be a necessary but not sufficient factor in decisions about industrial location: new or improved highway facilities may or may not attract new industry, but inadequate facilities are likely to discourage new industry.

4.4 EMPLOYMENT

If highway investments influence location choices of industry or other businesses, the impact should be observable as an increase in local employment. Several studies have tested this link, although many of them have focused on investments in the interstate system, rather than on bypasses per se, and on county- rather than city-level impacts. Investments are represented in a variety of ways: the presence or absence of a facility, dollars of investment, or facility mileage. Some studies, because they do not account for national or state trends in employment, call into question the validity of their results. As the findings for industrial location would suggest, the results for employment have been mixed.

Many studies — though not all — have found some increase in employment associated with highway investments. For example, a study of the impact of interstate investments on nonurban areas in Pennsylvania (Ref 30) found employment growth in counties with nonurban interchanges. Yeh (Ref 10), on the other hand, found that employment growth continued along the same trend after the construction of a bypass as before, suggesting no connection between

highway investments and employment levels. In another study of the impact of bypasses, Burress (Ref 14) found no appreciable impact on employment and concluded that, while bypasses did not have a positive impact on employment, neither did they have a catastrophic effect on Kansas towns.

Several other studies attributed growth in nonmanufacturing employment to the highway investment but concluded that manufacturing growth was not a result of highway expenditures. For example, in a study of loop, radial, and bypass highways, Buffington and Burke (Ref 13) found that communities served by relief routes experienced statistically significant employment growth, but that manufacturing employment was not affected by the construction of a relief route. A study that examined the impact of interstate investments on employment in nonmetropolitan areas (Ref 31) did not find an associated change in manufacturing or wholesale employment. Another study of the impacts of interstate investments (Ref 32) found significant impacts on employment in the nonlocal service industry. A statewide examination of employment change resulting from transportation investment (Ref 33) found that all sectors of the economy, save manufacturing, experienced an increase in employment, although the increase differed from district to district. An examination of the Interstate 40 corridor (Ref 34) showed employment to be substantially higher in corridor counties but manufacturing employment growth to be only slightly higher than the state average. An investigation of the impacts of highway spending and economic development in Indiana (Ref 12) found a positive impact on employment. However, while this study found a significant relationship between highway mileage and service sector employment, it did *not* find a relationship between manufacturing employment growth and highway mileage. Another study (Ref 15) found strong evidence to suggest a positive relationship between highway expenditures and employment increases in the wholesale sector.

Other studies point to differential impacts from one area to another. One study (Ref 24), for example, found a relationship between employment and highway mileage but determined that the employment was concentrated around service centers and was not evenly distributed. Stephanedes and Eagle (Ref 15) observed an increase in employment associated with highway investments in counties containing a “regional center,” and found that while jobs may move from nonregional centers to regional centers as a result of highway investments, commuters often remain in the nonregional centers. This study thus points to the redistributive effects of highway investments, but suggests that they may be somewhat moderated if population does not also

move. Conversely, Briggs (Ref 31) found that employment growth was related to the interstate system even when then analysis controlled for population and proximity to metropolitan areas.

A few studies have found a relationship between highway investment and manufacturing employment, at least under the right conditions. Singletary et al. (Ref 35) assert that "the location, timing and type of highway project investment influences its impact on manufacturing job creation. The consistent role of agglomeration forces, as approximated with employment density, suggests that increased highway investment in regions with above average employment levels would stimulate continued industry and business development." Zografos (Ref 36), however, found that while manufacturing employment increased in counties with major highway corridors, it decreased in counties without major highway corridors, again pointing to redistributive rather than generative effects. These studies, together with those noted above, suggest that small- and medium-size communities in particular should not expect an increase in manufacturing employment as a probable result of a highway relief route. They should, however, be prepared for the possibility that manufacturing employment will relocate to communities where transportation investments are being made.

