Using Empirical Information to Measure the Economic Impact of Highway Investments

Volume 1: Review of Literature, Data Sources, and Agency Needs

final report

prepared for

Federal Highway Administration

prepared by

Economic Development Research Group, Inc.

and

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prepared by

Economic Development Research Group, Inc.
2 Oliver Street, 9th Floor
Boston, Massachusetts 02109

and

Cambridge Systematics, Inc.
150 CambridgePark Drive, Suite 4000
Cambridge, Massachusetts 02140

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Preface

There is considerable current interest in using investments in expanded highway capacity as a means of furthering economic development objectives. The economic effects of a specific new highway investment, though, can vary significantly from project to project depending on where the highway is located, the specific economic interests served, the travel markets served, and the road's affects on accessibility and systemwide connectivity. Simplistic generalizations that highways either do or do not affect business locations and growth are not sufficient to distinguish between specific project alternatives. This project addresses the need for an improved base of information addressing the specific nature of the different economic development effects that can be associated with investments in individual highway projects. The use of this information by state Departments of Transportation (DOT) and regional planning organizations will help inform transportation program and project investments that are intended to advance economic development.

The results of this work are documented in two separate volumes:

- **Volume 1: Review of Literature, Data Sources, and Agency Needs**, reviews the results of existing empirical studies examining the relationships between investments in highways and economic development, focussing in particular on work performed during the 1990s and highways located in rural areas. This volume also describes available data sources that can be used in conducting such studies, presents the results of interviews with staff of transportation agencies and leading researchers regarding potentially available analysis methods, and presents guidelines for the conduct of future economic impact measurement studies.

- **Volume 2: Guidelines for Data Collection and Analysis**, then builds on these findings and general principles to define a specific structure for measuring economic impacts associated with investments in expanded highway capacity, including temporal, spatial, and causality considerations. Three prototype study designs are presented: a regional study of broad-area impacts, a narrow highway strip where the concern is with impacts on businesses located immediately adjacent to a highway or interchange, and a community study where the primary area of concern is a specific town or neighborhood.

The currently available base of information includes a wide assortment of studies, ranging from extremely broad national studies, such as the literature on national productivity impacts of highway spending over time, to extremely narrow and not adequately controlled project assessments. While interesting, many of these studies are not sufficient by themselves to differentiate the advantages and disadvantages of alternative highway investments. Measurements of highway-related economic impacts, in a range of contexts and using a variety of data sources and methods, will expand this existing knowledge base and provide a more credible foundation for making highway investment decisions based on sound economic development criteria.

Acknowledgments

The principal investigator for this project, and lead author of this two-volume final report, is Glen Weisbrod of Economic Development Research Group, Inc. Additional major contributors are Margaret Collins and Jinevra Howard of Economic Development Research Group; and Christopher Porter, John Suhrbier, and Christopher Wornum of Cambridge Systematics, Inc.

Martin Weiss of the Federal Highway Administration managed the overall project effort, and played a critical role in defining the project's direction.

For this first volume, the authors are indebted to a panel of state officials and academic experts in the field, who made a major contribution to assessing the state-of-the-art and the state-of–the-practice, and to identifying challenges for the future:

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1.0 Introduction and Summary

1.1 Project Motivation

The long-term benefits of new highway construction and continued highway system expansion have been an issue of continuing debate. Proponents of new highway investments often cite anticipated benefits such as local or regional job creation, business attraction, and income growth. Opponents often argue that new highway investments at best serve only to redistribute jobs and business activity, and at worst lead to more traffic generation without any real economic benefit to the local area or region.

This debate has been further clouded by a "disconnect" between public arguments about the merits of specific highway projects and research studies on the merits of expanding investment in the "capital stock" of the nation's highway system. In particular, studies of the general relationship between highway investment and national or regional economic growth are too broad to shed light on the effects of specific individual highway projects – and thus such general studies are not useful for planning and environmental documentation as required by federal law.

This situation leads to three key observations, which form the premise for this study:

1. **The economic effect of a specific highway can vary from project to project** (depending on the context of where the highway is located, who it serves, how much it is used, and how it affects local accessibility and/or broader systemwide connectivity). Simplistic generalizations that highways do or do not affect business locations and growth are not helpful for decision-makers trying to distinguish between specific proj??ect alternatives. There is a real need for a base of information on the nature of economic effects associated with individual highway projects.

2. **The potential economic effects of a specific new highway can be local** (e.g., redirecting economic growth to depressed areas where it is needed and desired) **and/or regional** (e.g., expanding the productivity and income-generating ability of industries through scale economies or improved supplier-buyer links). Both the localized and regional effects can be of interest for public policy, so there is a real need for a base of information on how local and regional effects of highway projects can differ.

3. **There has been a lack of post-project studies documenting the actual economic impacts of built highway projects**. This is partly because of the lack of any "political upside" associated with finding out that pre-project forecasts may not have been correct. The fact remains, however, that without a solid base of empirical information on actual impacts of past projects, the foundation for projecting future economic effects of proposed new highway investments is weak. There is a real need for more empirical data to document the extent of any actual economic impacts following completion of individual highway projects.

This project was undertaken to address existing limitations on empirical data regarding the lasting economic impacts of individual highway projects. The project is intended to serve as a starting point in efforts to equip the Federal Highway Administration (FHWA) and states with a consistent and believable base of information on how, and under what circumstances, highway improvements can provide desired economic development benefits.

1.2 Report Overview

This study includes two distinct components:

- **Phase 1**, presented in this Volume 1 report, provides a review of existing empirical studies, currently available data sources, and information needs for improved research; and
- **Phase 2**, presented in the Volume 2 report, presents prototype designs for empirical studies of the actual economic development impacts of specific highways.

This Volume 1 report summarizes the findings from Phase 1 and establishes a starting framework for Phase 2. The sections of this report are as follows:

- **Section 2.0** reviews the available literature and lessons learned from it concerning the methods that analysts have used for pre/post measurement of the local and regional impacts of highway projects and programs;
- **Section 3.0** reviews the available data sources that can be used to measure the local and regional impacts of highway projects and programs, and evaluates their capabilities and limitations;
- **Section 4.0** summarizes findings from interviews with researchers and transportation agency staff (at state and federal levels) concerning their experiences and needs for improvement in the measurement of highway program and project impacts; and
- **Section 5.0** builds upon these findings to develop general guidelines for using data sources and methods in post-project impact studies, which will serve as a basis for the Phase 2 study designs.

1.3 Summary of Findings

The findings are grouped into four categories:

1. Empirical literature;
2. Available data sources;

3. Methodological needs identified from interviews of agency staff and researchers; and

4. General principles for future studies.

1.3.1 Review of Empirical Literature

As an initial step in this study, the project team reviewed existing empirical studies on the economic impacts of transportation investments. This review focused on empirical studies performed in the past 15 to 20 years. Each past study was critically reviewed and characterized with respect to measures of impact, data sources, experimental design, analytical methods, explanatory variables, and substantive findings. The purposes of the review were to: 1) assess the state of knowledge on transportation impacts, 2) identify key methodological issues and limitations, and 3) lay the groundwork for recommendations for future research methodologies and studies.

Some key lessons learned from this review include:

- **Economic impact studies can be done, and economic impacts can be measured.** Many of the existing studies have been performed by academics and sponsored by non-transportation agencies such the Appalachian Regional Commission (ARC) and the Economic Development Administration (EDA). Given the importance role of transportation in local economies, the research role of federal and state Departments of Transportation (DOTs) could be increased.

- **Pooling findings from multiple studies can currently provide a clear picture of impacts of some types of investments but not of others.** Common conclusions already exist on the impacts of highway bypasses, for example, but not on the impacts of larger highway corridor projects.

- **Clear cause-and-effect relationships are not easy to establish.** Studies of regional and national-scale highway investments have generally established correlation to economic growth but not causation. The most informative studies use a combination of quantitative statistical techniques and qualitative assessments to identify causal factors and determine relationships.

- **Study methodologies are driven by readily available data and budget limitations.** Impacts are most commonly measured at the county level. Disaggregate economic data are available but are rarely utilized due to the expense and level of effort required.

- **More attention is required to improve explanatory variables.** Investigation is needed into how locality-specific factors and other explanatory variables play a role in the economic changes following completion of new highway investments. Those factors need to be described and incorporated into empirical studies and forecasting efforts.

- **More attention is required explain the time-dynamics of impacts.** Most studies to date have simply measure change over a single time period. In reality, some impacts may occur immediately while others may take many years to occur.

- **More attention to intermediate variables could improve behavioral interpretations**, particularly how changes in traffic volumes and patterns relate to business changes and economic impacts. Traffic increases can serve as indicators of increased economic activity as well as potential generators of activity.

1.3.2 Review of Available Data Sources

The project team reviewed available measures and corresponding data sources that can be used to analyze economic performance and growth before and after completion of new highways or major highway improvement projects. The team then evaluated each measure by two criteria: 1) *usefulness* for measuring economic development impacts; and 2) *reliability, accuracy, and timeliness* of the data sources that document each measure. Detailed information on each recommended data source – including coverage, frequency, possible applications in economic analysis, and the advantages and disadvantages of each source – is contained in Appendix A of this report.

The review focused on seven measures relating to different aspects of economic development:

- Jobs;
- Wages and other income;
- Number of businesses;
- Business volume and sales;
- Population;
- Private investment in buildings, plant, and equipment; and
- Real estate values.

There are at least 24 different data sources that can be used to obtain information on these seven measures. The data sources fall into four general categories:

1. **U.S. Federal Data –** These include data series published by the Census Bureau, Bureau of Labor Statistics, Bureau of Economic Analysis and Internal Revenue Service.

2. **State and Local Data Sources –** These include data on jobs and population published by the city, county, and state agencies. They include state data on population and employment, as well as local data on building permits and property assessments.

3. **Private Data Sources –** These include private companies providing market and real estate information. Some of these data are free on the web. Others are available only for a fee (e.g., Dun & Bradstreet business records and FW Dodge construction data).

4. **Interviews and Field Observations –** Telephone or in-person interviews with local businesses, public officials, and private organizations in the project area are a source of information that cannot be obtained from public data sources. They can provide information regarding causal factors affecting observed changes. In addition, field

observations can also provide contextual insight into the nature of development impacts and factors affecting those impacts.

These various data sources differ in *frequency of updating* (ranging from monthly to every 10 years) and *comprehensiveness* (from partial to complete coverage). They also differ in terms of *geographic detail* (from state level to neighborhood or tract level) and in *level of business detail* (ranging from hundreds of "four-digit industry" categories to just nine "single-digit industry" categories). Overall, these differences lead to clear-cut tradeoffs involved in selecting appropriate impact measures. Those tradeoffs are summarized in a table and discussed at greater length in the chapter.

1.3.3 Interviews of Agency Staff and Researchers

The project team conducted interviews with staff of 14 organizations that had some interest in issues concerning the economic development impacts of highway projects. They included staff members of nine state DOTs, and five academic researchers. These interviews were intended to provide the research team with some insight regarding perceptions of the nature of challenges to, and needs for, measurement of the economic development impacts of highway projects. The interviews focused on two major issues:

1. **Agency Interest in Measuring Economic Development Impacts –** To what extent do state DOTs seek to document the actual economic effects of past highway investments?

2. **Problems with Analysis Methods –** What kind of data sources and analysis methods have been used (by DOTs and other researchers) to measure and isolate the economic growth impacts of specific highway projects? What have been the strengths and weaknesses of the methods used to date?

Agency Interest in Impact Measurement

Staff of state DOTs who were interviewed indicated that most of their agencies had considered economic development impacts of highway projects in at least one of three distinct circumstances:

1. A statewide transportation investment program was undertaken in part to spur economic development of the state as a whole; or

2. A specific transportation project was initiated in part to spur economic development in a depressed region of the state; or

3. A project such as a community bypass route was assessed after completion to gauge the extent of negative as well as positive impacts on local communities.

Among the agency staff interviewed, consideration of potential economic benefits was most common in pre-project planning. Economic benefits are emphasized in federal transportation policy, most recently as embodied in the seven metropolitan and statewide planning factors established under the Transportation Equity Act for the 21st Century

(TEA-21), one of which is to "Support the economic vitality of the metropolitan area (or State)." As a result, state and local transportation policy documents generally include economic development goals. Economic impacts, therefore, are often considered at least qualitatively – and sometimes quantitatively – in project planning studies. In contrast to pre-project consideration, however, measurement of actual impacts *after* project completion is extremely rare. The staff who were interviewed had collectively sponsored a handful of empirical evaluations. In most cases, though, limitations on resources and lack of knowledge of evaluation methods have either precluded such undertakings or limited the information available from such undertakings.

Despite these resource limitations, the interviewed state DOT staff still have a high level of interest in obtaining better information on the actual effects of their highway investments on economic development. Particular needs were expressed for:

- **Better information on linkages** among transportation, other factors, and economic development. In particular, there was interest in understanding the conditions under which highways are most likely to help stimulate development;

- **Robust yet easy-to-use tools** to estimate the economic and benefit-cost impacts of specific projects; and

- **Better baseline economic data** from which to construct forecasts and conduct evaluations, especially small-area business and employment data.

Problems with Analysis Methods

A wide range of research conducted over the past two decades has attempted to identify the economic development impacts of highways. Quantitative techniques such as regression, matched-pair comparison, and shift-share analysis have been used to compare trends for areas with and without highway improvements, and to attempt to isolate the contribution of transportation projects to economic growth. Qualitative techniques such as interviews have also been applied to gain a greater understanding of how transportation projects have influenced local or regional economic development.

Discussions with researchers, however, indicated broad agreement that most studies conducted to date have three major data limitations. These include:

- **Measurement of Economic Changes –** Measures of economic change have been primarily available at a level of county or larger. That is a crude level of impact measurement, but time series (panel) data on economic characteristics is very limited and often not available at a finer level of spatial level.

- **Measurement of Transportation Changes –** Measures of transportation access changes also have been measured primarily at the county level – in terms of capital stock, lane miles or average distance to interstate highways. That is a crude representation of local accessibility changes, when those changes may in fact be concentrated in particular communities and neighborhoods.

- **Control for Exogenous Changes –** A variety of analysis methods have attempted to "control" for non-transportation factors affecting observations of pre/post-project changes in nearby economic conditions. However, they all have drawbacks, which limit our ability to establish "causality" between highway investments and any observed economic growth in areas served by the highway system improvements.

These limitations imply the need for research designs that can provide measurement of transportation and economic changes at a spatial level of detail responsive to impacts of specific highways. Furthermore, they highlight the key challenge, which is to distinguish the economic changes attributable to highways from those attributable to other factors.

1.3.4 General Principles

The reviews of existing studies and data sources, and the discussions with agency staff and researchers, lead to three general findings which may help guide future studies:

1. **Study Area –** It can be important to separately track local, state, and national economic impacts. Any or all of these levels of impact may be of public interest.

2. **Time Period –** Economic impacts of highways, if they occur, are likely to evolve over time, so it can be important to distinguish short- and long-term impacts. At different times, impacts may occur in property values, building investment, and job creation.

3. **Causation –** Any study which seeks to establish a connection between highway investments and economic changes must establish a causal connection between them. It must also distinguish it from effects of other (non-highway) factors.

2.0 Literature Review Findings

2.1 Overview

This section reviews and characterizes empirical studies which have sought to measure the economic development changes caused by completion of highways and other transportation infrastructure projects. It focuses specifically on studies to assess pre/post changes in business activity or area economic growth that are associated with the completion of individual facilities or regional programs of highway facilities. This review covers recent empirical studies and characterizes them in terms of their measures of impact, data sources, experimental design, analytical methods, explanatory variables, and substantive findings. The purposes of the review are to 1) assess the state of knowledge on transportation impacts, 2) identify key methodological issues and limitations, and 3) lay the groundwork for recommendations for future research methodologies and studies.

The range of studies on the economic impacts of highway improvements is potentially broad. The scope of this review is limited, however, by including only the following:

- Empirical studies that attempt to directly measure, rather than forecast or model, the impacts of projects;
- Studies that focus primarily on rural or interregional impacts, as opposed to impacts of projects which are entirely within an urban area;
- Studies that focus on direct measures of economic impact, such as jobs, earnings, and property values, rather than on business costs and productivity; and
- Studies that have been conducted within the past 15 to 20 years, with particular emphasis on studies performed in the 1990s.

The remainder of this section reviews the following characteristics of the studies reviewed:

- Type of study (general purpose and approach);
- Impacts measured and data sources used;
- Experimental design (pre/post comparison, control group, etc.);
- Analytical methods (comparison of means, regression, etc.);
- Explanatory variables; and
- Key substantive findings.

The section concludes with a set of lessons learned from the review. A bibliography of cited sources can be found at the end of this section.

2.2 Types of Studies

While this review is intended to cover transportation impacts in general, the vast majority of recent empirical studies focus on highways and highway-related impacts. The studies reviewed for this effort can be classified into a few general categories:

- **Studies of Rural Highway Systems –** These studies look at county-level growth rates in earnings and/or employment in rural counties. Rates are compared for counties with and without Interstate access (or, in some cases, other highways). The scope is usually national. Rates are usually compared over a five- to 15-year period, at some point following the development of the highways. (The implicit hypothesis is that highways should have a semi-permanent and relatively constant impact on growth rates.) Some studies have controlled for other factors such as proximity to a metropolitan area. Examples include studies of interstate and rural highways across the U.S. by Porterfield (1990), Broder (1992), and Kusmin (1996).

- **Studies of Regional Development Program Impacts –** These studies look at the impacts of specific regional infrastructure investment programs aimed at stimulating economic development. Impacts are usually measured in terms of county-level employment, earnings, and/or population. There are two primary experimental measurements: 1) *absolute levels before and after* highway development in affected counties, and 2) *growth rates after* highway development in affected versus unaffected counties. As a set, the counties that benefit from the highway project may be compared to 1) the remaining counties in the same region that do not benefit; 2) the state or U.S. as a whole; or 3) a set of "matched" counties elsewhere. Examples include studies of the Appalachian Development Highway System by Isserman (1989), Rephann (1994), Wilbur Smith Associates (1998), and the Delta Region studies by FHWA (1995).

- **Studies of Specific Highway Corridor Improvements –** These studies focus on specific projects rather than highway systems. A combination of quantitative and qualitative assessment is generally used. The benefit of gathering qualitative data (e.g., through interviews) is that important local factors can be identified and their relative impacts estimated. The limitation of this approach is that findings on impacts may not automatically apply to other highway corridors, but the major advantage of this approach is that it provides a basis for identifying how differences in local context can affect the nature of resulting impacts. Most of these studies of this type have been overseas. Good examples of this include studies of specific new motorways in France (Orus, 1996) and Finland (Parantainen, 1999), and the study design for another in Sweden (Anderstig, 1999).

