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Economic Impact Data Analysis Findings

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American Association of State Highway and Transportation Officials
AASHTO

SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

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PREFACE

P1. Project Products and Reports

This document is one of a series of technical products from SHRP2 Project C03, *Interactions between Transportation Capacity, Economic Systems, and Land Use.*

As of June 2015, the original web tool Transportation Project Impact Case Studies (TPICS) was rebranded into the web tool EconWorks. To provide guidance on the new web tool format, this document has been updated to reflect the new changes, although other resources documents may still refer to the original TPICS web tool.

EconWorks Tool. One of the products is a web-based database tool that contains 100 original case studies (5 additional cases were added in 2014) of the economic and development impacts of highway projects, along with analysis tools for screening, viewing and analyzing them. The web site can be accessed:

- Via the EconWorks web site sponsored by the American Association of State Highway and Transportation Officials which can be found at: https://planningtools.transportation.org/13/econworks.html

Technical Documents. The project also produced a series of technical reports, which can all be viewed and downloaded from the EconWorks web page by selecting the Research Reports button under the Project Tools category within the green banner on top. These reports include:

Case Study Analysis

- EconWorks User Guide (Instructions for Use)
- Description and Interpretation of Case Studies: Handbook for Practitioners
- Case Study Design and Development
- Data Dictionary

Research Methods and Findings

- Economic Impact Data Analysis Findings
- Highway Economic Impact Case Study Database and Analysis Findings
- SHRP2 C03 Final Report (TRB format)
- Working Paper: Stakeholder Needs, Limitations of Available Tools and Future Research

P2. Acknowledgements

Contract. This project was conducted under a contract from the National Academy of Sciences and Engineering, through the Strategic Highway Research Program II (Capacity Program, Project C03), to Economic Development Research Group, Inc.

Supervision. The project was undertaken with oversight from staff of the Strategic Highway Research Program, with direction from Stephen Andrle and David Plazak. The project benefitted from review provided by Oversight Panel of the SHRP2 Capacity Program.

Contractors. The case studies and technical reviews were conducted by a team comprised of Economic Development Research Group and subcontractors: Cambridge Systematics, Wilbur Smith Associates, Texas Transportation Institute and Susan Moses & Associates.

The original TPICS (Transportation Project Impact Case Studies) data base and web tool were designed and developed by Economic Development Research Group, and implemented by ICF Consulting.

The EconWorks data base and web tool were designed and developed by CH2MHill.

1 INTRODUCTION

This chapter provides an overview of the research project elements and description of the data analysis element – which focuses on identification of the range of long-term economic and land development impacts associated with highway capacity projects.

1.1 Project Background and Overview

The Strategic Highway Research Program II (SHRP2), Capacity Project C03 was entitled: *Interactions between Transportation Capacity, Economic Systems, and Land Use*. This project produced a series of reports on methods, models and case studies that examined the economic and development impacts of highway capacity investments projects. This report is one volume in that series.

Project Objective. The intent of this project and its research products and web tool is to further public and transportation agency understanding of the range of economic impacts that occur from various types of highway projects. This information can aid both technical research and public discussion of the topic. It can also help define the broad range of impacts and factors affecting them, to assist transportation agencies in their planning processes. And it can help refine public debate about highway projects by establishing boundaries of the likely positive and negative impacts that typically occur from such projects.

In the many ways discussed above, the findings of this study (and specifically this research report) can help the collaborative decision-making process for transportation planning, by providing a background context on the range of observed results from past highway projects. Such information can potentially be of substantial use in early stages of the planning process, in which alternative project concepts are being suggested and screened.

Of course, one cannot assume that every proposed project will have the same results as the average observed from past projects of a similar type that were previously implemented elsewhere. That is precisely why local data is collected and models are applied developed in later stages of the planning process, to identify expected changes in local traffic characteristics and subsequent economic development. Thus, this project should be viewed as a complement and not a replacement for local-specific transportation and economic impact analysis that may be necessary in later phases of the planning process.

Case Study Database. The most notable accomplishment of this project was the development of 100 case studies of highway projects, which (a) compared pre-project and post-project changes in economic and land development conditions,

(b) contrasted them with corresponding conditions for a base of comparison, and (c) included both quantitative impact measures and qualitative assessments based on local interviews.

This collection of case studies, completed in 2010, was compiled with the goal of including all known pre-post highway impact studies in the US, plus available English language studies from Canada and abroad. Members of the project team then conducted additional quantitative and qualitative data collection and analysis to bring all of the cases up to a similar standard of comparability. (For further information on the case study development process, readers are referred to report entitled *Case Study Design and Development,* which can be accessed as described in the Preface.)