4.5 SALES

Another way in which the economic impacts of highway investments are measured is through their impact on sales. Overall sales are expected to increase with highway investments, because new and improved highway facilities will bring more traffic to, through, or by the community and will thus increase the potential customer base for at least certain types of businesses. On the other hand, highway investments may lead to a shift in sales to businesses along the new or improved facility and a decline in sales elsewhere in the community. Most studies focus on the former impact, rather than on the latter, at least partly because of the lack of detailed data on retail sales by location. Sales are typically measured by receipts or taxes paid and are commonly broken down according to Standard Industrial Classification (SIC) codes.

Again, the results from the available studies are mixed. In a study of Kansas bypasses (Ref 14), no significant changes were found in taxable sales figures before and after the bypass. A study of rural bypasses in Minnesota and Iowa (Ref 4) found no impact on overall sales attributable to the construction of a relief route, and, while there were observable impacts in individual sectors, they were not statistically significant. A study of the effects of limited-access

highways on various retail sectors (Ref 7) showed that overall sales were unaffected but sales in the automotive group suffered. An examination of retail sales in the Interstate 40 corridor (Ref 34) revealed interesting variations in the impacts on sales: rural counties experienced a decline, while urban counties experienced an increase. This study, however, did not adequately account for national and regional trends that might explain some of the observed redistributive effect between rural and urban areas. Another study suggests that the impacts may vary over time: Whitehurst (Ref 8) found that sales figures dropped briefly following construction but expanded several years after.

Just a handful of studies shed light on the possibility that sales will shift from the old route to the highway relief route. In a study of the impact of relief routes on community businesses, Clay (Ref 34) found that sales adjacent to the new route increased but away from the facility sales decreased, and that as distance from the new route increased, the decline in sales grew more pronounced. This study supports the hypothesis of redistributive effects within the community. On the other hand, a study of bypassed communities in Wisconsin (Ref 10) did not find evidence of a retail flight. In fact, many bypasses did not have the requisite traffic counts to support development. The degree to which the relief route shifts retail activity from existing areas to the area surrounding the new route thus seems to depend on relative levels of traffic between the old and new facilities.

The 1992 University of Texas study (Ref 11) offers one of the most comprehensive analyses of the link between highway relief routes and retail sales. First, an analysis of matched-pairs communities in Texas revealed a significant impact on total sales owing to relief routes, but the impact was insignificant when assessed at the sector level. Second, a projected sales model used in the same study led the authors to conclude "that retail sales in fast-growing cities with inadequate infrastructure and with a high proportion of local traffic may be boosted by highway bypass construction." Third, econometric models indicated that overall gas station and restaurant sales decreased as traffic moved from the central business district route to the relief route — counter to general expectations. The study also found that the impact on general service receipts depended on type of access; in particular the study found that limited-access facilities reduced sales. In addition, the analysis suggested that a greater distance between the new route and the old route tends to reduce sales. Although highway relief routes were found to have statistically

significant impacts on sales, the impacts were limited; the researchers concluded that other non-highway-related variables had greater explanatory power.

4.6 WAGES

If a relief route improves the accessibility of a region, it may improve the productivity of the region, an effect that may then be passed on to workers in the form of increased wages. Although impacts on wages have not been studied to the same extent as other kinds of economic impacts, several studies have looked for a link between highway investments and wages, again with mixed results.

In the I-40 study (Ref 34), researchers compared counties in the corridor to the state average and found that the state average was slightly higher than the corridor average; tests for statistical significance were not performed, however. In a study of highway investments and economic development in Indiana, researchers found a relationship between wage increases and highway mileage, although they measured wage increases in terms of total wages rather than wages per job or per capita. Buffington and Burke (Ref 13) found a significant relationship between real wages and the construction of highway bypasses, but Burress (Ref 14) investigated the long-term impacts of bypasses on wages and did not find a statistically significant relationship. The impact of highway investments on wages may be too indirect to isolate in these studies.