- **Bypass and Other Access Change Studies –** These studies examine the impacts of highway bypasses around smaller cities and towns, or of other access restrictions that may affect businesses. Usually the focus is only on the city or town that is being bypassed, although some studies have tried to assess how bypassed locations may conversely benefit from bypasses elsewhere along the corridor. Impacts are generally measured in terms of employment, sales, and/or number of businesses at the city level or for another project-specific area for which data can be isolated. The focus is usually on retail/service businesses, especially traffic-oriented businesses. Traffic volumes are

also compared before and after construction on the bypassed and new routes. In contrast to other studies reviewed, *levels* of impacts are measured before and after the bypass rather than growth rates. The hypothesis is that a one-time "hit" occurs, although some studies have also looked at the longer-term evolution of impact levels. Bypass studies are frequently supplemented with local quantitative data gathering (windshield surveys, business surveys) as well as qualitative data from interviews.

Good examples of bypass studies are provided in Wisconsin (Wisconsin DOT, 1998), Kansas (Burress, 1996), Iowa (Anderson and Otto, 1991), North Carolina (Blackburn and Clay, 1991), Washington (Gillis and Casavant, 1994), Texas (Texas Transportation Institute, 1995), and Australia (Bureau of Transport and Communications Economics, 1994). National Cooperative Highway Research Program (NCHRP) Project 20-5 summarizes U.S. bypass studies. NCHRP Project 25-4 also provides findings from case studies of business changes associated with implementation of left-turn restrictions on divided highways (Weisbrod and Neuwirth, 1998).

- **Interchange Studies –** These studies utilize local business data (e.g., locations, sales) to evaluate the impacts of freeway interchanges on retail/service businesses, particularly traffic-oriented businesses. The scope is similar to bypass studies, although negative impacts are not hypothesized. Some creative work has been done in looking at spatial relationships among interchanges and with nearby cities/towns. Examples include Moon (1988) and Hartgen (1998).

The following additional types of studies were not included in the literature review, but still contain information and methods relevant to this study:

- **Surveys on Factors Influencing Business Location –** Forkenbrock and Foster (1996) summarize findings from recent surveys and studies of how proximity to highways affect subsequent business location decisions, although they do not evaluate impacts of any specific highway programs or projects. Nevertheless, such studies provide insight into the factors that should be considered in the empirical analysis of highway impacts.

- **Urban Beltway Studies –** These are studies which have assessed the impacts of urban freeway beltways on overall growth as well as the distribution of activities within specific metropolitan areas. They were primarily conducted in the 1960s, 1970s, and early 1980s. While the focus was primarily on intra-metropolitan impacts, some of the data sources, methodological approaches, and findings are relevant to the measurement of interregional effects. Payne-Maxie Consultants and Blayney-Dyett (1980) provide a comprehensive study of beltways as well as a review of previous methodologies.

- **Hedonic Pricing Studies –** Hedonic pricing models are statistical studies which use regression equations to explain the factors that affect property values. They have been applied primarily to assess the impacts of access to urban freeways and access to urban rail transit systems in various urban areas. At least 18 studies of the impact of rail transit on residential property sales price have been published since 1970, and some studies have also examined commercial property values (e.g., Weinberger, 2000). The approach could potentially be applied to a rural/regional setting to distinguish the effects of changing highway access, but that would not directly indicate any resulting impacts on income or employment.

2.3 Data Sources

Data sources used in the studies reviewed are discussed according to two categories:

1. Direct measures of economic impact, such as employment or personal income; and

2. Other related measures, such as traffic volumes, population, and quality of jobs.

2.3.1 Measures of Economic Impact

Table 2.1 classifies the types of studies identified above according to primary economic measure(s) used and geographic unit of the measurement. The results of the literature review illustrate two general themes.

Table 2.1. Economic Measures by Type of Study

Economic Measure	Scale of Measurement		
	County-Level	**City-Level**	**Disaggregate**
Employment	National and regional highway system studies	Bypass / access restriction studies	
Personal Income / Earnings		–	–
Business Sales		Bypass / access restriction studies	
Number of Establishments	–	Bypass / access restriction studies, Interchange studies	
Property Values	–	–	Hedonic price models

First, most studies of national or regional highway programs have utilized readily available county-level data on personal income and / or employment, taken from national sources. In a few cases, business sales at the county level have also been measured. The area of impact is assumed to be the set of counties crossed by the highway project(s).

Second, because the impacts in these studies are assumed to be localized, bypass and other access restriction studies have had to refine the scope of their analysis to the city level or to a disaggregate level. Some studies have utilized employment, establishment, and / or sales data at the city level from national or state sources. Others have utilized disaggregate data from published or primary sources to provide a much finer level of detail on employment, establishments, and / or sales. When disaggregate data from private or primary sources are utilized, the scope of the study area is more flexible. For example, the impact area can be defined as an aggregation of ZIP codes or as properties immediately adjacent to the affected highway.

Privately published sources include disaggregate data from Dun & Bradstreet; guides to establishments and traffic volumes along Interstate highways (Hartgen, 1998); and databases on real estate transactions. Tax assessment data to indicate property values may also be obtained from local sources. A few studies have also utilized self-reported disaggregate data from businesses and/or local officials. These include quantitative estimates of establishments, sales, and employment, as well as qualitative assessments of changes. Windshield surveys (direct observation) are another source of data on the number of businesses by type. According to NCHRP Project 20-5 (Buffington and Womack, 1995), primary data from surveys were conducted in roughly one-third of the bypass studies reviewed. Other examples are found in the NCHRP Project 25-4 (Cambridge Systematics, 1995) and in Australia (Bureau of Transport and Communications Economics, 1994).

2.3.2 Other Impacts

Traffic Volumes

Traffic volumes are an intermediate impact variable that relate to the potential impacts of the highway project but do not measure these impacts directly. Increased traffic volumes can 1) reflect increased potential for local business to serve the traffic, and/or 2) be a manifestation of higher levels of economic activity in the area. Of course, increased traffic may simply be pass-through traffic that has no source or impact in the area (although other areas may benefit.)

Before-and-after traffic counts have been utilized primarily in localized impact studies. One use of the findings is to make a statement that negative impacts would not be expected (i.e., because traffic volumes did not decrease on the bypassed route). Another use is to compare traffic changes to qualitative or quantitative findings from business surveys. For example, if traffic volumes decrease but business sales are unaffected, a reasonable hypothesis is that the diverted travelers were not the ones patronizing the businesses. Some studies have also measured traffic volumes over time to gauge whether long-term increases in traffic make up for any short-term decreases.

Traffic volumes appear to be an under-utilized data item in larger-scale studies of economic impacts. Increased traffic volumes are important indicator that economic benefits are occurring above and beyond those experienced by the existing users of the system. The travel "induced" by the transportation improvements must be separated from background effects such as population growth that would have occurred anyway. Nevertheless, observation of traffic data in conjunction with economic data could provide a means of corroborating the inferences made from the economic indicators. Traffic counts at the appropriate location(s) are not always available and may need to be commissioned as part of the study, or existing data collection may be expanded for the purposes of the study.

Surveys of customers and/or tourists have been utilized in a few cases (for example, Australia and Wisconsin) to assess before-and-after traffic patterns or changes in locations visited. These data can help assess the responsibility of transportation improvements for changes in traffic volumes. They can also provide insights into the details of economic benefits (e.g., whether it is primarily tourist industries, traffic-serving businesses, or local industries that benefit). Surveys of travelers and business customers appear to be another underutilized resource in empirical studies of economic impacts.

Population

Population can be considered another intermediate variable. Increases in population can reflect an improving economy, and should be related to greater levels of economic activity. On the other hand, increases in population also affect measures of change in total personal income, making percentage increases in per-capita income different from percentage increases in total income produced in a region. This effect was observed in Isserman and Rephann's (1995) study of the Appalachian region, in which total personal income grew by 48 percent while population grew by only five percent, for an overall growth in per-capita income of 17 percent. These kinds of findings make it important to measure per capita impacts as well as total income impacts, and to distinguish impacts on pre-existing population from impacts of new population. Population changes have been measured in a few studies, based on national or state data sources on county or city populations.

Quality/Desirability of Economic Impacts

The studies reviewed rarely looked at whether the economic impacts were actually of the type most needed or desired locally. For example, most did not examine whether the jobs created matched the skills of the local population or the extent to which wealth created in the area stayed in the area. Appalachian development programs in particular have received some criticism for benefiting national corporations rather than the local population (Isserman and Rephann, 1995). While it is not easy to define or measure the "quality" of economic development, this should nevertheless be an important consideration in studying localized impacts.

Cost-Effectiveness or Cost-Benefit of Impacts

Similarly, few of the studies reviewed have attempted to compare the actual impacts of the highway investments with their actual costs. Wilbur Smith Associates (1998) did attempt to estimate benefit-cost and net present value of Appalachian Development Highway System investments, although this was based on post-implementation modeling rather than empirical data collection. Cost-effectiveness could also be defined, in terms of dollars spent per job created or unit of additional income, but again, this has rarely been done.

Non-Economic Impacts

Non-economic impacts are a final area receiving little attention in the studies reviewed. Non-economic impacts might include factors such as noise, environmental impacts, community "livability," or other measures related to quality of life. These impacts were sometimes considered qualitatively in bypass studies that included interviews with local businesses, residents, and officials. The finding that non-economic impacts were rarely evaluated is not surprising given the nature of the studies reviewed. Most were post-hoc studies performed with the express purpose of measuring economic impacts, in contrast to planning studies that need to consider a wide range of benefits and impact measures as an input to decision-making. Nevertheless, non-economic impacts represent important considerations in assessing the overall desirability of any given project or program, and should not be ignored. They can also affect economic development in the long term.

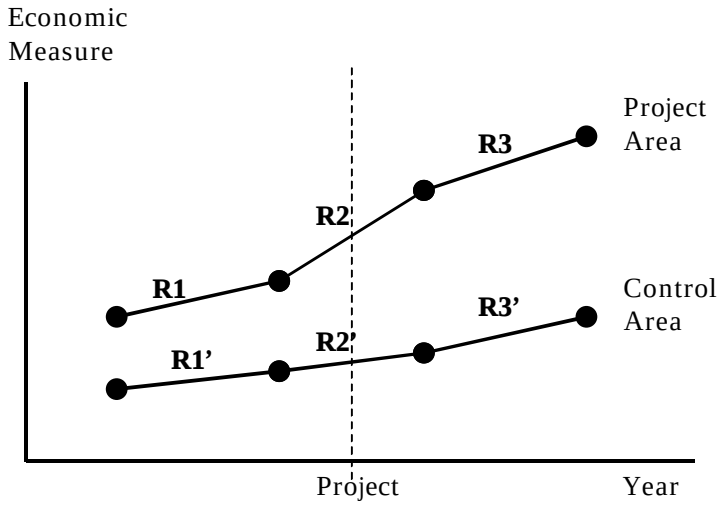
2.4 Experimental Designs

The experimental design approach of each study reviewed was classified under five categories as shown in Table 2.2 and Figure 2.1. ("R" denotes the growth rate between two time points.) Table 2.2 also indicates the frequency of each approach, as identified in the initial literature review. This is not a comprehensive sample of studies, but nonetheless indicates the common approaches.

Table 2.2 Possible Experimental Designs

Impact Variable Measure	Experiment Group Only	Experiment Versus Control Group
Time Points Compared (see Figure 2.1)		
Change in level before versus after project	R2	R2 versus R2′
Growth rate after project	(not applicable)	R3 versus R3′
Change in growth rate before versus after project	R3 versus R1	(R3 versus R1) versus (R3′ versus R1′)
Frequency of Occurrence in Literature		
Change in level before versus after project	5	2
Growth rate after project	(not applicable)	6
Change in growth rate before versus after project	1	2

Figure 2.1 Possible Time Periods for Comparison



Measurement of a percent change in level before versus after a project (R2) is primarily observed in the bypass studies. While these studies did not include control groups per se, impacts were measured for the bypassed area as well as the area with the new highway. The left-turn study (NCHRP Project 25-4) included control areas as well as the impact areas, where control areas were in the same county but outside the immediate impact area of the highway. The implicit assumption for these studies is that the highway project makes a one-time impact on levels of economic activity, although longer-term trends may also be measured.

Broader economic impact studies (corridors and Interstates) have largely focused on post-project growth rates (R3) for the indicator variables. That is, growth rates after project implementation are compared with growth rates in a control area during the same time period. Usually, the growth rate is measured over a five- to 10-year period, and the time since completion of the project is rarely considered. The Mississippi Delta study differs slightly in that the baseline year for measuring growth occurs before the transportation improvements occur rather than afterwards.

Examining growth rates both before and after implementation of the highway project, for both experiment and control areas, would add another measure of confidence to the analysis. However, this has been done only in a few cases, notably Texas (Anderson, no date) and France (Orus, 1996).

Given the relative lack of attention to time scale in these studies, the implicit hypothesis appears to be that growth *rates* should remain higher (relative to an unaffected control area) for an indefinite period after highway construction. This assumption may not be correct, because the nature of economic growth may change substantially over time due to business cycles and technology shifts, and also because some measures may experience only a short-term impact. For example, a study on the impacts of I-80 in Southwestern Wyoming (Long, Long, and Hooker, 1970) found that private investment rose rapidly after completion of the interstate in 1964, then declined almost as rapidly, and returned to near zero by 1970. The authors speculated that growth rates of non-local expenditures increased for about a two-year period and then returned to previous levels. For basic industries, other studies have found that it can take 10 to 15 years to observe the full impacts of highways on growth (Parantainen, 1999).

The choice of control group varies but may include 1) the remaining area (e.g., counties) in the same region that is assumed to be outside the immediate impact area of the highway; 2) the state or U.S. as a whole; or 3) a set of "matched" counties elsewhere (rare). One study of "developmental" highways (Broder, 1992) found that the estimated impacts varied depending upon choice of the control group. Specifically, it concluded that adjacent-county control models may understate impacts and non-adjacent county control models may overstate impacts.

2.5 Analytical Methods

The various analytical methods used to assess impacts include:

- Comparison of means;
- Multivariate linear regression;
- Simulation modeling;
- Qualitative assessment; and
- Other analysis techniques such as cluster and factor analysis or spatial mapping.

The majority of studies reviewed rely on a simple comparison of levels before and after project implementation or a comparison of mean growth rates for the experimental and control groups. Statistical tests for the significance of differences are rare. Other explanatory variables cannot be considered using this technique except by dividing areas into a small number of subsets (e.g., casino versus non-casino counties in the Mississippi Delta study).

The vast majority of studies reviewed can also be characterized as cross-sectional comparisons. That is, growth rates are compared between experiment and control areas over a single period of time. (As discussed previously, the baseline for measuring the growth rate may be set before or after project implementation.) Time-series analysis, which looks at changes in growth rates over a set of time periods before and after project implementation, is rarely performed.

A few studies have used multivariate regression techniques to consider statistical significance, other explanatory variables, and/or time trends. The value of using regression-type approaches to control for other factors is illustrated by Martin and Graham (1980). Examining the effectiveness of the Economic Development Administration's (EDA) programs, they initially found that income in the counties that received EDA funding grew significantly faster than income in the counties that received no aid. Controlling for factors unrelated to EDA, however, they found that EDA's programs had a very small effect on income growth rates during the period that the aid was received and had no significant effect in the years after the aid ceased.

Hedonic price modeling is a related regression technique that is used to predict property values. This technique has primarily been applied to study the impacts of urban transit systems (c.f. Weinberger, 2000). Hedonic modeling differs somewhat, however, in that the control variables are other attributes of the property that might affect its values, rather than concurrent programs, environmental factors, etc.

Simulation Modeling Techniques

Economic simulation modeling techniques, such as the REMI (Regional Economic Models, Inc.) model are most commonly used to forecast the future impacts of proposed projects. However, one study of the impacts of Appalachian Development Highways (Wilbur Smith, 1998) is noteworthy for its use of simulation modeling to look at project impacts

retrospectively. This study applied a special version of REMI to "predict backwards" how economic trends between 1967 and 1995 would have been different without the corridor improvements. The approach of using a structural simulation model is thus an alternative to statistical analysis of comparison areas. Both are ways of assessing the difference between observed economic conditions following the highway project and the purely hypothetical situation in which the highway project was never built. The approach of using a structural simulation model may be particularly useful when cost or data limitations preclude the measurement of impacts for appropriate comparison areas.

Qualitative Assessment Techniques

Qualitative assessment techniques are primarily used to identify key project impacts and explanatory factors and to gauge the relative magnitude of these impacts and factors. They have primarily been used in bypass / access restriction studies, where the impact area is smaller than in studies of larger-scale programs. Good examples of the use of local interviews and surveys in studying the impacts of bypasses are provided by Wisconsin DOT (1998) and in Australia (Bureau of Transport and Communications Economics, 1994).

Among larger-scale studies, the U.S. DOT-sponsored study of urban beltways (Payne-Maxie Consultants and Blayney-Dyett, 1980) demonstrates how case studies, based on interviews and surveys, can be used to describe real estate trends and changes as they relate to new highway development. A recent study of the impacts of the Appalachian Regional Commission (ARC) used interview techniques to estimate the impacts of ARC programs, including road investments, on jobs, tax revenue, investment, and other factors (The Brandow Company and Economic Development Research Group, 1999). Qualitative findings are also used on occasion to develop quantitative estimates of impacts. For example, in the Mississippi Delta study, findings from interviews in seven counties suggested that transportation accounted for 40 to 65 percent of job growth in non-casino counties and 25 to 40 percent in casino counties.

Other Methods

There are isolated examples of other creative analysis techniques. Anderson (no date), studying bypasses in Texas, uses cluster analysis to identify common factors among cities that relate to the magnitude of economic changes experienced. The cluster analysis is used to identify variables to include in a multiple regression. Hartgen (1998), studying development at interchanges, uses a proprietary classification system to assess the most significant variables. Tabulating and mapping data in different ways can also help to identify factors that may not emerge from pure statistical analysis. For example, Orus (1996) uses mapping to assess spatial patterns in the data, such as variance by proximity to metropolitan areas. The application of multiple types of qualitative and quantitative techniques in combination can help to increase confidence in the study's results.

2.6 Explanatory Variables

The inclusion of explanatory variables in empirical studies is limited. Specifically:

- The majority of aggregate-level studies have attempted to correlate growth rates with the presence of highways, but have not quantified the impacts of highways versus other factors such as exogenous economic trends.