EconWorks Web Tool. The case studies were put into a web-based viewing and analysis system called "EconWorks." This system includes: (a) a case study search ("Case Study Search") function that allows for user-defined screening and selection of relevant cases, (b) a case study viewer that provides user access to impact measures, discussion text, maps and related documents, and (c) an impact estimation calculator ("Assess My Project") that shows the average and expected range of impact associated with any user-defined project profile. (For further information on this system, readers are referred to a separate document, EconWorks User Guide, which can be accessed as described in the Preface.)

The EconWorks system was designed to assist transportation agencies in project planning and evaluation, by providing agency staff and interested stakeholders with a means for establishing the range of job, income and development impacts typically associated with various types of transportation projects in different settings.

Methodology Working Papers. A final aspect of this project was a series of working papers that reported on research findings regarding (a) stakeholder needs for improved assessment of economic impacts, (b) available metrics for portraying economic impact performance and impacts, and (c) needs for improvement to current economic impact assessment models tools. (For further information on the working papers, readers are referred to the list of additional project documents described in the Preface.)

This Research Report is designed to complement other products of this project, by providing research findings from data analysis conducted on the case study database. It also describes the formulas used in the EconWorks web tool's impact estimation calculator (Assess My Project).

1.2 Data Analysis Process

Meta Analysis Concept. The objective of the data analysis is to present results from an empirical analysis of the economic impacts of highway projects, based on pre/post data observations combined with case interviews. To accomplish this, it was recognized, early on in the project, that there had been past efforts to assess economic impacts of highways in this way. This included (1) a number of research reports produced by various state DOTs that included case studies of the actual impact of community bypass roads, and (2) additional research reports produced by various regional and state agencies that included case studies of the actual impacts of local access routes (typical built to enable development of industrial parks). In addition, (3) agencies such as the US DOT Federal Highway Administration and the Appalachian Regional Commission had sponsored pre/post case studies of the economic impacts of selected major highway projects.

This project sought to develop a database of pre/post case studies of highway projects across the US, with inclusion of additional projects in other developed nations, where available. To accomplish this, essentially all of the projects that had been previously studied in the above-cited studies were selected as candidates for inclusion in the new database. To ensure a fully consistent base of data, a decision was made to update the earlier case studies with additional data collection and interviews, and to also conduct the same kind of data collection for additional highway projects that had not been the subject of prior case studies. By pooling case studies from past research with new cases, we are providing the equivalent of a "meta analysis" of the datasets spanning multiple studies.

However, we had one additional consideration, and that was the need to ensure a wide distribution of different types of projects, spanning different regions of the US and different types of urban/rural settings. To meet that need, the final database of case studies included essentially all of the previously studied highway, bridge and interchange projects, but only a portion of the numerous bypass and access road projects. A further effort was made, though, to review findings from earlier studies of those project types, to ensure that results of this study are fully consistent with prior research..

Case Selection. The process of case selection focused on selection of highway projects that fall within the following parameters:

- ***Capacity Focus.*** Consistent with the goals of the SHRP (Strategic Highway Research Program) capacity research program, all projects studied here involved highway capacity enhancement, i.e., construction of new facilities, replacement of old facilities or enhancement of existing facilities. In each case, the intent of the capacity increase was to provide more traffic throughput (via some combination of greater volume, higher speed and/or reduced delay). And the magnitude of these projects (over

$10 million) and nature of their capacity improvements were deemed to be sufficiently large so that economic development impacts were considered to be likely. Major capital projects intended primarily for other reasons, such as safety enhancement or preservation were intentionally excluded.

- ***Project Age and Available Data.*** All projects were built at least five years ago and no more than twenty years ago. This range was set so that enough time had passed for economic development impacts to start emerging and be observed, but not so much time that pre-project data and interview sources are no longer available. Nearly all highway projects that had already been subject to a prior pre/post study of economic impact were selected to make best use of all available information. Findings from those prior study cases were, however, also reconfirmed and updated via new case study data collection conducted as part of this project.

- ***Project Selection.*** Projects were selected to provide the widest possible representation amongst ten types of highway system enhancements, five regions of the US, and a mix of urban/rural settings. In addition, a few Canadian and European case studies were also included.