4.7 LAND VALUE AND DEVELOPMENT

Economic development planners frequently point to increasing land values as evidence of the economic impact of transportation investments. According to classical theory (as described in Chapter 3), the more accessible a piece of property becomes — through transportation investments, for example — the more valuable it should be. On the other hand, new transportation investments provide access to more property within a community, thus increasing the supply of developable land. If the supply increases without a concurrent increase in demand, land values may decrease (Ref 37). Even for land immediately adjacent to the facility, the impact may be either an increase in value, owing to an increase in accessibility, or a decrease in value, owing to the negative effects of proximity to a transportation facility (noise, for example). Thus, the impacts on land values are likely to vary by land use type: commercial land, which depends

on accessibility, may increase in value, while residential land, which is sensitive to such effects as noise, may decrease in value. Numerous studies have found a link between highway investments and land values, but many of them also show that the impacts differ by type of facility and type of land use.

The overall impact on land values generally seems to be positive. For example, in a study of the impacts of controlled access highways on land values in Colorado, Bardwell (Ref 7) found almost all classes of land increased in value following construction. Other studies point to important variations, however. Holhouser (Ref 16) examined the impacts of two highway bypasses — one a controlled-access and one an uncontrolled-access facility — on land values. Land adjacent to the uncontrolled access facility increased more than land adjacent to facility with controlled access, but the controlled access facility affected land values at a greater distance. In addition, commercial and industrial land uses were impacted more than residential facilities. A series of case studies of Wisconsin bypasses showed that while land values may increase near the bypass, they may decrease in the central business district (Ref 2), suggesting redistributive rather than generative effects. On the other hand, Whitehurst (Ref 8) examined the impacts of facilities on downtown rental rates and found that after an initial drop, rates approached or exceeded initial rates. Burkhardt (Ref 38) studied the effects of highways on housing values and rents, among other variables, in major metropolitan areas and found that the results were often site-specific; some cities experienced declines while others displayed growth. In general, the effects of the bypass seem to be positive in growing cities and negative in declining cities or even cities growing at a below-average rate.

Other studies show that proximity to the highway can reduce land values. For example, Zeiss (Ref 39) examined the effect of noxious facilities on property values and found that highways generated several objectionable impacts leading to a decline in property values; the decline in property values was most apparent during “shock periods” occurring at the outset of a project. Gamble (Ref 40) found that accessibility benefits outweighed the negative impacts of noise and air pollution, but the highest property values were not directly abutting the highway: nonabutting properties enjoyed the benefits of improved accessibility but did not suffer the negative environmental impacts of being directly adjacent to the highway.

Hartgen (Ref 22) posits that development at interchanges occurs in stages. Depending on the presence of water and sewer, proximity to the nearest community, and traffic, the interchange

can develop to accommodate a heavy or light tourist market, compete with businesses in town, or become integrated into the town. Interchanges located close to towns were the most likely to experience growth. Hartgen found the presence of water and sewer, daily traffic volumes, visibility, and the grading of land to be the most critical predictors of growth. Given the presence of these factors, development will occur, with the intensity of development reflecting how adequately the interchange meets the preceding criteria. This study thus repeats an earlier theme: Highway investments alone do not guarantee development and other economic impacts.

4.8 POPULATION

In addition to generating direct impacts on a local economy through impacts on employment, wages, and sales, among other things, highway investments may also influence population growth. At first glance, population and employment seem intertwined, but numerous studies have shown that employment can increase without a subsequent population increase and vice versa. A relief route improves accessibility to and from adjacent areas and may thus enable a greater separation between where jobs are located and where employees live. When a highway relief route is built in a particular community, the result may be an increase in jobs in that community or an increase in commuting from that community to others or some combination of both. In either case, an increase in population may result, either to fill the new jobs within that community or to commute to new jobs elsewhere. This increase in population itself brings economic growth as demand for retail and services increases.

Not surprisingly, the empirical results are inconclusive. Broder (Ref 41), for example, found highways built in Appalachia with the express purpose of promoting economic development to have mixed results on population growth. In contrast, in a study of the effect of the interstate system on population growth, Briggs (Ref 31) found that interstate counties experienced higher growth rates than noninterstate counties. Everly (Ref 30) found a strong association between population growth and the presence of nonurban interchanges. A study of the Interstate 40 corridor in North Carolina (Ref 34) found that corridor counties grew faster than noncorridor counties; however, two corridor counties grew substantially faster than the others, and, without their inclusion, state and corridor growth rates were similar. Lichter (Ref 32) also found counties with interstate highways to have higher population growth but listed several caveats. First, interstate counties had a higher initial population and were located on existing

transportation corridors. Second, interstates were built in counties experiencing higher-than-average growth prior to implementation of the interstate highway system. These caveats raise an interesting question about causality: Do highway investments lead to growth or does growth lead to highway investments?