- In a few studies, multiple regression techniques or other statistical techniques have been used to include other variables. Studies utilizing regression to measure the impacts of highway programs have included Porterfield (1990); Kusmin, Redman, and Sears (1996); and Isserman and Rephann (1995, 1996). Multivariate regression techniques have also been used to look at left turn restrictions (Cambridge Systematics, 1995), bypasses in Texas (Anderson, no date), and interchange development (Hartgen, 1998). The key variables considered in those studies are listed in Table 2.3.

Table 2.3 Explanatory Variables Considered in Multiple Regression Analysis

- Business / industry type
- Experiment or control area
- Type of transportation improvement
- Proximity / distance to metropolitan area / city
- Area type (urban, suburban, rural)
- Population of city for which impact is being measured
- Development program designation (distressed, growth center, etc.)
- Region's industry base / economic type (tourism, coal, etc.)
- Median income of area
- Time-trend variable

- Most localized impact studies and a few aggregate-level studies have gathered qualitative data through surveys or interviews with local businesses and officials. The qualitative data have provided useful information on other explanatory variables, even if the relative impacts of each cannot be quantified. Factors considered include local economic conditions and trends prior to the highway project; other concurrent changes that could affect the impact measures; how and why impacts may vary by type of business; and the relative influence of the highway project versus other factors.

Taken together, the multiple regression studies and the qualitative evidence from the literature point to the following explanatory variables as being particularly important:

- **The Location of the Area in Relationship to Metropolitan Areas –** Areas located near larger metropolitan areas have benefited from highway improvements significantly more than remote areas.

- **The Size of the City/Town Affected –** Larger towns and cities have generally benefited more from access improvements than small towns and rural locations. Conversely, smaller towns are more likely to experience negative impacts from bypasses.

- **The Inherent Economic "Potential" of the Area –** This factor may involve important natural resources, a high-quality labor supply, or tourism potential. Evidence from a number of studies has demonstrated that areas of high tourism potential, such as beaches, have benefited significantly more than other, less tourist-oriented areas that are at a comparable distance from nearby metropolitan areas. Other predictors of economic "potential" have been more difficult to quantify or isolate as explanatory factors.

  Studies of factors influencing business location are consistent with these findings. Business location studies suggest that transportation *per se* is usually not one of the most significant factors in selecting a region in which to locate. Instead, *access* to raw materials, suppliers, labor, and consumer markets are all noted as significant factors. Access can be strongly influenced by transportation infrastructure. The influence of transportation, however, is highly dependent upon other considerations including the existence of such factors locally, the importance of each factor to the business or industry in question, and the actual accessibility improvement resulting from the transportation improvements.

- **The Type of Business –** Impacts vary by type of business for a number of reasons. Some businesses rely more on transportation than others for delivering supplies and products. Other businesses – such as gas stations and convenience stores – rely largely on pass-by traffic. The benefits of improved access to local suppliers, consumers, and labor will depend on the match of the business to the market; a research lab, for example, will benefit little from improved access to blue-collar workers. Businesses in highly competitive markets may even suffer as a result of greater accessibility, since their competitors receive an advantage as well. Tracking impacts by sector can therefore help to isolate the nature and distribution of the benefits of the transportation improvement.

- **Factors Unique to Each Situation –** Factors such as exogenous trends influencing local industries must also be considered. Otherwise, causality may be incorrectly attributed (or not attributed) to the transportation project. For example, the General Accounting Office (1996) notes that "a study of the growth of Appalachia would need to consider not only Appalachia's growth relative to that of the rest of the United States, but also factors such as whether this growth was concentrated in coal mining areas during periods of high prices…"

The importance of considering explanatory variables is generally recognized. Their inclusion, however, is limited by three interrelated factors: first, determining which factors are important and how they can be measured; second, obtaining data at a geographic scale consistent with the economic variables; and third, developing the analytical methodology to include multiple variables. The combined difficulty of these factors suggests why a simple comparison of growth rates is the most common approach.

2.7 Key Substantive Findings

Some of the studies reviewed point to common conclusions on the economic impacts of certain transportation improvements. In other cases, the extent of research is limited, and shortcomings in data and methodologies mean that common conclusions cannot be definitively stated.

Some key research findings include:

- Aggregate multi-county studies of the Interstate Highway System, Appalachian Development Highway System, and Mississippi Delta program have found higher employment and earnings growth rates in counties served by the highways than those not served. While quantitative methods have only shown correlation and not causation between transportation and economic growth, qualitative evidence from some studies suggests that transportation has helped to facilitate the observed growth.

- Studies that include specific causal factors have shown that other factors are often at least partially responsible for impacts correlated with transportation improvements. Furthermore, transportation impacts can vary considerably depending upon a variety of local circumstances. Important factors include the presence of other economic development programs or activities; area size and type (rural, urban, population, etc.); and proximity to a larger metropolitan area. Local economic characteristics are also important but have been more difficult to describe or quantify.

- Bypass and other access restriction studies have generally found that net impacts to the community are neutral or positive in the long term. Some businesses that are heavily dependent on pass-by traffic can suffer negative impacts if traffic is reduced on the bypassed roadway. However, the impact on "destination" retail is usually not significant, and in some cases, businesses on the bypassed route may benefit from a more pleasant environment or increased parking.

- While there is an extensive range of studies on bypass impacts, most have not sufficiently examined the cumulative effects of corridor improvements, especially on basic versus non-basic industries.

- Qualitative data from surveys and interviews have generally been the only means of assessing whether benefits are redistributive versus generative, and why specific industries or locations have benefited to greater or lesser degrees from transportation improvements.

- Very little research was uncovered on intermodal access projects, non-highway proj??ects, or highway projects aside from new access, capacity expansion, or level-of-service improvement. Most recent railroad studies have looked at the negative impacts of closing or consolidating terminals and branch lines. Studies of airport impacts have been predictive rather than evaluative in nature.

2.8 Lessons Learned

This literature review has helped to illustrate what is known and what is not known regarding the economic impacts of transportation investments. It also illustrates the uses and limitations of the available data sources and analytical methodologies. While most of the studies reviewed have focused on highways, the techniques and lessons learned are applicable to all types of transportation projects as well as to economic development proj??ects in general.

Some lessons learned from this literature review include:

- **Economic impact studies can be done, and economic impacts can be measured.** For the most part, however, such studies have been performed by academics or by non-transportation agencies such the ARC and the EDA. Given the important role of transportation in local economies, both the U.S. and State DOTs could play a greater role in measuring and predicting the economic impacts of transportation projects.

- **Pooling findings from multiple studies may provide a clear picture of impacts of some types of investments but not of others.** For instance, there is already an extensive literature on local economic impacts of highway bypasses, and the relationship between those impacts and local community characteristics should be fairly well understood. For other types of highway improvements, the literature is generally not sufficient to draw common conclusions about specific impacts and causes.

- **Clear cause-and-effect relationships are not easy to establish.** The most informative studies use a combination of quantitative statistical techniques and qualitative assessments to identify causal factors and determine relationships. Multivariate regression is an effective way of introducing explanatory variables, measuring statistical significance, and considering time trends. Interviews with local officials and businesses provide equally important insights into local factors and considerations.

- **Studies must explicitly recognize and distinguish among three scales of impact**: 1) micro-scale business impacts, e.g., locations that are helped or hurt by a bypass, interchange, or access restrictions; 2) net benefits to the area or region served by the improved transportation facility; and 3) net benefits to the national economy as a whole.[1] The most appropriate data sources and analytical methodologies will differ among these three scales.

- **Study methodologies are driven by readily available data and budget limitations.** Measurement of local economic impacts often require a finer level of spatial detail than is provided by readily available county-level data. Good quality disaggregate economic data are available through private sources or primary data collection and can facilitate a much richer and more detailed analysis. The effort to obtain and analyze such data, however, is not trivial, and therefore it is not usually done. (Existing data sources and limitations are discussed in detail in Section 3.0 and Appendix A.)

[1] Benefits at the national level are typically measured through studies of industry productivity and business costs, which are beyond the scope of this review.

- **There is a need for more attention to other explanatory factors.** In particular, investigation is needed into how locality-specific factors and other explanatory variables can be identified, described, and incorporated into empirical studies and forecasting efforts. Descriptors of accessibility, an area's "economic potential," industry-specific factors, and exogenous trends represent particular areas of importance.

- **More attention is required to the time-dynamics of impacts.** Most studies reviewed simply measure change over a single period, assuming either a one-time project impact or a sustained constant impact on growth rates. In reality, some impacts may occur immediately while others may take many years to observe. Depending on the choice of the measure and measurement time period, some impacts may be underestimated, overestimated, or missed altogether.

- **More attention could be paid to the use of intermediate variables**, particularly traffic volumes and patterns, and their relationship to economic impacts. Traffic increases can serve as indicators of increased economic activity as well as potential generators of activity. Origin-destination surveys can help identify the sources and purposes of increased traffic.

- **Empirical studies should be designed with the goal of improving the prediction of transportation impacts.** The ultimate objective is to be able to forecast the benefits of a transportation project before it is built, and thus to decide whether it is worth doing. Data resulting from empirical studies should inform and improve forecasting methods.

- **Lessons can be learned from international as well as U.S. studies.** Studies on corridor improvements in France and Australia demonstrate how a range of research methodologies can be applied to explore trends and causal factors at the regional level. The Denmark-Sweden bridge project (Anderstig et al., 1999) has laid out a long-term evaluation program that combines both empirical data analysis and modeling. The Channel Tunnel study (Echenique and Wegener, 1994 as referenced in Anderstig et al., 1999) demonstrates an approach to examining the spatial extent of positive and negative impacts by industry.

2.9 Cited Sources

Anderson, Connie and Otto, David. *The Economic Impact of Rural Highway Bypasses: Iowa and Minnesota Case Studies*, Ames Iowa, Office of Advanced Planning, Iowa Department of Transportation, 1991.

Anderstig, Christer, et al. *The Regional Development Impacts of the Öresund Bridge.* Department of Infrastructure and Planning, Roal Institute of Technology, Stockholm, Sweden; Draft, August 1999.

Blackburn, Sabrina and Clay, James W., University of North Carolina at Charlotte. *Impacts of Highway Bypasses on Community Businesses,* North Carolina Division of Community Assistance and the I-40 Steering Committee, November 1991.

Brandow Company and Economic Development Research Group. *Evaluation of the Appalachian Regional Commission's Infrastructure and Public Works Projects.* Prepared for the Appalachian Regional Commission, September 1999.

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 24:1, 1992.

Brown, Dennis M. and Oliver L. Flake. *Rural Transportation: An Annotated Bibliography*. Prepared for the U.S. Department of Agriculture and U.S. Department of Transportation, February 1999.

Buffington, Jesse L. and Katie Womack. *Synthesis of Information Related to a Highway Problem, Effects of Highway Bypasses on Rural Communities and Small Urban Areas.* NCHRP Project 20-5, 1995.

Burress, David. *Impacts of Highway Bypasses on Kansas Towns,* University of Kansas for the Kansas Dept. of Transportation, 1996.

Burchell, Robert W., et al. *Public Works Program Performance Evaluation.* Prepared for U.S. Department of Commerce Economic Development Administration, May 1997.

Bureau of Transport and Communications. *Economics, Economic Benefits of Investment in Transport and Communications Infrastructure: Berrima and Mittagong Bypasses*, Canberra, Australia, 1994.

Cambridge Systematics Inc., JHK & Associates Inc., and HBRS Inc. *Economic Impacts of Restricting Left Turns*. Prepared for the National Cooperative Highway Research Program, Project 25-4, 1995.

Economic Development Research Group. *Economic Impact Analysis: St. Croix River Crossing*. Prepared for Wisconsin Department of Transportation and Minnesota Department of Transportation, July 1999.

Federal Highway Administration. *Linking the Delta with the Nation and the World.* Report FHWA-PD-96-007, 1995.

Forkenbrock, David J., and Norman S.J. Foster. *Highways and Business Location Decisions.* Economic Development Quarterly Vol. 10 No. 3, August 1996.

Gillis, William R. and K. Casavant. *Lessons from Eastern Washington: State Route Mainstreets, Bypass Routes and Economic Development in Small Towns*, EWITS Research Report #2, Dept. of Agricultural Economics, Washington State University, 1994. www.bts.gov/ntl/data/732.pdf.

Hartgen, David T. and Ji Youn Kim. *Commercial Development at Rural and Small-Town Interstate Exits.* Transportation Research Record 1649, 1998.

Isserman, Andrew. *The Economic Impact of the Appalachian Development Highway System: Some Empirical Evidence.* West Virginia University, March 1996.

Isserman, Andrew and Terance Rephann. *The Economic Effects of the Appalachian Regional Commission – An Empirical Assessment of 26 Years of Regional Development Planning.* Journal of the American Planning Association 61:3, Summer 1995.

Isserman, Andrew M., Terance J. Rephann, and David J. Sorenson. *Highways and Rural Economic Development: Results from the Quasi-Experimental Approaches.* 1989.

Kusmin, Lorin D., John M. Redman, and David W. Sears. *Factors Associated with Rural Economic Growth: Lessons from the 1980s.* U.S. Department of Agriculture Technical Bulletin No. 1850, 1996.

Lichtman, Liat. *A Study of New and Expanding Manufacturing Plants in Wisconsin during 1990-1996: Analysis of New and Expanding Manufacturing Plants along Wisconsin's Highway Transportation Corridors.* Wisconsin Department of Transportation, 1999.

Long, Gale A., Gary D. Long, and Raymond W. Hooker. *A Corridor Land Use Study: The Impact of an Interstate Highway on Land Values, Private Investment, and Land Use in Southwestern Wyoming.* College of Commerce and Industry, University of Wyoming, Laramie, Wyoming, 1970.

Lower Mississippi Delta Development Commission. *Lower Mississippi Delta Development Center, Inc: Final Report*. Prepared for Federal Highway Administration, September 1996.

Moon, Henry E., Jr. *Interstate Highway Interchanges as Instigators of Nonmetropolitan Development*. Transportation Research Record 1125.

Moore, Tyrel G. *Core-Periphery Models, Regional Planning Theory, and Appalachian Development*. Professional Geographer 46:3, August 1996.

Orus, Jean-Pierre. *The Economic Impacts Of Major Motorways Infrastructures: Main Lessons Of Ex Post Studies.* S.E.T.R.A – Ministère de l'Equipement, du Logement, des Transports et du Tourisme, Bagneux, France, 1996.

Parantainen, Juha. *Effects of Transport Infrastructure on Regional and Peripheral Development*. Ministry of Transport and Communications, Finland, 1999.

Payne-Maxie Consultants and Blayney-Dyett. *The Land Use and Urban Development Impacts of Beltways.* Prepared for U.S. Department of Transportation and U.S. Department of Housing and Urban Development, 1980.

Porterfield, Shirley L. *Producer Services: A Viable Option for Rural Economic Development?* Paper, 1990.

Rephann, Terance J. and Andrew M. Isserman. *New Highways as Economic Development Tools: An Evaluation using Quasi-Experimental Matching Methods.* Regional Science and Urban Economics 24:6, 1994.

Texas Transportation Institute, *Effects of Highway Bypasses on Rural Communities and Small Urban Areas.* AASHTO, 1995.

Weinberger, Rachel. *Commercial Property Values and Proximity to Light Rail: Calculating Benefits with a Hedonic Price Model.* Paper submitted to the Transportation Research Board, Washington, DC, 2000.

Wilbur Smith Associates. *Appalachian Development Highways Economic Impact Study.* Prepared for the Appalachian Regional Commission, July 1998.

Weisbrod, G. and R. Neuwirth. *Economic Effects of Restricting Left Turns*, NCHRP Research Results Digest, No. 23. Transportation Research Board, Washington, DC, 1998

Wisconsin Department of Transportation. *The Economic Impacts of Highway Bypasses on Communities.* Technical Report, 1998.

3.0 Review of Data Sources

3.1 Introduction

In this section, appropriate measures are first identified by which to analyze economic performance and growth before and after the construction of highway improvements. Each measure is then evaluated based on two criteria:

1. **Usefulness for Measuring Economic Development Impacts –** To what extent does the measure provide an appropriate indicator of economic growth and development?

2. **Reliability, Accuracy, and Timeliness of the data Sources that Document Each Measure –** No source provides perfect data. What are the pros and cons of each alternative source? What are the tradeoffs in precision, frequency, and detail of data provided by alternative sources?

Detailed information on each recommended data source, including coverage, frequency, possible applications in economic analysis, and the advantages and disadvantages of each source is contained in Appendix A. Current data from most sources are accessible via the Internet, so Internet addresses are provided as well as telephone numbers for technical support. Table 3.1 at the end of this section provides a convenient reference that allows researchers to access critical features at a glance. The table ranks each source according to a detailed set of selection criteria (see Section 3.11).

3.2 Measures of Economic Growth and Development

Seven basic measures of potential economic impacts of transportation projects have been identified:

1. Jobs;
2. Wages and other income;
3. Number of businesses;
4. Business volume and sales (output);
5. Population;
6. Capital investment (in buildings, equipment, and supporting infrastructure); and
7. Property values.

It is important to note that various types of economic impacts may occur at different geographic scales. For instance, employment markets are often described as regional, and employment impacts are most often measured at the county level. In contrast, real estate markets are often described as subregional, and property impacts are most often measured in terms of individual properties, blocks, or neighborhoods. As a result, the scale and nature of the highway project may very well affect the type of data that is most relevant or available.

Regardless of the level of geography being studied, there is a need for good baseline preproject information to provide a basis for time series analysis of project impacts. Further comparison of the observed changes with a control group of areas that had no highway improvements provides a valid approach to assessing the impacts of a highway project on local economic development.

The remainder of this section discusses the availability, uses, and limitations of each of these seven impact measures. Volume 2 of this report discusses and provides guidelines for the application of these measures in actual impact analysis.

3.3 Data Sources

Twenty-four data sources that report on the above measures have been identified. A critical analysis of each source and its strengths and weakness is provided in Appendix A. The identified data sources fall into four categories:

1. **Federal Data –** These include data series published by the Census Bureau, the Bureau of Labor Statistics (BLS), and the Bureau of Economic Analysis (BEA).

2. **State and Local Data Sources –** These include data on jobs and population published by the State agencies. Also included are data on investment and property values that are available from local government sources.

3. **Private Data Sources –** These include private companies providing market and real estate information. Some of these data are free via the Internet. They are typically available only for a fee, which is sometimes steep.