Data Analysis Process. The database includes descriptive information on each project, its setting, pre-project and post-project economic conditions, and the extent to which observed changes can be attributed to the highway project. The database was built from case studies conducted specifically for this project, which assembled both quantitative data from available public sources and qualitative data from interviews with public and private sector sources. In addition, observed changes associated with major highway projects were compared with changes occurring elsewhere in corresponding comparison areas. Since projects differed widely in scale, various elements of the data were collected at the neighborhood, municipal, county or statewide levels.

The empirical analysis derives findings that emerged from an effort to explore a wide range of possible relationships between *project impacts* (measured in terms of changes in employment and land development) and explanatory factors including *project characteristics* (e.g., type of facility, size, and level of use), *settings* (e.g., population density, urban/rural class and economic distress level) and *project objectives* (e.g., congestion reduction or access enhancement).

A separate report entitled Case Study Design and Development explains how the case studies were selected and conducted. Another report entitled Handbook for Practitioners discusses the interpretation of both interview data and empirical data, and also discusses case study strengths and weaknesses.

The principal audiences for the data analysis findings are local, regional, state and federal transportation agencies. The motivation of these agencies is to assess the broad range of economic impacts associated with different types of highway projects in different settings, so as to better inform initial public discussion concerning highway policy and future project options. This information can help refine expectations about economic impacts, but of course it cannot replace the subsequent need for local data collection and analysis.

Sources of Data. Four categories of data were collected for each case study:

(1) Project Data
(2) Transportation Data
(3) Economic Data
(4) Demographic Data

"Project data" was collected in the course of conducting case studies to describe each project. Descriptors include location, construction start and completion years, capital costs, and the size of each project (in terms of linear length, lanes and lane miles). For some cases highway corridor lengths were calculated using GIS. Project data also included the qualitative assessments of interviewees, including the use of local policies (coordination of other infrastructure development, land use regulations and business climate/use of business incentives), motivation for developing the project (such as reducing congestion, or improving access to local, national and international destinations).

"Transportation data" was assembled in terms of annual average daily traffic (AADT), derived from the "MPSI TrafficMetrix" database. The daily average for Vehicle miles traveled (VMT) was calculated for each project by applying AADT to highway length.

"Economic data" included both indicators of project setting and indicators of project impact. The project setting metrics included a measure of the economic climate, portrayed in terms of economic distress level. Distress was measured by comparing the project area rate of unemployment (the numerator) against national unemployment rate (the denominator) when the project began construction, as well as post construction.[1] This data is available from the US Bureau of Labor Statistics. Generally, a product greater than 1.0 indicates distress and less than 1.0 indicates a non-distressed area.

Project impact was assessed by observing changes in the pre and post economies of each region and assigning a share of the change to the highway project. The primary measure was employment, though information on changes in property

[1] Comparing local to national unemployment rates is common way federal and regional agencies deifne local economic distress. For this analysis, project areas with high levels of distress have unemployment rates more that 110% above the national average and areas with low levels of distress have unemployment rates less than 90% of the national average.

development, land values, taxes and income were also assembled when available. This data was compiled from two sources: (1) local reports obtained from case study interviews, and (2) pre/post data assembled from the Bureau of Economic Analysis, the Bureau of the Census, and the Bureau of Labor Statistics. Impacts derived from the latter source were adjusted to reflect interviewee reporting on the extent to which some highway projects were only partially responsible for observed economic growth. Impacts on income and business output were estimated proportional to the employment changes, based on ratios for each county study area derived from IMPLAN.[2]

"Demographic data" included measures of population and employment densities, urban/rural setting, and region of the US.

More detailed information on the dataset and its sources is available in a separate document, entitled Case Study Database Documentation.

1.3 Key Indicators of Impact

A total of 98 quantitative and 10 qualitative economic indicators were assembled from case studies and by joining national databases to the case study findings. The key indicators are listed in the table that follows. Readers are referred to the Case Study Database Documentation for a data dictionary containing full description of each data field.

The various data fields are filled out only where relevant and where data is available. At both the project specific and local levels (particularly those that are sub-county), the impact elements differed by the unique contexts relevant to each case. The unique context elements are explained in the case study text fields, containing write-ups that describe which of these factors are relevant per project and how each applicable factor affect observed project development and outcomes in each case.

[2] To estimate wages, sales and the indirect and induced ("multiplier ") economic effects for each project, this study utilized the IMPLAN model system, which is now the most widely used input-output economic modeling system in the U.S.