CHAPTER 5. SUMMARY AND CONCLUSIONS

The initial phase of research summarized in this report — interviews with local officials and TxDOT engineers as to their concerns about highway relief routes and a review of the literature on highway relief routes with respect to theory, methodologies, and findings — provides important guidance for the research efforts that will follow. This initial phase of research also points to the complexity of the relationships between highway investments and economic growth and to the challenges researchers face in identifying and understanding these relationships.

Communities express a variety of hopes and concerns over proposed highway relief routes. On one hand, communities see the potential reduction of traffic through town as an important benefit of the new route. On the other hand, business owners as well as residents often fear that this same reduction in through traffic will mean a loss of customers for existing businesses and the decline of the traditional business center. Then again, some may see the new route as an opportunity for increasing overall development and, thus, tax revenues for the community. Owners of existing businesses, however, may see competition from this new development as an additional threat to their viability. Which of these views dominates public sentiment varies from community to community, and within any given community all of these views are likely to be heard.

Community leaders and residents often express specific concerns about the planning and design of highway relief routes, particularly about the location of the route relative to the town center and whether the relief route is built as a controlled- or an uncontrolled-access facility. Those who hope that the new route will generate new development generally push for uncontrolled access and proximity to town; those who hope to preserve the traditional town center may push for controlled access and greater distance from town. Some community representatives recognize the importance of coordination between the planning and design of the relief route, other kinds of infrastructure planning, and land use ordinances to shape the impacts of the relief route on development within the community.

These findings suggest three major categories of impacts to explore and evaluate in the research phases that follow:

- improvements to quality of life in the existing community resulting from a decline in traffic through town,
- declines in existing businesses in the town center resulting from a decline in traffic through town or from increased competition from new businesses along the relief route, and
- overall changes in economic activity in the community resulting from new development generated by the relief route.

The findings also suggest that because communities assume that the role of location relative to the town center and the type of access on the new route determine what impacts will occur, these characteristics need to be tested as to their relative importance in explaining the impacts of relief routes. Other explanatory factors will also need to be tested, of course, including local policies as well as larger economic forces.

Rather than pointing to one appropriate methodology, prior studies on the economic impacts of relief routes suggest that the most conclusive and ultimately useful results can be achieved through a combination of methods, lending support to the methodology proposed for this research. One approach will involve the development of econometric models to test the relative impact of a variety of potential explanatory variables on the economies of communities in Texas in which relief routes have been built in recent decades. These models will include data from before and after the construction of the relief routes, as well as data for a set of "control" communities in which relief routes have not been constructed. Another approach is to conduct case studies of selected communities in Texas in which relief routes have been built in order to explore in more detail impacts that are not easily measured and can, accordingly, not be included in the econometric models. The case studies will focus, for example, on possible improvements in quality of life as well as possible negative effects on the traditional business center that result from the reduction in traffic through town. The methodologies and findings for these two efforts will be described in subsequent research reports.

The review of findings from previous studies presented in Chapter 4 shows that conclusive answers about the economic impacts of highway relief routes and highway investments are more generally difficult to determine. This research is therefore unlikely to succeed in resolving all the questions raised by the extensive body of prior research and is

therefore unlikely to provide a basis for predicting impacts for specific communities. Nevertheless, Project 0-1843 should provide a comprehensive picture of the range of possible impacts, the factors that influence those impacts, and the steps that TxDOT and local communities can take to influence those impacts for the better.

REFERENCES

1. Oakes, Ann S. "Citizen Views of Transporting Radioactive Waste in Oregon, Idaho, Colorado, and New Mexico," *Journal of Environmental Systems,* 26:2, 1997–98.