4. **Interviews and Field Observations –** Telephone or in-person interviews with local businesses, public officials, and private organizations in the project area are a potential source of information, which cannot be obtained from public data sources. Field visits can also provide additional information on the nature of development impacts. These sources provide contextual insight into qualitative aspects of economic impacts.

The options for using specific data sources for time series analysis of these seven measures are explored in Section 4.0. Findings regarding the overall utility of each source are summarized in Table 3.1 at the end of this section.

3.4 Data on Jobs and Wages

3.4.1 Overview

A change in the number of jobs in a project area is perhaps the best indicator of the economic impact of a highway project. The pay level of those jobs is also an important indicator of job quality. The *Employment Security (ES) 202 Covered Employment and Wages* data, most commonly referred to as ES-202,, from the BLS is probably the best source of data on the number of jobs, number of businesses, and wage levels by industry in a given area. ES-202 is the most current and comprehensive source of detailed data on jobs, encompassing all positions covered by unemployment compensation. (Excluded are jobs not covered by unemployment, i.e., self-employment, military, farm, private household, and railroad workers.)

ES-202 data on employment and wages are published for detailed three- and four-digit Standard Industrial Classification (SIC) industries. This detail enables in-depth analysis of qualitative measures of employment, such as whether the project has produced higher skilled or better-paying jobs than was the case before the highway. For example, some highway projects may result in the development of a large volume of retail and service uses, which could in some cases create a greater number of low-paid, less-skilled positions. It is important to distinguish these impacts from projects resulting in more highly skilled, well-paying jobs. Ideally, ES-202 data can be compared to unemployment data and population educational attainment data (from the census) to assess the mix of jobs created.

ES-202 data are available for metro areas, counties, and labor market areas. More detailed ES-202 data for small cities is usually available from the *State Labor Market Information* (LMI) agencies, which supply the ES-202 information to BLS. Data are collected quarterly and are released by federal sources about nine months after the end of each quarter. Lead times for the ES-202 data from state LMI's is usually shorter – about three to six months. Federal data for detailed industries in rural areas are not disclosed in cases where there are fewer than three businesses in a given industry due to confidentiality concerns. However, these data are sometimes available from the state LMI's depending on their disclosure policies. It is important to note that ES-202 data are subject to significant fluctuation over the course of any given year, due to the seasonal nature of many jobs and industries, as well as some instability in business job reporting practices. In addition, employment data are subject to some error associated with reporting by employers with multiple locations within a single region.

Another good source for similar data on employment and payroll is *County Business Patterns*. County Business Patterns is actually built upon ES-202 data and is thus subject to the same coverage limitations and fluctuations as the ES-202 data. Unlike ES-202 data, however, County Business Patterns excludes government employment. This is usually not a big problem because government jobs are generally not particularly relevant for highway impact analysis. The major drawback is the delay in publication. County Business Patterns is an annual series, but data are not published until 18 months after the end of the year. Thus, the ES-202 are not only more comprehensive, they are available in half the time. If they are procured at the state level, the lead time can be reduced to three to six months. On the other hand, County Business Patterns is available for ZIP codes

which, depending on the project, may be a better fit than the ES-202 county-level data. Unfortunately, there is a high prevalence of data withholding in the ZIP code business patterns, since data are not provided whenever there are less than three establishments in the same four-digit SIC group in any specific ZIP code area.

Data listing individual businesses within a project area are available from *Dun & Bradstreet's* Marketing Division, whose *Prospecting Records* have information on SIC, employment size, and sales volume for individual companies. Data can be requested for cities, counties, ZIP codes, or telephone area codes. Based on addresses, groups of businesses in subareas can be identified and separately analyzed. Detailed data can be analyzed by SIC code and there are no non-disclosure requirements so no data are withheld due to confidentiality concerns. At $435 for 1,000 listings, costs for data can be high for areas with a large number of businesses.

Data on jobs and wages in major metro areas are also available from BLS's *Current Employment Statistics*, but only manufacturing industries are covered in depth. These data are published monthly and have a lead-time of just 60 days. BEA's *Regional Economic Information System (REIS) Employment Series* also has jobs by major, single-digit SIC division. These data are much less current; there is a 16-month delay in publication of this annual data series. Even less current is the Economic Census, conducted every five years, which provides employment and payroll information for 18 major industries that are recognized by the new *North American Industrial Classification System* (NAICS; see Section 3.6 for a full discussion of the Economic Census and NAICS).

Finally, it is worth looking at the monthly *Local Area Unemployment Statistics* (LAUS) from BLS to analyze pre- and post-project unemployment rates. These data are available for cities and counties as well as for larger areas. They are very current, being released just 60 days after the end of each month. Like other data, they should be analyzed with caution. Change in the unemployment rate can be due to myriad factors and, since only aggregate unemployment rates are published, no fine-tuned analysis by industry or occupation is possible.

3.4.2 Wages by Industry

Three of the sources on wages mentioned above provide data by industry. This is normally the preferred method for economic analysis of structural and qualitative changes in the workforce. These sources include:

1. **ES-202** Data from BLS and state LMI's give average annual and weekly wages by four-digit SIC.

2. **Current Employment Statistics**, the most current and reliable source for average hourly manufacturing wages, provides two- to three-digit detail. Other industries are covered only at the single-digit level.

3. **County Business Patterns** provides payroll data by four-digit industry, from which averages can be calculated. However, the data are 18 months old by the time of release.

Other pros and cons of these sources have been discussed in the previous section.

3.4.3 Wages by Occupation

In some cases, sufficient detailed industrial wage information is not available by industry due to confidentiality or other issues. In these cases, the next best fit could be data on wages by occupation. This is particularly true when the occupational mix of a new business attracted by a highway is known or if the majority of workers are engaged in similar occupations. BLS's *Occupational Employment Statistics* provides very current data on mean and median hourly wages and mean annual wages for over 700 detailed occupations. Data are only available, however, for major metropolitan areas, but metro averages can be adjusted for non-metro areas. The *National Compensation Survey*, a source for average hourly earnings for selected occupations, uses a different structure with fewer occupational categories. This source also reports on average hours per week worked. It covers the largest 79 metro areas in the country as well as a sample of non-metro counties, but data are provided for only 19 of the latter. Annual data for the calendar year are released in July of the next year.

3.4.4 Total Income

Other sources of income, in addition to wages, include investments and transfer payments. Because a highway project is less likely to impact wealth and poverty as much as wages, these measures are usually of secondary or tertiary interest to the economic impact analyst. However, for some projects in areas of multiple deprivation, for example, it may be worthwhile to consider the proportion of population receiving transfer payments before and after the project. In other cases, it could be interesting to calculate Location Quotients to compare an area's income structure with regional, state, or national averages both before and after the project. This allows the analyst to determine whether the project has addressed imbalances in the local economy that may have been caused by isolation or poor access. It should be noted that sources providing data on total income report on those living, rather than working, in the project area. The reverse is true for wage data.

BEA's *REIS Personal Income Series* measures a community's personal income from all sources, including wages, investments, and transfer payments for metro area and counties. Per capita income data are also provided. Wage data are reported by two-digit SIC code. This annual series is released 18 months after the end of the year, so that the most current data available can be up to 30 months old. Depending on how long ago the proj??ect was completed, this may or may not be a concern.

The Internal Revenue Service publishes the *County Income Data Series*, providing detailed information on adjusted gross income for counties. Data on the community's total income from wages, dividends, interest, rents, and royalties are available. Annual data are released two years after the end of the year and can be up to three years out of date at any given time.

In contrast to the sources cited above, the income data in the *Decennial Census* are focused on median family and non-family income. Median income data are reported separately for households with wage, self-employment, interest, public assistance, social security, and retirement income. Mean and per capita income data are also available by household size, composition, and race. Data are available down to the block level but they can be up to 12 years old. The Census Bureau also publishes the *Small Area Income and Poverty Estimates*, which is the most current and comprehensive source on the poverty rate. Data are published biennially for counties and school districts. This information can be from three to five years old at any given time. The *American Community Survey*, which is now being piloted in 10 locations, will provide more timely and comprehensive data on income, wealth, and poverty.

3.5 Data on Number of Business Establishments

Highway projects can affect business attraction, expansion, closure, or contraction of businesses. Analysis of changes in the total number of businesses in the project area is usually of more secondary interest to the economic impact analyst than are impacts on total jobs and wages. It is also important to identify changes in the mix of businesses, however, to identify whether the new jobs are being created in retail, service, professional office or other types of businesses, and for analyzing overall structural changes in the economy (such as business size and diversity).

The top three sources for jobs – *the ES-202 Covered Employment and Wages, County Business Patterns,* and *Dun & Bradstreet's Marketing Data* – all provide detailed information on the number of firms by four-digit SIC for counties. County Business Patterns Geographic Area Series also provides information on business size. Based on these data, it is possible to examine changes in the structure of employment by detailed industry. County Business Patterns data are available for ZIP codes as well as counties and metro areas. The Geographic Area Series of the Economic Census also provides information on the number of businesses in each of 18 major industries recognized by the NAICS system for counties, cities, and ZIP codes. This is detailed in the next section.

Some mapping programs and geographic information systems (GIS) may be available that show the mix and locations of commercial business establishments. These sources are updated annually based on Yellow Pages listings, and hence suffer from issues regarding level of coverage and updating. They can provide a means of tracking changes in business establishments over time, but they do not provide accompanying data on employment or wages.

3.6 Data on Business Sales Volume

Changes in business volume are an important indication of the impact of highways on the economy of the project area. The most comprehensive and detailed source for information

on business volume is the *Economic Census.* This is published for the following 18 major industries recognized by the new North American Industrial Classification System:

1. Mining;
2. Utilities;
3. Construction;
4. Manufacturing;
5. Wholesale Trade;
6. Retail Trade;
7. Transportation & Warehousing;
8. Information;
9. Finance and Insurance;
10. Real Estate Sales, Rental, and Leasing;
11. Professional, Scientific, and Technical Services;
12. Management of Companies and Enterprises;
13. Administrative & Support & Waste Management & Remediation;
14. Educational Services;
15. Heath Care and Social Assistance;
16. Arts, Entertainment, and Recreation;
17. Accommodation and Food Services; and
18. Other Services.

The NAICS system recognizes 13 different service industries, whereas the old SIC system recognized only three.

In addition to providing detailed sectoral (four or more digits) information on employment, payroll, and businesses, the Economic Census provides some measure of business volume that is appropriate to each industry, such as sales receipts, revenues, value of shipments, value added, or value of work done. The Economic Census is conducted every five years. There is an 18- to 30-month delay in publication so, during some periods, information can be more than six or seven years old.

Much more current but much less detailed is the information on Gross Metropolitan Product that is disseminated by the U.S. Conference of Mayors. These data show total output and export sales for the country's largest 317 metropolitan areas. No industry detail is provided and data are published only for metro areas, so this series is not useful for rural areas. These annual data are released nine to 12 months after the end of the year.

For states with retail sales taxes, many states prepare annual tabulations of tax data that can be used to track changes in retail sales at the county and sometimes, at the city level. Some states and localities have special taxes, such as hotel taxes that are useful for measuring

tourism impacts on the local economy. Corporate income tax data are also available from some states, but these should be interpreted with caution. Gross sales are a better indicator of business volume.

3.7 Data on Capital Investment

Private sector capital investment in buildings, plant, and equipment (by new and expanding businesses) is a leading indicator of positive effects on future economic activity. The link between private capital investment and employment growth is nebulous, however. When capital investment occurs, employment in expanding firms may remain the same or it may contract, as capital replaces human labor. Particularly in a manufacturing environment, value added and value of shipments may be increasing while employment is decreasing. Therefore, it can be important to look at trends in private capital investment as well as in employment. The extent of public as well as private investment in supporting infrastructure (including water and sewer pipelines, and fiber optic cable) may also be of interest, either as an indicator of investment to support local economic growth or as an explanatory factor limiting local economic growth despite highway access improvements.

Unfortunately, there are few good published sources for capital investment information. The *Census of Manufacturers,* published every five years as a part of the Economic Census (discussed above), gives data on capital investment by manufacturing industries. Data are provided by very detailed industrial categories. The main drawback is the long lead-time for release of the geographic data for counties and smaller areas – this can range up to 26 to 42 months. For older projects that have been completed for some time, this may not be a major issue. But most analysts like to get the most current data possible in order to measure trends over the longest term possible.

New highways often spawn residential development as well as business investment. The Census Bureau publishes the *Residential Building Permit Data Series.* These data report on the number and value of building permits issued in counties and smaller places for single family houses and for apartments in two-, three-, four-, and five-unit structures. Data are released monthly with a six-month delay in release so they are relatively current. Newer data can usually be accessed directly from cities and towns. Local governments may be able to provide more data on the volume of commercial and institutional investment in the project area.

3.8 Data on Property Values

Real estate values reflect the attractiveness of locations as places to locate businesses or as places to live. In general, rising property values mean increasing wealth for property owners, and often indicate expectations of opportunity for increasing business activity. Unfortunately, sources of data on real estate values tend to be more fragmented and

localized. No central agency collects systematic information on property values. The most comprehensive source of real estate values is normally the local city or county *Assessors Office*. The reliability of these data in reflecting market values will vary according to assessment practices. But for most non-metro areas, these will be the only data on real estate values available. The advantage is that the records are entered individually, normally by address, so it's possible to select a subarea for analysis.

In most large metropolitan areas, prominent local real estate firms produce quarterly and annual market data on sales prices, rents, vacancy, absorption, and construction of commercial and industrial properties. Some data sources provide historical analysis of actual lease transactions. Data are published for Central Business Districts as well as suburban employment centers. For commercial properties, data are published for office, warehouse, manufacturing, and high-tech space. These data can be used to compare changes in prices and other market indicators with a control group of properties located outside of the proj??ect area. Many of these data are available via the Internet free of charge but moderate charges are sometimes levied for these. A good free source of market data is listings of commercial and industrial properties available for rent and for sale. These are widely available via the Internet.

Another good barometer of commercial property market performance is *FW Dodge's Commercial Property Market Indicators*. These are available free of charge via the Internet for the top 58 metro areas of the country. Supply and demand for office, hotel, retail, and warehouse properties is evaluated and indexed. Metro areas are ranked according to trends in vacancy and in volume of new construction. Also available for most metro areas are databases on residential sales that are commonly assembled by a local business publisher (e.g., *Banker & Tradesmen* in Boston). These are based on documents filed with local Recorders of Deeds Offices. They typically contain records of individual properties with addresses, dates, prices, and size information. They are excellent and very current sources of detailed, current data. Unfortunately, they cover only residential properties but are well worth evaluating for areas that have experienced significant housing development as a result of highway improvements.

3.9 Data on Population Change

There is a clear link between economic growth and population increase. In most cases, economic growth results in an expansion of the population in the area, as new people are attracted to the area by job opportunities. Sometimes, though, a highway project may be associated with impacts on residential development and population change which are not proportional to the increase in business activity and jobs. In such cases, there may be either positive or negative fiscal impacts on local government, in the form of an imbalance in local public revenues and expenditures.

There are two good, current sources of data on population size and components of change: 1) the Census Bureau's Population Estimates Program; and 2) individual state agencies responsible for demographic analysis.

The Census's *Population Estimates Program*, released annually seven months after the end of the data collection period, estimates the current population and components of change including births, deaths, and migration. The *Local Area Unemployment Statistics* (LAUS) from BLS are the most current data upon which to assess impacts on local unemployment rates among the resident labor force. Pre- and post-project unemployment rates from LAUS should be evaluated. These data are available for cities and counties as well as for larger areas. They are very current, being released just 60 days after the end of each month. Like other data, they should be analyzed with caution. Change in the unemployment rate can be due to myriad factors and, since only aggregate unemployment rates are published, no fine-tuned analysis by industry or occupation is possible.

Of interest are not only changes in the number of people living in the area, but also the characteristics of the new people, their income, educational levels, and skills. The best source for in-depth information on changes in characteristics of the labor force, including sex, race, age, wages, occupation, and employment by industry, and class of workers is the *Decennial Census*. Data are available for metro area, cities, counties, census tracts, ZIP codes, and block groups. Unfortunately, the Census is only published every 10 years. Since it takes two years to prepare the data for release, they can be up to 12 years old. The *American Community Survey*, however, which is now being piloted in 10 locations, will provide an annual update of labor force and other information on characteristics of the population. The survey is being deployed in phases over the next decade. Results will be available for small areas of under 30,000 population by 2008, and annually thereafter. If it is successful, the American Community Survey will provide a vital source of current demographic and labor force data.

3.10 Unpublished Data Sources

No matter how good published data sources are, the data are meaningless unless the researcher knows the story behind the numbers. Coming to grips with the reality of the project entails interviews with project participants as well as a site visit to witness first hand the development generated in the vicinity of the highway project. These are vital, if not entirely scientific, methods.

3.10.1 Interviews and Surveys

The quantitative, published data sources cited on the previous pages do not tell the whole story about the project and its impacts. It is essential to supplement quantitative sources by interviewing people in the project area to provide the background regarding the impetus and goals for the project and its perceived direct and indirect outcomes. For some small, rural areas, interviews will be the only way to research impacts on such factors as real estate values and prices, which are not covered by published, central data sources. There are four main groups to interview:

1. **Government –** Local planning, economic development, and elected officials can provide contextual information. Key issues to probe with local officials include the need

for the project, economic development goals, and the extent to which these goal have been achieved. It is also worth getting estimates of project impacts on employment, wages, land values, quality of life and other local economic indicators to compare with published sources and to assist in interpreting quantitative data. In small and rural areas, for which published data sources are not available, interviews may be the only means of determining impacts such as levels of capital investment and trends in real estate values.

2. **Businesses –** The businesses within the project impact area should be interviewed about trends in employment, earnings, and capital invested and the project's impact on investment decisions. Both businesses within the project that have benefited by highway improvements as well as those outside of the project area who may have lost trade due to the new route should be consulted.

3. **Local Property Market Professionals –** Developers and real estate agents can provide quantitative information as well as contextual information and qualitative impressions of project impacts on sales values, rents, vacancy, and occupancy. In non-metro areas that are generally not covered by published data sources, interviews with local real estate professionals will be the only source of real estate market impacts.

4. **Shoppers and Tourists –** In cases where a highway project has generated retail and tourism development, intercept interviews can be conducted with shoppers and tourists in the area regarding spending, visitation, and origins.