List of Database Fields for Analysis

PROJECT DESCRIPTION

1a. Type of Project – major highways, local access roads, widening projects, bypasses, beltways, connector links, interchanges, bridges, freight intermodal terminals, passenger intermodal terminals

1b. Cost -Actual dollars, dollars in current year and adjusted to 2008

1c. Linear Miles – number

1d. Lane Miles - linear miles x lanes

1e. Time for Construction, years and months (calculated)

PROJECT SETTING

2a. Location – New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, Far West

2b. Type – Urban, Rural, Mixed (part of project in both urban and rural settings)

2c. Impact area – Neighborhood, corridor, municipality, county, multi-county region, state, other

TRAFFIC IMPACTS

3a. Average Daily Traffic - Pre-project on facility before replacement or renovation, or point to point if the project is a new facility

3b. Average Daily Traffic - Post-project on facility

PROJECT MOTIVATION

4a. Reason projects were proposed

4b. One or more motivations – relieve congested conditions, improve access to airports, marine ports and/or international borders, facilitate site development, enhance tourism, increase local labor market, enlarge access of one-day truck delivery span.

SUPPORTIVE POLICIES

5a. Complementary infrastructure including water and sewer, elecommunications, and local feeder roadways

5b. Land use regulations that support economic development

5c. General business climate, including incentives and permitting processes

PROJECT-GENERATED ECONOMIC IMPACTS

6a. Direct jobs as a consequence of project development from case study research
6b. Calculated new direct business sales and wages
6c. Local multiplier impacts on jobs, wages, and business sales
6d.New Building Construction (sq. ft.)
6e. Local Property Values
6f. Real Estate tax collected

REGIONAL ECONOMIC CONTEXT AND DISTRESS

7a. Pre-construction[3] unemployment rate compared to national averages
7b. Population and population densities for pre- and post-construction[3] periods, covering local impact area, region (county or multi-county area) and state
7c. Employment and employment densities for pre- and post-construction[3] periods, covering local impact area, region (county or multi-county area) and state
7d. Per capita income for pre- and post-construction[3] periods, covering defined local impact area, region (county or multi-county area) and state

For a more information on data fields, see the Dataset Documentation report.

1.4 Report Organization

The remainder of this report is organized into five additional chapters:

- Chapter 2 presents findings from a tabulation of case study data describing characteristics of case study projects and their economic impacts.
- Chapter 3 presents findings from statistical (regression) analysis of the relationship between job impacts and various explanatory factors.
- Chapter 4 discusses additional considerations that cause some projects to have less or more impact than would otherwise be expected.
- Chapter 5 lays out the formulas that drive economic impact estimates provided by the EconWorks web tool.
- Chapter 6 summarizes key conclusions drawn from the analysis described in Chapters 2-5.

[3] Pre-construction observation was typically the year before project initiation; Post-construction observation was three years after project completion

2 FINDINGS FROM DATA TABULATIONS

This chapter describes the mix of case studies in terms of project types and explanatory factors such as local setting (economic well-being and development density). It then presents findings in terms of job impact rates and ratios relative to the different types of projects, traffic characteristics and settings.

2.1 Project Types and Settings

The SHRP2 dataset contained 100 highway projects, distributed amongst categories of facility types[4], urban/rural settings and economic distress levels.[5]

Table 1. Project Types and Settings

Classification[4]	Total	Location			Economic Distress[5]		
		Metro-politan	Rural	Mixed	High	Even	Low
Access Road	7	2	5	0	2	2	3
Beltway	8	8	0	0	2	3	3
Bridge	10	4	3	3		8	2
Bypass	13	4	8	1	6	2	4
Connector	8	4	2	2	3		5
Interchange	12	10	0	2	6	2	4
Major Highways	14	5	0	9	3	5	6
Widening	9	4	2	3	1	3	5
Intermodal	19	15	15	15	5	11	3
TOTALS	100	56	23	21	28	36	35

Using case study research, and data sets from the US Bureau of Economic Analysis, US Census Bureau and the US Bureau of Labor Statistics, the cases present an array of indicators of economic impacts of highway investments. These indicators describe economic, geographical and demographic contexts at local, county and state levels; including the following:

[4] Project types are defined in the *Description and Analysis of Case Studies: Handbook for Practitioners*. Intermodal terminals refer to projects involving highway – rail interchange, and typically include access road, parking facility and terminal for passengers or freight transfers.

[5] "Economic Distress" is calculated on the basis of unemployment rate. Areas with high levels of economic distress have unemployment rates more that 110% above the national average and areas with low levels of distress have unemployment rates less than 90% of the national average.

- **Economic Context for each project.** These include population, extent of economic distress, jobs and income in geographical contexts before projects were built and after they were completed.