2. *Highway Bypasses: Wisconsin Communities Share Their Experiences.* Wisconsin Department of Transportation, 1988.

3. *A Literature Review of Urban Bypass Studies.* Iowa Department of Transportation — Project Planning, 1992.

4. Otto, Daniel, and Connie Anderson. *The Economic Impact of Rural Bypasses: Iowa and Minnesota Case Studies.* Midwest Transportation Center, Ames, January 1995.

5. Parolin, Bruno, and Barry Garner. *Evaluation of the Economic Impacts of Bypass Roads on Country Towns.* R&D Project TEP/93/6, New South Wales Roads and Traffic Authority, New South Wales, 1996.

6. Helaakoski, Reijo, Hani S. Mahmassani, C. Michael Walton, Mark A. Euritt, Robert Harrison, and S. Johann Anderson. *Economic Effects of Highway Bypasses on Business Activities in Small Cities.* 1247-1, Center for Transportation Research, The University of Texas at Austin, October 1992.

7. Bardwell, George E., and Paul R. Merry. "Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value," *Highway Research Bulletin 268,* Highway Research Board, Washington, D.C., 1960, p 37–73

8. Whitehurst, Clinton H. *The Road Around: A Study of the Economic Impact of Highway By-passes on Rural South Carolina Cities and Towns.* South Carolina State Highway Department, Clemson University, Clemson, SC, April 1965.

9. Blackburn, Sabrina P., and James W. Clay. *Interstate 40 Economic Impact Study: Impacts of Highway Bypasses on Community Business.* TPR 66, North Carolina Division of Community Assistance, UNC Charlotte, November 1991.

10. Yeh, Daniel, Matt Gannon, and Dennis Leongl. *The Economic Impacts of Highway Bypasses on Communities.* SPR-0092-45-93, Wisconsin Department of Transportation — Economic Planning and Development, Madison, February 1998.

11. Anderson, A. J., Robert Harrison, Mark A Euritt, Hani S. Mahmassani, C. Michael Walton, and Reijo Helaakoski. *Economic Impacts of Highway Bypasses.* 1247-3F, Center for Transportation Research, The University of Texas at Austin, November 1992.

12. Lombard, Paul C., Kumares C. Sinha, and Deborah J. Brown. "Investigation of the Relationship Between Highway Infrastructure and Economic Development in Indiana,"

Transportation Research Record 1359, Transportation Research Board, Washington, D.C., 1992.

13. Buffington, Jesse L., and Dock Burke, Jr. "Employment and Income Impact of Expenditures for Bypass, Loop, and Radial Highway Improvement," *Transportation Research Record 1305,* Transportation Research Board, Washington, D.C., 1991.

14. Burress, David. *Impacts of Highway Bypasses on Kansas Towns.* KU-95-5, Institute for Public Policy and Business Research, Lawrence, October 1996.

15. Stephanedes, Yorgos J. *Transportation and Economic Development.* 9RD0004, Minnesota Department of Transportation — Materials and Research Laboratory, Maplewood MN, May 1989.

16. Holhouser, Eugene C., "An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology," *Highway Research Bulletin 268,* Highway Research Board, Washington, D.C., 1960.

17. Hartgen, David T. "Twin Studies: Applications to Transportation Analysis," *69th Annual Meeting of the Transportation Research Board,* Washington, D.C., January 1989.

18. Beemiller, Richard M. "Hybrid Approach to Estimating Economic Impacts Using the Regional Input-Output Modeling System (RIMS II)," *Transportation Research Record 1274,* Transportation Research Board, Washington, D.C., 1990.

19. Forkenbrock, David J., Thomas F. Pogue, Norman S. J. Foster, and David J. Finnegan. *Road Investment to Foster Local Economic Development.* Public Policy Center, Iowa City, May 1990.

20. Rephann, Terance J. "Highway Investment and Regional Economic Development: Decision Methods and Empirical Foundations," *Urban Studies,* 30:2, March 1993.

21. Forkenbrock, David J. "Putting Transportation and Economic Development into Perspective," *Transportation Research Record 1274,* Transportation Research Board, Washington, D.C., 1990.