In-person surveys can be time-consuming and expensive. Telephone surveys are a more cost-efficient way to gather data, particularly when the analyst is based outside of the local area. Intercept interviews with tourists and shoppers must normally be conducted on site, however. Although interviews with local project administrators and beneficiaries are time-consuming and somewhat subjective, they are an essential collaborative source that complement collection of published, qualitative data and help to interpret and provide contextual information about the project and its impacts.

3.10.2 Windshield and License Plate Surveys

A "windshield survey" is an inventory of what is seen out the window of a passing car. Seeing is believing, so if feasible, a visit to the study area can be an invaluable way to come to grips with the reality of the project and with the nature of the development that it has spurred. There is no substitute for first-hand observation of the project, the area it serves, and the commercial and residential development that has been fostered by access improvements.

A "license plate survey" is an inventory of the license plate numbers on cars found in particular parking lots. In some but not all states, the state motor vehicle department will provide government transportation agencies with the home ZIP codes for the license plate registrations. While this source excludes corporate vehicles and rental cars, it can be used as an option for measuring the market area for retail activities or visitor attractions. If surveys are conducted before and after the highway improvement, the percentages of vehicles by origin market can be compared to evaluate shifts in the market area related to the change in the highway system.

An additional potential source of information on market areas is a breakdown of billing ZIP codes associated with credit card purchasers, which may be obtainable from specific businesses in a project study area. Information collected before and after the highway improvement can be similarly compared to evaluate changes in the locations of customers shopping in the area.

3.11 Evaluation of Alternative Data Sources

In summary, there are tradeoffs in terms of comprehensiveness, level of detail, currency of data, and quality of data among alternative sources. Each source of data discussed in the previous section has been listed and evaluated in Table 3.1. Each source has been assigned an "Overall Rating" based on the following criteria:

- How current and frequent the data are;
- Availability of data for small areas;
- Level of industrial detail;
- Comprehensiveness;
- Quality of data collection and sampling methodology;
- Cost;
- Ease of accessibility via the Internet;
- Responsiveness of technical support; and
- Potential applications of data to analysis of economic impacts of transportation projects.

The ratings range from one (the best) to five (the worst). This table provides a convenient and quick reference by which to evaluate alternative data sources. Additional information on these sources, including Internet access and technical support, is provided in Appendix A.

Table 3.1 Evaluation of Data Sources for Economic Impact Analysis

Source	Data Series	Data Measured							Geography[a]				SIC Level		Most Current	Overall Rating[b]
		Pop.	Jobs	Income	Firms	Sales	Invest.	RE Val.	Metro	County	City	Small	Highest	Freq.		
BLS	LAUS (Unemployment)		x						x	x	x		0	Monthly	Jan-00	3
Census	Decennial Census	x	x	x					x	x	x	x	NA	10 Years	1990	4
BLS	Covered Empl. & Wages		x	x	x				x	x	x		4	Quarter	1998-99	1
Census	County Biz Patterns		x	x	x				x	x		x	4	Annual	1997	2
D & B	Marketing Data		x		x	x			x	x	x	x	4	Monthly	Jan-00	2
BEA	REIS Employ. Series		x						x	x			1	Annual	1997	3
BLS	Current Empl. Statistics		x	x					x				2[c]	Monthly	Jan-00	3
BLS	Occupation. Empl. Stats			x					x				4[d]	Annual	1999	2 to 3
BLS	Natl. Compensa. Survey			x					x				4[d]	Annual	1998	4
BEA	REIS Income Series			x					x	x			2	Annual	1997	3
IRS	SOI County Income			x					x				0	Annual	1997	3
Census	Small Area Income. Est.			x					x			x	NA	2 Years	1995	5
Census	Economic Census		x	x	x	x	mfg.		x	x	x	x	4	5 Years	1992	3
USCM	Gross Metro Product					x			x				NA	Annual	1998	4
Census	Res. Bldg. Permit Data						x		x	x	x	x	NA	Monthly	Sep-99	3
Loc. Gov.	Building Permit Data						x			x	x	x	NA	Monthly	Jan-00	2
Loc. Gov.	Assessor's Data							x		x	x	x	NA	Varies	Varies	3
Realtors	Local Com'l. RE Data							x	x		x	x	NA	Quarter	Dec-99	2
Realtors	Res. Sales Transactions							x	x		x	x	NA	Quarter	Jan-00	3
FW Dodge	Com'l. Prop. Mkt. Ind.							x	x					Annual	1997	2
Census	Population Estimates	x							x	x			NA	Annual	1999	1
States	State Pop. Data	x							x	x	x		NA	Annual	Varies	2
Leaders	Interviews	x	x	x	x	x	x	x	x	x	x	x	2	NA	Present	1
–	Field Observations				x		x		x	x	x	x	1	NA	Present	1

[a] "Small" area means by ZIP code, School District, Area Code, or address.

[b] Overall Rating: 1 = best; 5 = worst.

[c] Manufacturing sectors are reported for two-digit SIC's and a few three- and four-digit groups. Data are reported by one-digit SIC for non-manufacturing.

[d] Employment data are reported for detailed occupations, not industry.

4.0 Interviews with Agency Staff and Researchers

4.1 Overview of Data Collection and Analysis Process

This section describes findings from a series of personal interviews, which the project team conducted with interested staff of state DOTs and academic researchers. The interviews were conducted to obtain insight into how these parties view the available methodologies and level of public interest in measuring economic impacts of completed highways. The interviews were conducted with staff of nine state DOTs (Arizona, California, Colorado, Indiana, Mississippi, Oregon, Pennsylvania, Virginia and Wisconsin) plus researchers at six other organizations (the Appalachian Regional Commission, University of Illinois, University of Iowa, University of Virginia, Upjohn Institute for Employment Research, and U.S. DOT Volpe Center).

This summary of findings from those interviews is presented in terms of two major lines of inquiry:

1. **State DOT Interest in Measuring Economic Development Impacts –** To what extent do state DOTs seek to conduct studies to measure the economic growth and development effects of their past highway investments?

2. **Research Designs and Analysis Methods –** What kind of data sources and analysis methods have been used by DOTs and researchers to measure and isolate the economic growth impacts of specific highway projects? What methods are needed to isolate the economic impacts of specific highways?

4.2 Interest in Analyzing Economic Development Impacts

A significant component of the interviews with state DOT staff focused on the policy aspects of economic development in transportation planning; specifically, how the DOT considers economic impacts, what types of impacts are considered, and under what conditions are they considered. DOT staff members were also asked about their data and information needs as well as their interest in participating in future empirical studies. The findings are summarized in Table 4.1 and described in the text that follows.

4.2.1 Consideration of Economic Development in Transportation Planning

Each of the state DOT interviewees was asked whether they currently give consideration to economic development impacts in project or systems-level planning. Since states with a known interest in economic development were specifically targeted for the interviews, economic benefits were not surprisingly given at least some consideration in most of these states, including California, Indiana, Mississippi, Pennsylvania, Virginia, and Wisconsin.

The specific way in which economic development issues are considered varies from state to state, with the following approaches:

- California Department of Transportation (Caltrans) has looked at economic impacts on a case-by-case basis, primarily focusing on the impacts of bypasses on communities. Caltrans also requires an economic impact analysis as part of the environmental review conducted under the state's California Environmental Quality Act (CEQA) requirements.

- Indiana DOT has developed economic analysis tools that it uses to assess major corridor investments. Economic development is included in the purpose and need statement for some proposed projects serving underdeveloped areas of the state.

- Mississippi DOT has undertaken a statewide highway investment program largely for the purposes of economic development. The DOT has the objective of putting the entire state within 20 miles of a four-lane highway.

- Pennsylvania DOT typically addresses economic development issues in the needs assessment stage of the long-range transportation planning and programming processes. Some projects are included with a primary motivation of spurring economic development and creating jobs.

- Virginia DOT has also undertaken projects specifically for economic development purposes in underdeveloped areas. The DOT may conduct quantitative or qualitative analysis of project impacts in response to any questions that may arise.

- Wisconsin DOT has taken the most comprehensive approach to integrating economic development into transportation planning. The DOT has established an Economic Development and Planning Section that actively conducts in-house research. The Department has undertaken economic impact studies for specific corridors and for community bypasses. In its long-range plan, Wisconsin has established a statewide corridors plan with the goal of promoting economic development, and has explicitly involved business and economic development organizations in the planning process.

Three state DOTs were also contacted that do not explicitly consider economic development as a separate element of their *highway* planning process: Arizona, Colorado, and Oregon.[1] These DOTs sometimes conduct user cost-benefit analysis of highway projects,

[1] Oregon DOT has conducted assessments of economic development impacts for airports and rail lines.

but they do not measure economic impacts such as job creation, nor do they select projects based on these impacts. The DOT staff that were interviewed cited various reasons for this perspective:

- They felt that an assessment of traffic levels or user benefits was sufficient to make comparisons among highway projects and gauge a project's benefits versus costs;
- They did not feel it was the role of the DOT to favor specific areas of the state;
- Economic development was not a concern in some areas, or was actually undesirable locally due to existing growth pressures (e.g., the mountain region of Colorado); and
- They felt that there were significant limitations in existing economic assessment methodologies, and/or did not have the resources to apply these methodologies.

While these viewpoints represent only a small sample of DOT staff, they may help to indicate why other state DOTs have not traditionally considered economic development impacts in project or system planning. The state DOTs that do consider economic development appear to be motivated by a variety of factors. The first factor may be a legislative mandate, such as Indiana's establishment of "commerce corridors" in 1991 or Mississippi's 1987 highway program. The second is inclusion of economic development as an objective in the long-range transportation plan, as evidenced in Indiana and Wisconsin. The third is pressure from local community and business leaders to serve their area for economic development purposes, as evidenced in California, Mississippi, Pennsylvania, and Virginia.

4.2.2 Types of Impacts of Interest

The most common measure of impact of interest cited was job creation or employment growth. Other impacts of interest cited by one or more states included business attraction/location, business income, new investment, and local tax revenues. While a number of states expressed an interest in benefit-cost ratio or internal rate of return, these measures are also commonly used by states that do not explicitly consider economic development benefits. Indiana appeared to be unique in that its estimation of benefit-cost ratio is based on macroeconomic growth benefits in addition to direct user benefits. Mississippi noted that it viewed freight traffic volumes as a good indicator of economic development.

Economic benefits can be viewed at three scales within a state: first, to the state as a whole; second, to specific regions within the state; and third, to local businesses directly affected by a project. All of the six states interviewed with an economic interest were at least concerned with the second level – using transportation investments to benefit specific regions of the state. Indiana, Mississippi, and Wisconsin have also taken a broader viewpoint, with transportation investments seen as improving the economic health of the state as a whole. Potential negative localized impacts have been addressed by DOTs in California, Indiana, Virginia, and Wisconsin, depending on the nature of the project and local concerns.

4.2.3 Data and Information Needs

The state DOT staff interviewed were also asked about data, information, and methodologies that would be useful to them in assessing the economic benefits of proposed transportation improvements.

- A need cited by most staff was for robust yet easy-to-use tools to estimate the benefit-cost and/or economic impacts of specific projects. Agency staff from at least three states mentioned that existing tools such as MicroBenCost required too many assumptions or were not easy to use. Indiana DOT staff would like to see federal investment in standard, sketch-level benefit/cost tools. Indiana and Virginia also noted the need for tools to assess localized impacts. As a result of frustration over the cost and complexity of existing tools, Caltrans has developed their own their own spreadsheet benefit-cost tool, Cal B-C, which can address some economic issues.

- Staff from several state DOTs also expressed a desire for better information on the linkages among transportation, other factors, and economic development. This included staff from a couple of the states that have not considered economic development issues in part because they cited a lack of information. In general, the interviewees from state DOTs generally acknowledged that transportation is only one of many factors influencing economic development. They wanted to know under what conditions transportation would (or would not) stimulate development, and what other factors are necessary to make that happen. Their suggestions were that: 1) a series of case studies on this topic could be helpful, 2) information on business location factors would be useful, and 3) it would be useful to have more information on how economic benefits actually change after a project is completed and the local economy adjusts to it over time.

- Empirical evidence on actual results from built projects (which may take the form of impacts, elasticities, etc.) is another type of information that would be useful. Virginia DOT has applied data from other studies to estimate impacts of proposed projects, and would appreciate more of this type of data. Staff of other state DOTs indicated that they have cited figures from other studies (e.g., return on investment) to justify highway investment programs. Some state DOTs have used numbers from only one or two studies that were published through the American Association of State Highway and Transportation Officials (AASHTO) or conducted locally. Their staff representatives noted that these numbers may not be applicable to their particular situation, but did not know of better evidence to cite.

- Staff from three state DOTs expressed a desire for better baseline economic data from which to construct project impact forecasts, including: 1) freight/commodity flow data, 2) small-area employment forecasts and linked population/employment forecasts, and 3) income, tax, and other economics-related data below the county level.

- Staff from one state DOT, which already plans to undertake an empirical study of highway impacts, asked for assistance in defining control groups, measures of impact, and monitoring methods for long-term evaluation. Staff from another state DOT noted a desire for a check list and a set of standard methodologies for staff who do not have extensive experience with economic impact analysis.

4.2.4 Interest in Participating in Future Studies

All of the various state DOT staff members who were interviewed expressed some interest in participating in future empirical studies of transportation impacts. At the same time, they generally noted limitations in their own funds and a reluctance or inability of the DOT to expend significant resources on this topic. One exception is Wisconsin DOT, which is now sponsoring an *ex-post* evaluation of improvements to a highway corridor that had been the subject of an economic forecasting study. Indiana DOT staff also noted that Purdue University may be conducting an *ex-post* study of highway improvements within their state.

4.3 Research Designs and Analysis Methods

Interviews were conducted with researchers who have studied the economic impacts of highway investments for federal agencies, state DOTs, or as independent research proj??ects. Researchers were asked about the data sources and methodologies used in their studies, and about data and methodological limitations that have hindered studies in this field by themselves and others. Researchers were asked what gaps existed in current knowledge, and how these gaps could best be filled.

4.3.1 Data Analysis Limitations

A wide range of research has been conducted over the past two decades with the intention of identifying the economic impacts of highways. Discussions with researchers, however, indicated broad agreement that the studies to date have all had data limitations. These limitations fall into three major categories:

1. **Measurement of Economic Changes –** *Measures of economic change have been primarily available at a level of county or larger.* That is a crude spatial level of impact measurement, but time series (panel) data on economic characteristics is widely available only at that spatial level or broader state level. The result has been a focus largely on net aggregate changes in employment or output, rather than an understanding of how highways may affect business turnover, industry mix, attraction of new business and/or growth of existing businesses in areas served by highway interchanges and other access points.

2. **Measurement of Transportation Changes –** *Measures of transportation access changes have been primarily measured at the county level* – in terms of capital stock, lane miles or average distance to interstate highways. Those are crude measures of the behavioral "driver" for economic impacts, since they are not sensitive to differences in highway access, travel times, or reliability among locations affected by a new highway.

3. **Control for Exogenous Changes –** *A wide variety of analysis methods have been used to "control" for non-transportation factors* affecting observations of pre/post-project changes in economic nearby conditions. They all have serious drawbacks, however, which limit the ability to establish "causality" between the highway investments and any observed economic growth surrounding them.

4.3.2 Five Basic Study Designs

Of the above data limitations, the first two imply the need for research designs that can provide *measurement* of transportation level-of-service changes and economic changes which are responsive to impacts of specific highways. The third data limitation implies the need for *analysis methods* that can isolate impacts attributable to specific highway system improvements. Interviews with researchers, as well as professional experience, indicate that these needs are intertwined.

The interviews further identified a general agreement among researchers that *the key challenge for assessing impacts of highway investments is to distinguish the economic changes attributable to highways from the economic changes attributable to other factors.* In all cases, this requires some sort of direct *comparison* or statistical *control* to (implicitly or explicitly) establish a "counter-factual" base case – i.e., a representation of what would have happened in the affected area if the highway investment had not been made. The impact is then calculated as the difference between a) the actual changes in economic conditions in the affected area and b) the changes that hypothetically would have been expected to occur without the highway improvement.

Based on interviews with researchers and a review of the literature, five approaches can be identified to control for exogenous factors. These approaches have all been used in prior studies, both individually and in combination. They are:

1. Time Series Trend Comparison;
2. Shift-Share Trend Analysis;
3. Matched Comparison Areas;
4. Time Series / Cross-Sectional Regressions; and
5. Pre / Post Case Studies.

Each of these approaches has its defenders who point out its benefits as well as the deficiencies of the alternative approaches. Overall, there is a clear consensus that there is no *perfect* way to distinguish the economic development impacts of highway projects. Taken together, the comments of the interviewed researchers provide a clear view of the trade-offs involved in each approach, and they point to possibilities for hybrid data analysis studies in the future. Following is a summary of each approach, including:

- The calculation methodology and underlying logic;
- Examples of application; and
- Advantages and limitations of the approach.

1. Time Series Trend Comparison

Calculation and Logic – This approach requires measurement of the rate of change in business output or employment over a period of time spanning the pre- / post-construction time period. Those changes are observed for 1) a region where major highway system

improvements have been made, and compare them to 2) a surrounding broader area where there have not been such significant highway improvements. Presumably, any changes over time attributable to business cycles, technology development or broader economy expansion would be reflected in economic change for both areas, so we can infer that any difference in economic growth rate between the two is attributable to the highway investment.

Applications – This general approach was used for the Lower Mississippi Delta Study, which compared employment growth in the Delta region to national growth rates. (Federal Highway Administration. *Linking the Delta with the Nation and the World.* FHWA-PD-96-007, 1995; also *Lower Mississippi Delta Development Center, Inc: Final Report.* Prepared for FHWA, 1996.) This approach was also used in the Wisconsin studies of manufacturing plant growth, which compared industrial plant expansions within five miles of statewide corridors to corresponding rates for the rest of the state. (Lichtman, Liat. *A Study of New and Expanding Manufacturing Plants in Wisconsin during 1990-1996: Analysis of New and Expanding Manufacturing Plants along Wisconsin's Highway Transportation Corridors.* Wisconsin Dept. of Transportation, 1999.)

Advantages and Limitations – This approach has the advantage (over simple pre/post measurement) that it compares across space as well as time, which can control for exogenous technology change or business cycles affecting all locations. However, this approach has two limitations. One limitation is *comparability* – since it does not control for any differences in economic activity mix or density (of employment or population) between the study region and the broader comparison area. Another limitation is *causality* – since we cannot be sure whether highway investments caused the observed higher economic growth, or whether the highway investments were placed in areas with greater density and expected growth rates.