22. Hartgen, David T., Janet E. O'Callaghan, Wayne A. Walcott, and Jane Opgenorth. "Growth at Rural Interchanges: What, Where, Why," *Transportation Research Record 1359,* Transportation Research Board, Washington, D.C., 1992.

23. "Effects of Highway Bypasses on Rural Communities and Small Urban Areas," *Research Results Digest,* NCHRP, 1996.

24. Orus, Jean-Pierre. *The Economic Impacts of Major Motorway Infrastructures: Main Lessons From After Studies,* Permanent International Association of Road Congresses, 1997.

25. Mudge, Gordon, and Linda Chinn. *The Impact of the Okehampton Bypass.* TRL 268, Transport Research Laboratory, Crowthorne, Berkshire, 1997.

26. Barrell, John M., and Christopher G. Robson. "The Bypass Demonstration Project: An Overview," *Traffic Engineering and Control,* 30:9, September 1989, pp. 400–404.

27. Baker, Merl W., and Erich Kramer. *The Cushman and Wakefield Business America Real Estate Monitor: The Second Survey.* Study No. 871010, Cushman and Wakefield, New York, May 1987.

28. Bowersox, Donald J. "Influence of Highways on Selection of Six Industrial Locations" (nd).

29. Hartgen, David T., Alfred W. Stuart, Wayne A. Walcott, and James W. Clay. "Role of Transportation in Manufacturers' Satisfaction with Locations," *Transportation Research Record 1274,* Transportation Research Board, Washington, D.C., 1990.

30. Everly, Richard W., Richard D. Twark, and Roger H. Downing. "Interstate Highway System: Reshaping the Nonurban Areas of Pennsylvania," *Transportation Research Record 1274,* Transportation Research Board, Washington, D.C., 1990.

31. Briggs, Ronald. "Interstate Highway System and Development in Non-Metropolitan Areas," *Transportation Research Record 812,* Transportation Research Board, Washington, D.C., 1981.

32. Lichter, Daniel T., and Glenn V. Fuguitt. "Demographic Response to Transportation Innovation: The Case of the Interstate Highway," *Social Forces,* 59: 2, December 1980.

33. Crane, Laurence M., Dock Burke, and Clay Hanks. "Highway District and Economic Sector Employment Effects of Transportation Expenditures," *Transportation Research Record 1359,* Transportation Research Board, Washington, D.C., 1992.

34. Clay, James W., David T. Hartgen, Tracy H. Newsome, Alfred W. Stuart, and Wayne A. Walcott. "I-40 Economic Development Study: Growth Points Analysis," *Transportation Research Record 1359,* Transportation Research Board, Washington, D.C., 1992.

35. Singletary, Loretta A., Mark S. Henry, Kerry R. Brooks, and James B. London. "The Impact of Highway Investment on New Manufacturing Employment in South Carolina: A Small Region Spatial Analysis," *The Review of Regional Studies,* 1995.

36. Zografos, Kostas G., and Yorgos J. Stephanedes. "Impact of State Highway Investment on Employment Along Major Highway Corridors," *Transportation Research Record 1359,* Transportation Research Board, Washington, D.C., 1992.

37. Wendt, Paul. "Influence of Transportation Changes on Urban Land Uses and Values" (nd).

38. Burkhardt, Jon E. “Socioeconomic Reactions to Highway Development,” *Transportation Research Record 991,* Transportation Research Board, Washington, D.C., 1984.

39. Zeiss, Chris. “Cause and Effect Patterns of Noxious Facility Impacts on Property Values,” *Journal of Environmental Systems,* 26:2, 1997–98.

40. Gamble, Hays B., and Owen H. Sauerlender. “Adverse and Beneficial Effects of Highways on Residential Property Values.” *Transportation Research Record,* Transportation Research Board, Washington, D.C., 1979.

41. Broder, Josef M., Teresa D. Taylor, and Kevin T. McNamara. “Quasi-Experimental Designs for Measuring Impacts of Developmental Highways in Rural Areas,” *Southern Journal of Agricultural Economics,* pp. 199–207, July 1992.