2. Shift-Share Trend Analysis

Calculation and Logic – This approach is a variant on the first one, in that it also compares economic pre/post trends between the project impact area and a broader surrounding area. However, it attempts to adjust for compositional changes between these areas. This is done through a form of economic base analysis called *shift-share.* Basically, shift share analysis decomposes the observed changes in regional economic growth into three components: 1) a trend effect – reflecting how the regional economy historically grows faster or slower than the national trend, 2) an industry mix effect – reflecting how the regional growth rate changes due to its mix of faster-growing and slower-growing industry sectors, and 3) an unexplained effect – reflecting remaining changes in the regional economy which cannot be correlated with either overall growth rates or industry mix differences. The logic of this approach is that it explicitly produces a profile of *expected* regional growth based on historical economic trends and current industry mix, and then represents the difference between that and the observed economic change as the "unexplained" effect which can be attributed to public or private interventions (such as a new highway).

Applications – This general approach is widely used by economic developers as a diagnostic tool for identifying local economic strengths and weaknesses. It has not been widely used for post-project evaluation, though.

Advantages and Limitations – This approach has the advantage (over the type #1 broad trend comparison) that it corrects for *non-comparability between* the study area and the broader comparison area, insofar as they are due to differences in industry mix. This correction can also capture spurious differences in economic trends which are related to urban / rural differences. However, this approach has two limitations. First, it still fails to correct for non-comparability related to differences among areas in their baseline transportation networks and conditions. Second, it does not resolve the issue of *causality*, since there is no guarantee that the "unexplained" difference is due solely to highway investments during the pre / post period.

3. Matched Comparison Areas

Calculation and Logic – This approach also compares trends over a pre / post time period for both the study area and a comparison area. However, this approach identifies the key socioeconomic characteristics of the local areas receiving highway improvements, and then seeks to identify outside areas which have not had such highway improvement but otherwise share similar socioeconomic characteristics. The matching factors may include income, population density, economic mix and ratings of baseline highway access availability. The process of paired matches among similar areas is presumed to control for all of these factors, leaving any observed differences attributable to the presence or lack of highway improvements. In effect, this is a "quasi-experimental" design in which the matched areas lacking highway improvements represent the "control group," which is compared to the "experimental group" receiving the highway improvements.

Applications – This general approach was used in studies (by Isserman et al) for the Appalachian Regional Commission, which compared economic growth in 391 Appalachian counties with that of 391 outside counties which were selected to be their closest "twins." (e.g., see Isserman, Andrew. *The Economic Impact of the Appalachian Development Highway System: Some Empirical Evidence.* West Virginia University, 1996; also Isserman, Andrew M., Terance J. Rephann, and David J. Sorenson. *Highways and Rural Economic Development: Results from the Quasi-Experimental Approaches.* 1989.)

Advantages and Limitations – This approach has the advantage that it attempts to correct for a broader range of *comparability* factors than either of the preceding approaches. However, some researchers raise concerns about whether the selection of "twin" counties (control group) truly captures all of the necessary variables that can explain economic growth rates. In particular, there is the intractable problem that *all* of the control group areas are necessarily located in a different location than the project impact areas. That raises the issue of whether other regional factors, such as the different location of the study and control areas, may represent an unexplained factor affecting observed differences in economic growth rates. For instance, if the study and control areas are in different states, then there may also be differences in state tax or business policies, proximities to airports or seaports, or proximities to other growing market areas among those areas.

4. Time Series/Cross-Sectional Regressions

Calculation and Logic – This approach differs from the preceding three approaches in that it does not require the selection of comparison areas (i.e., a control group). In lieu of

designating any comparison areas (which are open to criticism), it uses statistical methods to effectively create a "pseudo-control group." This is done by collecting time series data on economic trends for a wide range of areas representing a broad mix of location characteristics – including population patterns, economic mix, urbanization, location in the U.S., baseline transportation conditions, and changes in highway investment. The analyst then applies multiple regression analysis to statistically isolate the marginal impact of each of those factors *holding all else constant*. In theory, this works as long as the dataset includes variation among all combinations of these factors, so that no two of them are correlated. The marginal effect on economic growth due to changes in the last factor – highway investment or highway improvement – can thus be isolated.

Applications – This general approach has been used in national and local studies sponsored by the Federal Reserve Bank, FHWA, and NCHRP (e.g., see Duffy-Deno, K.T. and R.W. Eberts. "Public Infrastructure and Regional Economic Development: A Simultaneous Equations Approach," *Journal of Urban Economics.* V. 30, pp. 329-343, 1991.) These studies have used "production functions" to estimate the economic growth impact of county-level or state-level highway investment (capital stock), controlling for other factors. A newer ongoing study by Dr. Eberts is substituting county-level measures of road lane-miles (for different functional classes of roads) as the explanatory variable to describe highway system changes.

Advantages and Limitations – This approach has the advantage that it avoids criticism about comparability of the comparison group, by using a wide range of observations with statistical controls in lieu of any formal comparison group. However, it requires data observations to be collected for a wider range of locations. That requirement for a large dataset, in turn, naturally leads researchers to rely on available aggregate county-level transportation data (on investment dollars, lane-miles, or existence of interstate highways) to represent baseline transportation conditions and pre/post changes in them. Such transportation measures do not fully capture variation in the effect of individual highway corridor improvements on accessibility within subareas of counties.

5. Pre/Post Case Studies (Including Surveys)

Calculation and Logic – This approach focuses just on the pre/post changes in economic conditions in areas directly affected by highway system improvements. It typically involves a combination of (a) *observations of changes* in adjacent or nearby property values, business turnover, business sales and/or employment associated with the completion of a highway project (using public data bases, private data sources or survey data), and (b) *surveys or interviews* of key players – public agencies and business representatives – regarding their views of how and why the highway project had the impact that it did. In that way, the analyst can obtain highly detailed information to tell a "story" concerning what happened to change the local economy, how the highway project affected it, and what other local factors either accentuated or mitigated the highway impacts. If multiple case studies are done, then the analyst can also infer how local differences in local development conditions, local highway access characteristics and/or highway usage may lead to different types of economic impacts.

Applications – This general approach was used for studies of the economic impacts of seven highways in France (Orus, Jean-Pierre. *The Economic Impacts Of Major Motorways*

Infrastructures: Main Lessons Of Ex Post Studies. S.E.T.R.A – Ministère de l'Equipement, du Logement, des Transports et du Tourisme, Bagneux, France, 1996) and one in Finland (Parantainen, Juha. *Effects of Transport Infrastructure on Regional and Peripheral Development*. Ministry of Transport and Communications, Finland, 1999), as well as for local access road impacts in 15 Appalachian communities (Brandow Co. and Economic Development Research Group. *Evaluation of the Appalachian Regional Commission's Infrastructure and Public Works Projects.* Prepared for the Appalachian Regional Commission, 1999). It was also used for highway bypass studies in Wisconsin (17 locations), Kansas (21 locations), Iowa (11 locations), Washington (three locations) and also in California, Texas, North Carolina and Australia (refer to Section 2.0 for overviews and citations of these bypass studies).

Advantages and Limitations – Case studies rely on in-depth surveys and interviews in lieu of comparison groups or statistical controls, as the method for deriving net impacts of highway projects beyond the counter-factual (of what would have been expected to occur anyway). As such, they can provide a wealth of information on local factors affecting the observed economic impacts of highways. Business surveys also provide a basis for establishing causation for the observed impacts. However, this abundance of information on causal factors can also make it difficult to extrapolate findings to other locations. In other words, while the preceding methods can all be criticized for "under-specification" of behavioral factors affecting observed economic trends, the usefulness of individual case studies can be limited by *"over-specification"* of behavioral factors.

The major shortcoming of case studies is overcome when there are compilations of parallel case studies, using similar measurement methods for similar types of projects in different types of locations. To date, there have been studies of the local economic impacts of highway bypasses in roughly 100 communities spanning at least seven states. Those case studies yield enough observations to observe broad similarities in findings regarding both the dominant range of economic impacts (nearly all small) and the key factors affecting the magnitude and direction of impacts (related to the orientation of local retailing to tourism, special destination or pass-by traffic). When findings from multiple studies are pooled to derive greater statistical precision, this is sometimes referred to as "meta analysis" – an approach widely used in medical and epidemiological studies. Yet while this approach may have some promise, there is not yet any comparably large set of case studies for major highway corridor projects.

Table 4.1 Staff Interview Summary – State DOT Interest and Involvement in Economic Development Issues

State	Considers Economic Impacts in Highway Planning		Has Conducted Studies to Measure Highway Economic Impacts		Impacts of Interest	Reasons for Not Considering Economic Impacts	Interest in Participating in Studies	Data and Technical Assistance Needs
	Regional Impacts	Localized Impacts	Pre-Project	Post-Project				
Arizona					Job creation	Limited interest Data and methodology limitations		
California		Yes	No[1]		Business activity (sales, location)		Yes	Small-scale economic data (less than county level) Easy-to-use tools / standard methodologies
Colorado						Limited interest Data and methodology limitations		Freight commodity data Business location factors Guide to tools
Indiana	Yes	Yes	Yes		Employment growth Benefit / cost		Yes (planned)	Linked / more detailed pop, emp forecasts Localized impact analysis Sketch-plan regional-level methods
Mississippi	Yes				Rate of return Freight traffic	Lack of knowledge on data and methodologies	Yes (but limited resources)	Easy-to-use B / C analysis tools

[1] Not for highways, but economic assessment has been done for proposed high-speed rail service.

Table 4.1 Staff Interview Summary – State DOT Interest and Involvement in Economic Development Issues (continued)

State	Considers Economic Impacts in Highway Planning		Has Conducted Studies to Measure Highway Economic Impacts		Impacts of Interest	Reasons for Not Considering Economic Impacts	Interest in Participating in Studies	Data and Technical Assistance Needs
	Regional Impacts	Localized Impacts	Pre-Project	Post-Project				
Oregon						Few new investments		Better understanding of Trans/ED linkages Effects of land use policies, congestion relief on ED
Pennsylvania	Yes			Yes	Job creation Overall economic $ activity	Lack of information and tools		Roles of various factors (trans and other) in ED; case studies Good tools to quantify economic impacts
Virginia	Yes	Yes	Yes	Yes	Investment New jobs/by industry Tax revenues		Yes (but limited resources)	Empirical evidence (impacts, elasticities, etc.) "Quick" assessment tools relevant to a variety of situations
Wisconsin	Yes	Yes	Yes	Yes	Business location/investment Business income Job creation		Yes (planned study)	Monitoring methods Selection of control areas

5.0 Guidelines for Future Impact Measurement Studies

The preceding reviews of prior studies, available data sources and current methods lead to general conclusions concerning needs to improve approaches for future studies of the economic development impacts of highways. Specifically, six "general principles" are identified that should be considered in the design of future highway impact studies. The remainder of this section briefly discusses these principles, which then serve as a foundation for the study methods recommended in Volume 2 of this report.

1. Additional Data Collection

Published data sources, by themselves, are most often insufficient to portray the full nature of impacts that highway investments can have on economic growth. They should therefore be supplemented when possible with local data, private business data sources, and / or surveys. These sources should be used as follows:

- **Long-Term Economic Growth –** This is usually measured in terms of employment, income or output, and data on it is generally available from *government data series*. The presence or absence of any such growth may, however, take many years (following completion of a highway project) to be measurable.

- **Localized and Short-Term Growth –** This can provide a leading indicator of changes in demand for locations, which eventually can affect economic growth. It can be measured in terms of changes in local property values, local development (investment), and mix of economic activities locating along a corridor or at major nodes or interchanges. Such data can sometimes be assembled from *local sources* (e.g., property sale transaction data, building permits, newspaper clipping files, windshield surveys, business directories).

- **Causation –** To make the case that there is some causal connection between business growth and new highways, there should presumably be some business reliance on those same facilities for access to customers, suppliers and workers. Such information could potentially be collected through *surveys.*

2. Spatial Nature of Transportation Impacts

Highway projects can affect overall transportation system efficiency, localized traffic activity (levels and performance) and access (travel times between certain origins and destinations). All three types of transportation impacts can affect the pattern of economic development around them, and hence may need to be addressed. Specifically, any such transportation changes can affect the *spatial distribution* of businesses and population as a consequence of three types of travel-related impacts, which vary over locations:

- Impacts of a highway project on *directly* improving travel efficiency (reducing costs) for existing personal and business users on their already-existing trips;

- Impacts of a highway project on *indirectly* reducing the cost of personal and business activities by allowing those activities to redistribute in more efficient ways; and

- Impacts of a highway project on *induced* travel and business demand associated with bringing people access to a greater selection of job, shopping and recreational opportunities (available within a given travel time).

Each of these items has implications for the broader costs and benefits of projects. However, the point here is that they represent different types of transportation impacts, which can affect the magnitude and spatial distribution of economic development impacts from highway projects.

3. Spatial Nature of Economic Impacts

National and state agencies have legitimate interests in both overall economic efficiency and localized economic growth / decline. They must therefore ensure that economic impact studies distinguish localized economic development impacts of highway projects from their broader state and national impacts. This can include highway effects relating to:

- Impacts on *nearby businesses* due to expansion of their labor market and / or customer market access;

- Impacts on *non-nearby businesses* that use the highway, or businesses whose workers or suppliers or customers use it; and

- Impacts which are *redistributions* of business activity and income between nearby and non-nearby locations, due to shifts in traffic patterns.

4. Causal Linkage

Any economic impact analysis that seeks to establish causation should be able to link the economic impacts back to changes in highway user activity patterns. The transportation-economic causal linkages may include:

- Creating new or improved connection for existing car and truck travel, leading to savings in expenses for individuals and businesses;

- Expanding the breadth of customer, labor or supplier markets, leading to additional market access for businesses (increasing productivity from scale economies) and personal opportunities for jobs and shopping (also leading to increases in income); and

- Shifting travel and activity patterns among alternative origins, destinations and travel corridors, leading to net benefits to highway users and distributional changes (losses as well as gains) for businesses serving them.

5. Industry Mix

The impacts of a highway improvement can vary dramatically for different sectors of the economy. The analysis of project impacts may therefore need to consider:

- How *prior* business mix affects the magnitude of overall size of economic impacts; and
- How the transportation impacts can also change the *future* business mix of affected areas.

6. Evolution of Impacts Over Time

Economic growth and change resulting from a highway project can manifest itself in a series of distinct steps over time. For instance, a highway that brings dramatically improved access to an isolated area could possibly have the following evolution of impacts:

- In the short term, *property* may start to be sold and purchased at higher prices by companies or individuals anticipating increased demand for the affected location;
- In the medium term, *construction* may begin as companies locate new facilities or expand existing facilities to meet emerging demand for their services in that area;
- In the longer term, *businesses* start to operate in the newly constructed (or expanded) facilities and thus generate additional jobs in that area; and
- Ultimately, personal *income* levels may rise due to the increase in available jobs in the area.

The time distribution of impacts is an oft-neglected dimension of analysis, because the data collection process seldom provides a time series long enough for more than a simple comparison of times immediately before and immediately after project construction. In fact, several studies have indicated that it can take 10 or more years before there are measurable employment and income effects. Since economic changes can occur over such a long time period, it can be useful to observe the various types of highway impacts using different measures at different points in time.

These six principles serve as a foundation for Volume 2 of this report, which provides prototype study designs for measuring the economic impacts of highway projects.

Appendix A

Characteristics of Economic Data Sources

Characteristics of Economic Data Sources

A.1 Classification of Data Sources

There are many different types of economic impact data, which have been used for time series analysis of the economic impacts of public investment in highway improvements:

1. **Population Demographics Data –** Of most relevance to socioeconomic impact analysis of transportation improvements are population change and population characteristics. The latter includes characteristics such as age, race, gender, and educational attainment, among other factors.

2. **Labor Force and Employment (Workforce) Data –** Information on number of businesses and jobs by industry and occupation on unemployment in the local area are important to time series analysis. Data are published on both the labor force (the people living in the project area and the workforce (the people working in the area).

3. **Wage and Total Income Data –** Data are available on wages and income from other sources such as investments and transfer payments.

4. **Capital Investment and Real Estate Value Data –** Data on the volume of private investment generated and/or property value changes due to highway improvements can indicate private sector responses. Most of these data are *not* collected by a central, national source and are harder to gather.

5. **Non-Quantitative Assessment Data –** Information concerning the quality, image and type of activity occurring can be collected from interviews or direct observation, and can provide insight into the nature of changes which are not otherwise measurable.

Many of the data on employment, wages, business volume, and capital investment have been classified by industry according to the Standard Industrial Classification (SIC) system. In 1998, the North American Industrial Classification System (NAICS) was introduced to replace the SIC system, which had become obsolete in the face of changes in the nature of business that have been wrought by the new economy. Developed in conjunction with Canadian and Mexican partners, it recognizes 350 new industries and nine new service sectors.

NAICS identifies 1,170 four-digit industries, compared with 1,004 that were recognized by the SIC system. Thirty percent of NAICS industries are new, 30 percent have been revised, while the remaining 40 percent remain unchanged. Data for two-thirds of all four-digit SIC industries will be retrievable but the remaining one-third of industries has been substantially revised. This will cause some problems for time series analysis, which is the main focus of this handbook. The new system's first application is the 1997 data from the Economic Census, which is currently in the process of being released. By 2003,

all federal data sources cited in this handbook, including BLS and BEA as well as most states sources, will use the new system. For more information on NAICS and for correspondence and sample bridge tables, see http://www.census.gov/naics.

A.2 Population Demographics Data

Demographics data include information on the socioeconomic characteristics of the population living in the project area. They also include information on the resident labor force, who are the people living (as opposed to those working) in the project area. There are two main sources of data on population size and components of change: the Census Bureau's Population Estimates Program and individual state agencies responsible for demographic analysis. The Census Bureau updates and releases annual population data. The methods used by some state agencies differ from those of the Census Bureau, resulting in different estimates. The Decennial Census is still the best source of information on the resident labor force. Eventually, decennial data will be updated by the American Community Survey, which is currently being piloted.

1. Population Estimates Program, Bureau of the Census

- **Measures –** Current population (as of July 1) and components of change, including births, deaths, and migration – both domestic and international.
- **Geographical Basis –** All data are reported for states, counties, and metropolitan areas. For places and county subdivisions, only population estimates are available.
- **Frequency –** Annual.
- **Delay in Release –** Seven months.
- **Latest Currently Available –** July 1999.
- **Strengths –** Very current, best source available.
- **Weaknesses –** No detail regarding population characteristics.
- **Applications –** To look at population change and its components in an area before and after a highway project.
- **Access –** Current data and trend analysis (1990-1999) are available on the Internet at http://www.census.gov/population/www/estimates/popest.html.
- **Technical Support –** Population Division, (301) 457-2422 or pop@census.gov.

2. State Government Demographic Data

Many state governments produce or sponsor estimates of state and local population and components of change. Sometimes, these are conducted by a state university. These are available from state data centers. Links and contact information are available at http://www.census.gov/sdc/www/sdctxt.html.

A.3 Labor Force Data

There are two main sources of federal data on employment among the labor force that are residents of the project area.

1. Local Area Unemployment Statistics. Bureau of Labor Statistics and State Labor Market Information Agencies

Local Area Unemployment Statistics are available from both the U.S. Bureau of Labor Statistics (BLS) and from the State Labor Market Information (LMI) agencies is the best source for current labor force information.

- **Measures –** Labor force size, number employed and number unemployed, number economically active, and unemployment rate.
- **Geographical Basis –** States, counties, cities of over 25,000, and all cities and towns in New England.
- **Frequency –** Monthly.
- **Delay in Release –** Two months for federal data, one month for state data.
- **Most Recent Data Currently Available** – January 1999.
- **Coverage –** Total labor force.
- **Advantages –** Most current source available on unemployment and economic activity; Comprehensive (measures total labor force).
- **Disadvantages –** No breakdown of employment by industry.
- **Application –** To measure the impact of a project on the size of the labor force and on unemployment in a county or small city.

- **Access –** State LMI agencies have the most current data and most have web sites. BLS web page data can be found at www.stats.bls.gov. County-level data are available through BLS's web page but data for cities and towns must be obtained through state LMI agencies.

- **Technical Support –** Contact BLS at (202) 606-5200 or the state LMI agencies.

2. The Decennial Census

- **Measures –** Characteristics of the labor force of a given area, including sex, race, occupation, industry, and class of worker.

- **Geographical Basis –** Metro areas, cities, census tracts, ZIP codes, block groups.

- **Frequency –** Census data is published every 10 years.

- **Delay in Release –** For the Decennial Census 18 months to two years.

- **Most Recent Data Currently Available –** 1990.

- **Strengths –** Comprehensive. Provides data on occupation as well as industry; this is useful in assessing job quality.

- **Weaknesses –** Data are two to 12 years out-of-date at any given time.

- **Application –** This is the only source of detailed employment data available by place of residence. It can be used to assess baseline labor force conditions against which quantitative, qualitative, and structural changes can be measured.

- **Access –** 1990 Census data can be accessed at http://venus.census.gov/cdrom/lookup.

- **Technical Support –** For the Decennial Census contact (301) 457-2422 or pop@census.gov.

2A. A Note on the American Community Survey

The American Community Survey (ACS) is now being piloted in 10 locations. It will provide an annual update of Decennial Census data, based on a one-in-six sample of American households. The ACS will be implemented nationally starting in 2003. The first national data will available in 2005. By 2008, results will be available for all areas over 65,000 and by 2009, data will be available for the smallest areas. The ACS will provide detailed annual labor force data, replacing the Decennial Census as a source of labor market information. Results will be available within seven months after the data are collected. Data from test ACS locations are available at http://www.census.gov/acs/www/. For further information call (888) 456-7216 or e-mail acs@census.gov.

A.4 Business Size and Employment (Workforce) Data

The previous section discusses sources for data on the resident labor force. This section looks at sources for information on *businesses* located within the project area and their workforces. These data focus on those working (as opposed to those living) in the project area. Many transportation improvement projects benefit businesses and workers in the area more than the area's residents. Therefore, changes in employment by business are more commonly used as an indicator of economic impact than are data based on people who live in the area. There are four main sources of business and workforce data available at the county level. Three of these provide information on both employment and the number of businesses. The fourth provides information only on employment.

1. Covered Employment and Wages (ES-202), BLS and State LMI Agencies

- **Measures –** Businesses, workers, and wages covered by state and federal unemployment compensation program. Data are available for counties and states up to the four-digit SIC level.

- **Geographic Basis –** States, metro areas, labor market areas, and counties. Data on small cities and towns are available from the state LMI agencies.

- **Frequency –** Monthly data collected and published quarterly.

- **Delay in Release –** Nine months for federal and state data, three to six months for state data.

- **Most Recent Data Currently Available –** 1998 from BLS, second quarter of 1999 for state data.

- **Strengths –** Level of industry detail available (three- to four-digit). Most current and comprehensive source, includes government employment.

- **Weaknesses –** Excludes occupations not covered by unemployment compensation (self-employed, private household workers, farms, military, and railroads). Federal data for detailed industries in rural areas are not disclosed in cases where there are fewer than three businesses in an industry due to confidentiality concerns. However, these data are sometimes available from the state LMI's depending on their disclosure policies.

- **Application –** To measure changes in employment. Number of businesses and wages by detailed sector before and after a transportation improvement project.

- **Access –** Annual data for up to four-digit industries are available on BLS's web page at http://stats.bls.gov/sahome.html. In some states, more current quarterly data are also available on the state LMI's web pages but, in some cases, these only go to the two-digit level. It is usually possible to get detailed data directly from the state. County-level data are available through BLS's Internet page. Data for cities and towns must be obtained through state LMI agencies, which often have more current data. Unlike federal sources, some states are not required to withhold confidential data.

- **Technical Support –** From state LMI agencies or BLS, ES-202 program office at (202) 606-6567.

2. County Business Patterns, Bureau of the Census

- **Measures –** Employment, payroll, and businesses by up to four-digit SIC level. Provides information on the number of businesses by employment size. Covers all businesses except farming, railroads, government, and self-employed people.

- **Geographical Basis –** Available for counties, metro areas, and by ZIP code.

- **Frequency –** Annual.

- **Delay in Release –** 18 months after the end of the year.

- **Most Recent Data Currently Available –** 1997.

- **Strengths –** Easy to access on the Internet.

- **Weaknesses –** Generally, less comprehensive and not as current as BLS ES-202 data. Data on self-employment, farming, and government are excluded. For employment in detailed three and four-digit SIC private industries at the local level, however, coverage can be more thorough. Data for detailed sectors in rural counties is often withheld due to confidentiality issues.

- **Application –** To gauge changes in employment and wages after the implementation of transportation improvements.

- **Access –** Data for states, counties, metro areas, and ZIP codes are available on CD-ROM at (301) 457-4100. Data for cities and counties are available on the Internet at http://www.census.gov/epcd/cbp/view/cbpview.html.

- **Technical Support –** County Business Patterns Division, (301) 457-2580 or cbp@census.gov.

3. Dun & Bradstreet Marketing Data, Prospecting Records

- **Measures –** Provides information on individual companies in a given area, including SIC, employment, sales, and contacts. Data can be requested by area, by SIC, or by employment size or sales volume. Individual listings can be aggregated by bringing data into a spreadsheet program.

- **Geographic Basis –** Data can be requested for cities, counties, ZIP codes, or telephone area code.

- **Frequency –** Continually updated.

- **Delay in Release –** Two months.

- **Most Recent Currently Available –** January 2000.

- **Strengths –** Most current available. Can look at individual company performance in small areas. No data are withheld due to confidentiality issues. Data can be analyzed by detailed SIC.

- **Weaknesses –** Uneven updating frequencies. Data can be expensive.

- **Application –** To measure employment and sales change in firms within a highway project impact area. It is possible to select individual companies for analysis of business performance within small subareas of larger areas.

- **Access –** The data must be ordered from Dun & Bradstreet: (800) 624-5669. Costs are $435 per 1,000 individual company prospecting records. Further details are on the Internet at www.dbleads.com.

- **Technical Support –** Call Dun & Bradstreet Marketing Division, (800) 624-5669.

4. Regional Economic Information System (REIS) Employment Series, Bureau of Economic Analysis

- **Measures –** Annual average employment by industry. Two-digit SIC detail is available for states. Only one-digit is available for smaller areas. Information is available on employment and earnings. Unlike the other three sources cited above, no data are provided on the number of businesses.

- **Geographic Basis –** States, metro areas, and counties but only one-digit SIC detail is available for metro areas and counties.

- **Frequency –** Annual.

- **Delay in Release –** 18 months after the end of the year.

- **Most Recent Data Currently Available –** 1997.

- **Strengths –** Most comprehensive data on employment, includes self-employment, business owners, government employment, and jobs not covered by unemployment compensation (farming, railroads, self-employed). For Middlesex County, MA, for example, the total jobs reported by REIS exceeded those reported by County Business Patterns and by ES-202 by 23 percent to 25 percent.

- **Weaknesses –** No detailed data are available at the local level. Only single-digit SIC level data are available for counties and metro areas. Most recent data available can be 18 to 30 months old.

- **Application –** To gauge broad impacts of a transportation project on the number of private and public sector jobs, including self-employment.

- **Access –** Available on the Internet at http://fisher.lib.virginia.edu/reis/.
- **Technical Support –** Regional Economic Measurement Division, (202) 606-5360.

5. Interviews

Interviews with local project partners are an important source of quantitative and qualitative information regarding new jobs in the project area and the highway's impact on creation of those jobs. See Section A.10 for a full discussion of the role of interviews in economic impact analysis.

A.5 Wage Data

A key measure of the economic impact of a transportation improvements project is its contribution to the income of people living and working in the project area. There are three main sources of income:

1. Wages and earnings from work;
2. Investments yielding dividends, interest, and rents; and
3. Transfer payments, such as Social Security, pensions, and welfare.

Wages and earnings changes associated with either new jobs or changes in pay levels for existing jobs are an important indicator of economic impact. An assessment of the per capita income of the area from all sources can be of secondary interest to compare the project area with other areas in order to gauge the extent of economic deprivation.

Income from Employment – Wages

As previously mentioned, of most interest to the analyst evaluating economic impacts of highway projects are impacts on jobs and household income. Wage data are available in two forms:

1. Total wages; and
2. Average wages.

Through time series and cross-sectional analyses of **total wages** by industry, it is possible to see the importance of each industry to a region's income and to trace trends in that industry over time. If a transportation project is intended to diversify or otherwise impact a region's economic base, it can be useful to calculate location quotients based on earnings in order to assess the region's competitive strengths and weaknesses. Examining industrial structure by looking at jobs but not earnings can be misleading, as sectors with high-paying jobs contribute much more to regional income than they do to the job base. The reverse is true for low-paying jobs. As economic development in large part is about getting money to people in a given area, knowing the key sources of cash flow is key to effective analysis and strategy formulation.

Total earnings by industry are provided through three data series – REIS, ES-202 data, and County Business Patterns. Data from ES-202 and REIS come directly from employers and tend to be more reliable than County Business Patterns, which is based mainly on census surveys. ES-202 provides data at the four-digit level for counties and is thus probably the best source for detailed analysis of specific industries rather than overall industrial structure.

Average wages (annual, weekly, hourly) allow us to evaluate the quality of employment stimulated by highway improvements and to estimate benefits to area households. Target industries are often selected on the basis of pay levels and value added. Average wage data are also available for occupations, as well as industries. Average annual earnings are determined by taking total annual earnings and dividing by number of jobs – both full and part-time. Thus, annual and weekly pay averages do not distinguish between full and part-time jobs. A low wage level (e.g., retail) can in part reflect a high proportion of part-time workers. The only data source that gives annual and weekly average pay is the ES-202. Although average earnings can be estimated from REIS and County Business Patterns data, this is not recommended due to data composition and collection methods.

Average hourly wages are derived from survey data. The BLS Current Employment Statistics (CES) series provides hourly wage data by industry. CES data are released monthly and come to market quickly. The main sources for total and average earnings are listed on the following pages.

1. Covered Employment and Wages – ES-202, Bureau of Labor Statistics and State LMI Agencies

- **Measures –** Total payroll, average annual wage, average weekly wage by industry down to four-digit level.
- **Geographic Basis –** States, metro areas, labor market areas, and counties. Data on small cities and towns are available from the state LMI agencies.
- **Frequency –** Monthly data collected and published quarterly.
- **Delay in Release –** Nine months for federal and state data, three to six months for state data.
- **Most Recent Data Currently Available –** 1998 from BLS, second quarter of 1999 for state data.
- **Strengths –** Level of industry detail available (three- to four-digit). Most current and comprehensive source, includes government wages.
- **Weaknesses –** Excludes industries not covered by unemployment compensation (self-employed, private household workers, farms, military, and railroads).
- **Application –** For the basis of assumptions about wages for jobs enabled by highway improvements. Also, for cross-sectional analysis of the income base of an area. Other applications include time series analysis of before and after highway improvements to assess changes in local business activity. The data can also be used to calculate location quotients based on the county or region's income sources for shift-share analysis.

- **Access –** Annual data for up to four-digit industries are available on BLS's web page at http://stats.bls.gov/sahome.html. In some states, more current quarterly data are also available on the state LMI's web pages but, in some cases, these only go to the two-digit level. It is sometimes possible to get more detailed data directly from the state. County level data are available through BLS's web page but data for cities and towns must be obtained through state LMI agencies.

- **Technical Support –** From state LMI agencies or BLS, ES-202 program office at (202) 606-6567.

2. Current Employment Statistics, Bureau of Labor Statistics and State LMI Agencies

- **Measures –** Average hourly manufacturing wage. Average wage data are also available for selected two to four digit manufacturing industries.

- **Geographical Basis –** States and major metropolitan areas.

- **Frequency –** Monthly, with annual averages.

- **Most Current Available –** January 2000.

- **Advantages –** Most reliable source for average hourly manufacturing wages. Very current.

- **Disadvantages –** Covers only manufacturing wages. No data are available for the county level, only statewide and for MSA's.

- **Application –** To estimate impacts of manufacturing plants attracted by highway proj??ects on wages and household earnings in the project area.

- **Access –** Current data are on the Internet: http://www.bls.gov/790home.htm.

3. County Business Patterns, Bureau of the Census

- **Measures –** Number of business, payroll, and employment by industry. Up to four-digit SIC detail is available. Covers all businesses except farming, railroads, government, and self-employed people.

- **Geographical Basis –** Available for counties, metro areas, and by ZIP code.

- **Frequency –** Annual.

- **Delay in Release –** 18 months after the end of the year.

- **Most Recent Data Currently Available –** 1997.

- **Strengths –** Easy to access on the Internet. For detailed three and four-digit industries at the local level, however, coverage can be more thorough.
- **Weaknesses –** Generally, less comprehensive and not as current as BLS ES-202 data. Excludes farming, government, and self-employment. Detailed data on industries in sparsely populated small rural areas are often withheld due to confidentiality problems.
- **Application –** Time series analysis to gauge changes in wages after the implementation of transportation improvements.
- **Access –** Data for states, counties, metro areas, and ZIP codes are available on CD-ROM at (301) 457-4100. Data for cities and counties are available on the Internet at http://www.census.gov/epcd/cbp/view/cbpview.html.
- **Technical Support –** County Business Patterns Division, (301) 457-2580 or cbp@census.gov.

4. Occupational Employment Statistics, Bureau of Labor Statistics

- **Measures –** Mean and median hourly wage and mean annual wages for detailed occupational categories.
- **Geographic Basis –** State and metro areas.
- **Frequency –** Annual.
- **Delay in Release –** Two months.
- **Most Recent Data Currently Available –** 1999.
- **Advantages –** Very current, very detailed hourly and annual wage data by occupation.
- **Disadvantages –** Data are by occupation rather than industry. No data available at the county level.
- **Applications –** To estimate wages in non-manufacturing establishments locating in an area after transportation improvements.
- **Access –** Available on the Internet at http://www.bls.gov/oes/oes_data.htm.
- **Technical Support –** Occupational Employment Statistics, (202) 691-6440.

5. National Compensation Survey, Bureau of Labor Statistics

- **Measures –** Average hourly wage by selected occupation. Also reports on average hours worked per week.
- **Geographical Basis –** 154 metropolitan and non-metropolitan areas, on a rotating basis. Data are published for the 79 largest metro areas but are available for only 19 of the 79 non-metro counties that are surveyed.

- **Frequency –** Annually.
- **Delay in Release –** six months.
- **Most Recent Data Currently Available –** 1998.
- **Advantages –** Different occupational structure than National Compensation Survey which may be more relevant, depending on the project.
- **Disadvantages –** Does not include all areas; areas are surveyed on a rotating basis so annual data are not available for all places.
- **Application –** Collaborative source with Occupational Employment Statistics if the area was included in the most recent survey data.
- **Access –** On the Internet at http://www.bls.gov/comhome.htm.
- **Technical Support –** Office of Compensation Levels and Trends, (202) 691-6302.

6. Interviews

Interviews with local project partners are an important source of wage and qualitative information regarding new jobs in the project area and the highway's impact on creation of those jobs. See Section A.10 for a full discussion of the role of interviews in economic impact analysis.

A.6 Total Income Data

Total income can include more than just wages, it also can include investments and transfer payments. Analysis of all sources of income data can be of interest in determining project impacts in order to assess the overall economic structure of an area and the extent of wealth and deprivation there. Time series analysis of total income can be compared with those of earnings. The main sources of income data are BEA, Decennial Census, and the Internal Revenue Service (IRS).

These different sources of data use different definitions of income. The Census Bureau defines income as **money income**. This includes only money received by individuals from wages, investments, and transfer payments. It excludes non-cash benefits, such as employer-subsidized pension plans, health insurance, and food stamps. BEA's much broader concept of **personal income** includes income from all sources, including money income and in-kind income. Contributions for social insurance are deducted from personal income and the value of in-kind benefits are added. The IRS data are based on income reporting requirements, which includes a wide range of non-wage sources.

These various sources of income data also differ in units and application. For instance, BEA personal income data are provided in aggregate and per capita. These measures are

used to analyze a region's overall economic status and spending power. The census money income data largely focus on household median income and poverty rates. Poverty rates and median, rather than mean, income give a sense of the relative standard of living among typical households in a project area. Since they measure different aspects of a region's income, BEA and census data are complimentary in combination.

1. Regional Economic Information System (REIS) Personal Income Series, Bureau of Economic Analysis

- **Measures –** Personal income by source, including wages, investments, and transfer payments. Wages are reported by industry at the two-digit SIC level. Also provides per capita income. Includes proprietor's income.
- **Geographic Basis –** States, metro areas, and counties.
- **Frequency –** Annual.
- **Delay in Release –** 18 months after the end of the year.
- **Most Recent Data Currently Available –** 1997.
- **Strengths –** Most comprehensive data on earnings from farm, non-farm, wages, self-employment, and government employment. Detailed breakdown by two-digit SIC level.
- **Weaknesses –** Of limited interest for economic impact analysis. Most recent data available can be 18 to 30 months old.
- **Applications –** Cross-sectional analysis of sources of income in a community. Good for studies of disposable income in a community for retail market analysis.
- **Access –** Available on the Internet at http://fisher.lib.virginia.edu/reis/.
- **Technical Support –** Regional Economic Measurement Division, (202) 606-5360.