APPENDIX

Table A.1. Methodologies Used in Selected Highway Impact Studies

Study	Author	Year	Before and After	Case Study	Econo-metric*	Survey Control	Matched Pairs	Other
An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology	Holhouser	1960				X		
Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value	Bardwell and Merry	1960	X					
The Road Around: A Study of the Economic Impact of Highway By-passes on Rural South Carolina Cities and Towns	Whitehurst	1965	X					
Adverse and Beneficial effects of Highways on Residential Property Values	Gamble	1979			X			
Demographic Response to Transportation Innovation: The Case of the Interstate Highway	Lichter and Fuguitt	1980			X			
Interstate Highway System and Development in Nonmetropolitan Areas	Briggs	1981			X			
Socio-Economic Reactions to Highway Development	Burkhardt	1984	X					
Highway Bypasses: Wisconsin Communities Share Their Experiences	Wisconsin Department of Transportation	1988		X				
Transportation and Economic Development	Stephanedes and Eagle	1989			X			
Role of Transportation in Manufacturers' Satisfaction with Locations	Hartgen, et al.	1990			X			
Interstate Highway System: Reshaping the Nonurban Areas of Pennsylvania	Everly, et al.	1990			X			
Interstate 40 Economic Impact Study: Impacts of Highway Bypasses on Community Bypasses	Blackburn and Clay	1991	X	X				
Employment and Income Impact of Expenditures on Bypass, Loop, and Radial Highway Improvements	Buffington and Burke	1991			X			
Highway District and Economic Sector Employment Effects of Transportation Economics	Crane, et al.	1991			X			
A Literature Review of Urban Bypass Studies	Iowa Department of Transportation	1992		X				
Economic Effects of Highway Bypasses on Business Activities in Small Cities	Helaakoski, et al.	1992		X	X		X	
Economic Effects of Highway Bypasses on Business Activities in Small Cities	Anderson, et al.	1992		X	X		X	X

Table A.1. Methodologies Used in Selected Highway Impact Studies (continued)

Study	Author	Year	Before and After	Case Study	Econo-metric*	Survey Control	Matched Pairs	Other
Investigation of the Relationship Between Highway Infrastructure and Economic Development	Lombard, et al.	1992			X			
Growth at Rural Interchanges: What, Where, Why	Hartgen, et al.	1992			X			
I-40 Economic Development Study: Growth Points Analysis	Clay, et al.	1992						X
Impact of State Highway Investment on Employment Along Major Corridors	Zografos	1992			X			
Quasi-Experimental Designs for Measuring Impacts of Developmental Highways in Rural Areas	Broder	1992			X			
The Economic Impact of Rural Highway Bypasses: Iowa and Minnesota Case Studies	Otto and Anderson	1995					X	
The Impact of Highway Investment on Manufacturing Employment in South Carolina: A Small Region Spatial Analysis	Singletary, et al.	1995			X			
Evaluation of the Economic Impacts of Bypass Roads on Country Towns	Parolin and Garner	1996	X	X				
Impacts of Highway Bypasses on Kansas Towns	Burress	1996			X			
Effects of Highway Bypasses on Rural Communities and Small Urban Areas	NCHRP	1996						X
The Economic Impact of Major Motorway Infrastructure	Orus	1997	X					
The Impact of the Okehampton Bypass	Mudge and Chinn	1997	X	X				
Citizen Views of Transporting Radioactive Waste in Oregon, Idaho, Colorado, and New Mexico	Oakes and McBeth	1998						X
The Economic Impact of Highway Bypasses on Communities	Yeh, et al.	1998	X			X		
Cause and Effect Patterns of Noxious Facility Impacts on Property Values	Zeiss	1998						X
*includes time-series and/or cross-sectional models								