2. County Income Data, Statistics of Income Division, Internal Revenue Service, Department of the Treasury

- **Measures –** Data on income from all sources, including wages, dividends, interest, rents, and royalties. Also provides information on returns and exemptions upon which to calculate averages.
- **Geographic Basis –** States and counties.
- **Frequency –** Annual.
- **Delay –** Two years.

- **Most Recent Currently Available –** 1997.
- **Strengths –** Accuracy. Based on actual returns. Best source for detailed non-wage data.
- **Weaknesses –** Not many applications for economic analysis. Data are slower to be released than some sources.
- **Applications –** To monitor changes in incomes before and after implementation of highway improvements.
- **Access –** Must be ordered from IRS. $5.00 per state or $50 for the entire U.S. Details on ordering and availability can be found at http://www.irs.ustreas.gov/prod/tax_stats/soi/soi_pub.html.
- **Technical Support –** Statistics of Income Division, (202) 874-0410.

3. The Decennial Census

- **Measures –** Household, family and per capita money income and poverty rates.
- **Geographical Basis –** Metro areas, cities, census tracts, ZIP code, block group.
- **Frequency –** Every 10 years in years ending in "0."
- **Delay in Release –** Two years.
- **Most Recent Data Currently Available –** 1990.
- **Strengths –** Comprehensive. Provides income data on families as well as households. Reports on sources of income.
- **Weaknesses –** Decennial Census data can be up to 12 years out of date at any given time.
- **Applications –** Assessment of socioeconomic structure of project areas. Cross-sectional analysis of sources of income to area residents. Long-term trend analysis.
- **Access –** 1990 Census data can be accessed at http://venus.census.gov/cdrom/lookup.
- **Technical Support –** For the Decennial Census contact (301) 457-2422 or pop@census.gov.

3A. A Note on the American Community Survey

The American Community Survey (ACS) is now being piloted in 10 locations. It will provide an annual update of Decennial Census data, based on a one-in-six sample of American households. The ACS will be implemented nationally starting in 2003. The first national data will be available in 2005. By 2008, results will be available for all areas over 65,000 and by 2009, data will be available for the smallest areas. The ACS will provide detailed annual income data, replacing the Decennial Census as a source of labor market

information. Results will be available within seven months after the data are collected. Data from test ACS locations are available at http://www.census.gov/acs/www/. For further information call (888) 456-7216 or e-mail acs@census.gov.

4. Small Area Income and Poverty Estimates Program, Bureau of the Census

- **Measures –** Median household money income and poverty rates.
- **Geographical Basis –** States, counties, school districts.
- **Frequency –** State data are published annually. County and school district data are published every two years.
- **Delay in Release –** 32 months, but since data are published every two years, data can be up to five years out of date.
- **Most Recent Data Currently Available –** 1995.
- **Advantages –** Provides data at the school district level, though this is of limited use for economic impact analysis.
- **Disadvantages –** Long lead times for information. Web site is difficult to navigate.
- **Applications –** To measure changes in income and poverty rates in a project area, but there are more current sources.
- **Access –** Data are available on-line at http://www.census.gov/hhes/www/saipe.html. At the time of this writing, the web page is not easy to use.
- **Technical Support –** Small Area Income and Poverty Estimates Program, (301) 457-3182.

A.7 Business Volume (Sales) Data

It is often useful to measure changes in business volume and output before and after a highway construction project. Annual data on output for metropolitan areas are published by the U.S. Conference of Mayors. For counties, the Economic Census provides information on business operations for small areas. The Economic Census, a full-blown census of U.S. business carried out every five years for a wide variety of industries, provides data for counties, cities, and ZIP codes. Unfortunately, it takes the Census Bureau several years to publish the data. The Annual Survey of Manufacturers addresses this gap for manufacturing industries, but data are provided only at the statewide level.

1. Economic Census, Geographic Area Series, Bureau of the Census

- **Measures –** Number of businesses, employees, payroll, and wages. Provides a measure of output appropriate for each industry such as sales receipts, revenue, value added, value of shipments, or value of construction work done. Other data particular to an industry, such as investment in plant and equipment, are provided.

- **Industries Covered –** Prior to 1997, industries were classified according to the SIC system. For the 1997 census, a new classification system, the NAICS, is being used, so all data for many categories will not be strictly comparable. The NAICS includes:

  – Mining;
  – Utilities;
  – Construction;
  – Manufacturing;
  – Wholesale trade;
  – Retail trade;
  – Transportation and warehousing;
  – Information;
  – Finance and insurance;
  – Real estate sales, rental, and leasing;
  – Professional, scientific, and technical services;
  – Management of companies and enterprises;
  – Administrative and support and waste management and remediation;
  – Educational services;
  – Heath care and social assistance;
  – Arts, entertainment, and recreation;
  – Accommodation; and
  – Other services.

- **Geographical Basis –** Metro areas, counties, cities, and towns, ZIP codes.

- **Frequency –** Every five years in years ending in "2" and "7."

- **Delay in Release –** 15 to 42 months. For city and county data, 18 to 30 months. For ZIP code data, 39 to 42 months.

- **Most Recent Currently Available –** 1997 for most of the Geographic Area Series. 1992 for the Manufacturing and Mining Geographic Area Series.

- **Strengths –** Very detailed, available for small areas.

- **Weaknesses –** Data are two to three or more years old by the time of release. Self-employed people, who account for 75 percent of all businesses (but only three percent of total output) are excluded.

- **Applications –** For cross-sectional analysis of the local economic base. For long-term analysis, to compare business volume in the area before and after a highway project.

- **Access –** 1992 and 1997 data are on the Internet at http://www.census.gov/epcd/www/.

- **Technical Support –** General information from the Economic Census Bureau, (301) 457-4151. Contacts for information specific to a particular industry can be found at http://www.census.gov/epcd/www/ec97contacts.html.

2. Gross Metropolitan Product, U.S. Conference of Mayors and National Association of Counties

- **Measures –** Gross product of the nation's 317 largest metropolitan areas which is compiled by Standard and Poor's DRI. Also provides information on export sales for 253 metro areas.

- **Geographic Basis –** States and metropolitan areas.

- **Frequency –** Annual.

- **Delay in Release –** Nine to 12 months.

- **Most Recent Currently Available –** 1998.

- **Advantages –** Only source that provides annual gross product data for metro areas.

- **Disadvantages –** Only state and metro areas are covered. No data are provided for counties.

- **Applications –** To measure changes in total business volume in a project area before and after a highway project.

- **Access –** The most current data are available on the Internet at www.usmayors.org/uscm/home/html.

- **Technical Support –** Contact Jube Headley, U.S. Conference of Mayors, (202) 861-6766.

3. Taxes as an Indicator of Local Business Activity

Most states have taxes on personal and corporate incomes, retail sales, and real property. Many states prepare annual tabulations of tax data that can be used to measure business sales. Sales tax data can be analyzed to track trends in retail sales at the county and sometimes, at the city level. Some states and localities have special taxes, such as hotel taxes, that are useful for measuring tourism impacts on the local economy. Corporate income

tax data are also available from some states, but these should be interpreted with caution. Gross sales are a better indicator of business volume.

A.8 Capital Investment Data

Highway projects can stimulate investment in new buildings, and in business plant and equipment. There are a number of ways to measure capital investment before and after the implementation of a highway project, including census and local government sources. These are reviewed below.

1. Census of Manufacturers, Bureau of the Census

- **Measures –** Capital expenditures on buildings, machinery, and equipment. Also provides data on employment, revenue, payroll, inventory, materials, and value added of shipments.

- **Industries Covered –** Data are provided for up to 459 detailed SIC industries. Prior to 1997, industries were classified according to the SIC system. For the 1997 census, a new classification system, the NAICS is being used, so data for many categories will not be strictly comparable.

- **Geographical Basis –** States, metro areas, counties, cities, and towns, ZIP codes.

- **Frequency –** Every five years in years ending in "2" and "7."

- **Delay in Release –** For metro, city, and county data 15 to 26 months. For ZIP code data, 39 to 42 months.

- **Most Recent Currently Available –** 1997 for most of the national industry data. 1992 for the Geographic Area Series for metro areas, cities, counties, and ZIP codes.

- **Strengths –** Very detailed, available for small areas.

- **Weaknesses –** Data are two to three or more years old by the time of release. Covers only manufacturing industries.

- **Applications –** To analyze post-highway project changes in capital spending by manufacturers in an area with a significant concentration of industry.

- **Access –** 1992 and 1997 data are on the Internet at http://www.census.gov/epcd/www/.

- **Technical Support –** General information from the Economic Census Bureau, (301) 457-4151. Contacts for information specific to a particular industry can be found at http://www.census.gov/epcd/www/ec97contacts.html.

2. Residential Building Permit Data, Bureau of the Census

- **Measures –** Number and value of building permits issued in local areas for single-family to five or more unit structures. Total number of units built and renovated is also reported.
- **Geographic Coverage –** Counties, metro areas, and places.
- **Frequency –** Monthly for Current Month and Year-to-Date Reports. An annual report is also issued.
- **Delay in Release –** Six months.
- **Most Recent Currently Available –** September 1999 for Monthly and Year-to-Date Reports. 1998 for the Annual Report.
- **Advantages –** Current, available for small areas.
- **Disadvantages –** Covers only residential construction.
- **Applications –** To look at changes in the level of investment in residential structures by density in a project area which has experienced significant residential development as the result of a highway project.
- **Access –** Available on the Internet at www.census.gov/const/www/C40/sample.html. A more user-friendly way of accessing the same data is available at www.economagic.com/cenc40.html. Monthly data are available for counties and MSAs for 1995 through 1999.
- **Technical Support –** Census of Construction, Statistics Division, (301) 457-1321.

3. Local Municipal and County Building Permit Data

Counties and cities allow public access to building permit information for industrial, commercial, and institutional as well as residential construction projects.

Measures – Investment in residential, commercial, industrial, and institutional building projects. Data are usually presented alphabetically by address.

Geographic Coverage – Cities and counties.

Frequency – Usually monthly.

Most Current Available – Current, monthly data should be available.

Advantages – Very current, direct from source. Distinguishes between new construction and additions and alternations.

Disadvantages – Unlikely to be available on the Internet.

Access – From the local municipal or county building department.

4. Interviews

Interviews with local project partners are an important source of quantitative and qualitative information on post-project investment in a local area and the project's impact on leveraging that investment. See Section A.10 for a full discussion of the role of interviews in economic impact analysis.

A.9 Real Estate Value Data

Improved highway access could boost property values in a local area, adding to the wealth of local households as well as to the tax base. No central government agency collects information on real estate values. The most comprehensive source of real estate values is local assessors' data. Data on real estate transactions, including sales, rents, and vacancies is often collected and published by local or regional real estate agencies. Generally, this is only available for major metropolitan areas. Sources include those listed below.

1. Local Assessors' Data

In areas with real estate property taxes, listing of assessed values, usually by address, are available from most county and municipal assessors offices. The reliability of these data in reflecting market trends in real estate values will vary according to assessment practices and time lag between assessments. This method is not recommended unless no other data sources are available, which is sometimes the case for rural areas.

- **Measures –** Changes in assessed property values over time.
- **Geographic Basis –** Usually organized alphabetically by address. Addresses within specific subareas can be selected for analysis.
- **Frequency –** Varies, according to statutory requirements. Reassessments commonly occur every five years but this varies, according to local practice and state statutory requirements.
- **Advantages –** Comprehensive of commercial, residential, and institutional property values.
- **Disadvantages –** Assessment practices vary, both in method and lag between assessments. In some places, assessed values do not relate well to market values.

- **Applications –** To measure post-project impacts on values of affected properties against control groups of unaffected properties.

- **Access –** From local assessors' offices. It is sometimes possible to get data on disk.

2. Commercial and Industrial Properties

In most large metropolitan areas, prominent local real estate firms produce data on market sales prices, rents, vacancy, absorption and construction statistics for commercial and industrial properties. Listings of commercial properties for sale and for rent are given. Some data sources provide historical analysis of actual lease transactions. A typical profile is provided below:

- **Measures –** Vacancy, rents or sales prices, leasing activity and new construction of Central Business District (CBD) and non-CBD office, warehouse, manufacturing, and high-tech industrial properties.

- **Geographical Basis –** Available for most major metropolitan areas as well assorted semi-rural exurban areas.

- **Frequency –** Quarterly.

- **Delay in Release –** One month.

- **Most Recent Currently Available –** Fourth Quarter of 1999.

- **Advantages –** Very current and comprehensive.

- **Disadvantages –** Available only for major metro areas and their exurbs. Not available for rural counties.

- **Applications –** To measure changes in sales prices, rents, vacancy, absorption, and new construction in project areas and to compare them with performance of properties control groups outside of the project area.

- **Access –** Usually available free of charge. The number of web pooled listing sources for commercial properties is growing. National rental market data on metro and surrounding areas are available on the Internet at http://www.cushwake.com. In most metropolitan areas, prominent local real estate firms produce market reports on rents, vacancy, and construction statistics for commercial properties similar to those provided by Cushman & Wakefield. Other listings of rental and for properties in metro areas can be found at http://loopnet.com. Analysis of five-year trends in rents in 50 major metro areas can be purchased from REIS for $79 each. Submarket reports for subareas within metro areas are also available. For more information see http://www.reis.com. In non-metropolitan areas, it is advisable to interview local commercial property realtors regarding changes in rents, sales prices, and occupancy before and after a highway project. Other national real estate market data can be found at http://www.pikenet.com.

3. Commercial Property Market Indicators, Dodge Analytics, F.W. Dodge Co.

- **Measures –** Commercial real estate market indicators for the top 58 metropolitan markets in the nation. Supply and demand for offices, hotels, retail, and warehouse properties is evaluated and indexed. Areas are ranked according to trends in vacancy and in the volume of new construction.
- **Geographic Basis –** Provides data for 58 major metro areas only.
- **Frequency –** Annual.
- **Delay in Release –** 16 months.
- **Most Current Available –** 1997.
- **Advantages –** Provides good synthesis of supply and demand factors.
- **Disadvantages –** Data are out of date by the time of release. Available only for major metro areas.
- **Applications –** To measure changes in the viability of the local property market before and after a highway project.
- **Access –** Data are available free of charge at http://www.mag.fwdodge.com/realestate/mktinfo.htm.
- **Technical Support –** From Dodge Real Estate Group, (780) 860-6880.

4. Residential Sales Transaction Data

For most metropolitan areas, there are sources of data for residential sales based on rec??ords filed with the local recorder of deeds. These records typically contain addresses, dates, prices, and size information. For the Boston metro area, these data are available for purchase from Banker & Tradesmen newspaper. Information can usually be furnished on disk for specific ZIP codes or street addresses.

- **Measures –** Prices, sizes, locations of residential property sales within a given timeframe.
- **Geographical Basis –** Varies, but most widely available for metro areas.
- **Frequency –** Monthly or Quarterly.
- **Delay in Release –** Normally, one to two months.
- **Strengths –** Very current, based on actual transactions.
- **Weaknesses –** Usually available only for residential properties inside of major metro areas.

- **Applications –** To measure impacts on housing values before and after the implementation of a construction project.

- **Access –** Varies by locality.

5. Interviews

Interviews with local project partners are an important source of quantitative and qualitative information on changes in property values in the project area and the project's impact on observed changes. A full discussion of the role of interviews in economic impact analysis appears on the next page.

A.10 Data on Non-Quantitative Change

No matter how good published data sources are, the data are most useful if the researcher knows the story behind the numbers. Coming to grips with the reality of the project entails interviews with project participants as well as a site visit to witness first hand the development generated by the highway project. These are vital, if not entirely scientific, methods.

1. Interviews

The quantitative, published data sources cited on the previous pages do not tell the whole story about the project and its impacts. It is essential to supplement quantitative sources with interviews with people in the project area in order to provide the background regarding the impetus and goals for the project and its perceived direct and indirect outcomes. For some small, rural, areas interviews will be the only way to research impacts on such factors as real estate values and prices, which are not covered by published data sources. There are four main groups to interview:

1. **Government –** Local planning, economic development and elected officials can provide contextual information. Key issues to probe with local officials include the need for the project, economic development goals, and the extent which these goal have been achieved. It is also worth getting estimates of project impacts on employment, wages, land values, quality of life and other local economic indicators to compare with published sources and to assist in interpreting quantitative data. In small and rural areas, for which published data sources are not available, interviews may be the only means of determining impacts on such measures as capital investment and real estate values.

2. **Businesses –** The businesses within the project impact area are direct sources regarding the volume of employment, earnings, and investment that have been generated as a result of the project. It is advisable to speak with at least some of the businesses that have been impacted by the project. This includes businesses within the

project area who have benefited by highway improvements as well as those outside of the project area that may have lost trade due to diversion of traffic to the new route.

3. **Local Property Market Professionals –** Developers and real estate agents can provide quantitative information as well as contextual information and qualitative impressions of project impacts on sales values, rents, vacancy, and occupancy. In non-metro areas that are generally not covered by published data sources, interviews with local real estate professionals will be the only source of real estate market impacts.

4. **Shoppers and Tourists –** In cases where a highway project has generated retail and tourism development, intercept interviews can be conducted with shoppers and tourists in the area regarding spending, visitation, and origins.

In-person surveys can be time-consuming and expensive. Telephone surveys are a more cost-efficient way to gather data, particularly when the analyst is based outside of the local area. Intercept interviews with tourists and shoppers must normally be conducted on site, however. Although interviews with local project administrators and beneficiaries are time-consuming and somewhat subjective, they are an essential collaborative source that complement collection of published, qualitative data and help to interpret and provide contextual information about the project and its impacts. Model interview and survey forms are provided in Volume 2 of this report.

2. Direct Observation

Seeing is believing. If at all feasible, a visit to the study area is an invaluable way to come to grips with the reality of the project and with the nature of the development that it has spurred. There is no substitute for first-hand observation of the project, the area it serves, and the commercial and residential development that has been spawned as a result of access improvements. "Windshield surveys" represent a form of direct observation based on driving along or through a study area. While direct observation can be used to count or business establishments or their customers, they further provide a means for classifying the quality, nature, and image of the business activity. Observations of license plates in parking lots can also be used in some states to track the market areas for businesses by identifying the home ZIP code of privately-owned vehicles parked there.