Table A.2. Dependent Variables Used in Selected Highway Impact Studies

Study	Author	Year	Area	Employ-ment	Industrial Location	Sales	Population	Land Use/ Value	Safety	Traffic	Income/Wages	Other
Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value	Bardwell and Merry	1960	Colorado			X		X				
Adverse and Beneficial Effects of Highways on Residential Property Values	Gamble	1979	Mid-Atlantic					X				X
Demographic Response to Transportation Innovation: The Case of the Interstate Highway	Lichter and Fuguitt	1980	United States				X					
Interstate Highway System and Development in Nonmetropolitan Areas	Briggs	1981	United States	X			X					
Socio-Economic Reactions to Highway Development	Burkhardt	1984	Varied				X	X				X
Highway Bypasses: Wisconsin Communities Share Their Experiences	Wisconsin DOT	1988	Wisconsin	X		X			X	X		
Transportation and Economic Development	Stephanedes	1989	Minnesota	X								
Role of Transportation in Manufacturers' Satisfaction with Locations	Hartgen, et al.	1990	North Carolina									
Interstate Highway System: Reshaping the Nonurban Areas of Pennsylvania	Everly, et al.	1990	Pennsylvania	X			X	X			X	X
Interstate 40 Economic Impact Study: Impacts of Highway Bypasses on Community Bypasses	Blackburn and Clay	1991	North Carolina			X				X		
Employment and Income Impact of Expenditures on Bypass, Loop, and Radial Highway Improvements	Buffington and Burke	1991	Texas	X							X	
Highway District and Economic Sector Employment Effects of Transportation Economics	Crane, et al.	1991	Texas	X								

Table A.2. Dependent Variables Used in Selected Highway Impact Studies (continued)

Study	Author	Year	Area	Employ-ment	Industrial Location	Sales	Population	Land Use/ Value	Safety	Traffic	Income/Wages	Other
A Literature Review of Urban Bypass Studies	Iowa DOT	1992	Iowa									X
The Economic Impact of Rural Highway Bypasses: Iowa and Minnesota Case Studies	Otto and Anderson	1992	Minnesota/ Iowa			X				X		
Economic Effects of Highway Bypasses on Business Activities in Small Cities	Helaakoski, et al.	1992	Texas			X		X				
Economic Effects of Highway Bypasses on Business Activities in Small Cities	Anderson	1992	Texas			X						
Investigation of the Relationship between Highway Infrastructure and Economic Development	Lombard, et al.	1992	Indiana	X							X	
Growth at Rural Interchanges: What, Where, Why	Hartgen, et al.	1992	North Carolina					X				
I-40 Economic Development Study: Growth Points Analysis	Clay, et al.	1992	North Carolina	X			X				X	
Impact of State Highway Investment on Employment Along Major Corridors	Zografos	1992	Minnesota	X								
Quasi-Experimental Designs for Measuring Impacts of Developmental Highways in Rural Areas	Broder	1992	Appalachia			X	X				X	
The Impact of Highway Investment on Manufacturing Employment in South Carolina: A Small Region Spatial Analysis	Singletary, et al.	1995	South Carolina	X								
Evaluation of the Economic Impacts of Bypass Roads on Country Towns	Parolin	1996	New South Wales	X								

Table A.2. Dependent Variables Used in Selected Highway Impact Studies (continued)

Study	Author	Year	Area	Employ-ment	Industrial Location	Sales	Population	Land Use/ Value	Safety	Traffic	Income/Wages	Other
Impacts of Highway Bypasses on Kansas Towns	Burress	1996	Kansas	X		X				X	X	
Effects of Highway Bypasses on Rural Communities and Small Urban Areas	NCHRP	1996	United States	X		X	X	X		X		X
Economic Impact of Major Motorway Infrastructure	Orus	1997	France	X	X							
The Impact of the Okehampton Bypass	Mudge and Chinn	1997	United Kingdom							X		X
Citizen Views of Transporting Radioactive Waste in Oregon, Idaho, Colorado, and New Mexico	Oakes and McBeth	1998	Oregon, Idaho, Colorado, and New Mexico	X					X			
The Economic Impact of Highway Bypasses on Communities	Yeh, et al.	1998	Wisconsin	X			X			X		
Cause and Effect Patterns of Noxious Facility Impacts on Property Values	Zeiss	1998	Varied					X				