- **Policy context.** As case studies were developed local informants were asked to verify the motivation for development of each project, and whether there were synergies with other types of infrastructure or economic development policies that also helped generate economic impacts, or other local factors that reduced or prevented economic impacts from occurring.

- **Geographical context.** These include market size, distance to key destinations and extent of mountain terrain.

2.2 Project Impact Metrics

Nature of Impacts. To understand the nature of highway economic impacts, it is important to first establish the range of economic impact indicators. Basically, highways can lead to economic impacts that are observed in a variety of different forms over time. The most typical sequence of impacts occurs as follows:

1. *Transportation Impact.* A highway project improves a location's accessibility or usefulness by enabling faster or more reliable travel to and from that area, or enabling access to a broader set of origin or destination opportunities.

2. *Land (Property) Value Impact.* The transportation improvement makes an area more attractive as a place for living, working or recreation – which results in greater demand for land there. That improvement is sometimes referred to as an increase in the productivity of the location. The greater demand typically leads to higher land values, as reflected in more property sales at higher prices.

3. *Building Construction and Investment Impact.* The greater value of the location attracts investment in new construction or expansion of housing, commercial buildings and/or recreation facilities. That is reflected initially in terms of building permits and later in terms of new or upgraded building structures (which can be measured as square footage or investment $).

4. *Employment, Income and Output Impacts.* Once the buildings are occupied, there are commonly measurable increases in population (for residential use) or employment (for commercial and other uses). The employment increase reflects an added activity level that can also be viewed in terms of income (wages associated with the employment) or business activity (measured in terms of value added or total output growth). It is important to note that all

of these measures reflect different ways to measure the same economic activity growth, so these measures cannot be added together.

5. *Tax Revenue Impacts.* The added land value and construction activity lead to increases in local property tax collections, while the added wages and associated spending lead to increases in income and sales tax collections.

There are three key conclusions to draw from this list of impact measures. One is that impacts unfold over time, so it is dangerous to make conclusions about economic impacts unless a sufficient period of time (typically five to ten years) has passed to allow for these impacts processes to be observed. A second conclusion is that not every project will show every type of impact at the same time. A third conclusion is that each of these forms of impact can have a different spatial pattern of observation. In other words, some will be concentrated at a neighborhood level, while others will be spread over a broader community or regional level. Some types of projects will also tend to have highly localized impacts (e.g., a connector or access road), while other types of projects can have broader impacts in which major beneficiaries are hundreds of miles away (as may occur with a major highway project or a bypass project).

Further information on the full range of economic impact metrics is provided in a separate report from this study, entitled, Economic Impact Performance Metrics.

Observed Incidence of Impact Measures. Table 2 shows the extent to which each of the impacts was observed or measured in the case study process. Of the 100 projects studied, 86% had some indication of an economic impact associated with the project. However, the incidence varied widely among impact measures.

Table 2. Economic Impact Measures Observed in Case Studies

Measure of Impact	Qualitative: Change Observed	Some Quantitative Impact Data	Full Quantitative Data in Dataset
Employment	86	86	86
Income	*	*	*
Business Value Added or GDP	*	*	*
Bldg Development (Sq.Ft.)	73	44	6
Direct Private Investment ($)	58	31	14
Property Values	36	25	6
Property Tax Revenue	50	40	5

** measures that were calculated (in the database) from employment change ratios*

The results shown in Table 2 must be interpreted carefully. The differences among rows in that table are likely to reflect variation in availability of data rather than differences in occurrence of impacts. Generally, a change in any one of those impact elements is likely to also lead to changes in the other impact elements. However, there are more substantial differences in availability of the data measure. In general, employment change is the measure most likely to be observable, because there are widely available datasets on annual employment changes available at the county, community, and even zip code levels across the US. (For this study, the measure of employment change reported as a highway impact was defined to be whatever level of geography was deemed most relevant for that kind of project, adjusted for case study interview findings on the portion of observed impact that could be attributed to the highway project.) Information on building permits, property transactions and investment are more difficult to obtain because they come from municipal or county records, which differ widely in their availability and format for tabulation.

The differences among columns in Table 2 indicate the vast difference between obtaining case study interview observations of economic development impact (reflected in the column labeled "qualitative observations") and obtaining empirical datasets reflecting the full set of impacts (reflected in the column labeled "full quantitative data"). In many cases, data was available for some forms of development or some building projects, but not for all such investments. These differences are also illustrated in Figure 1 which follows.

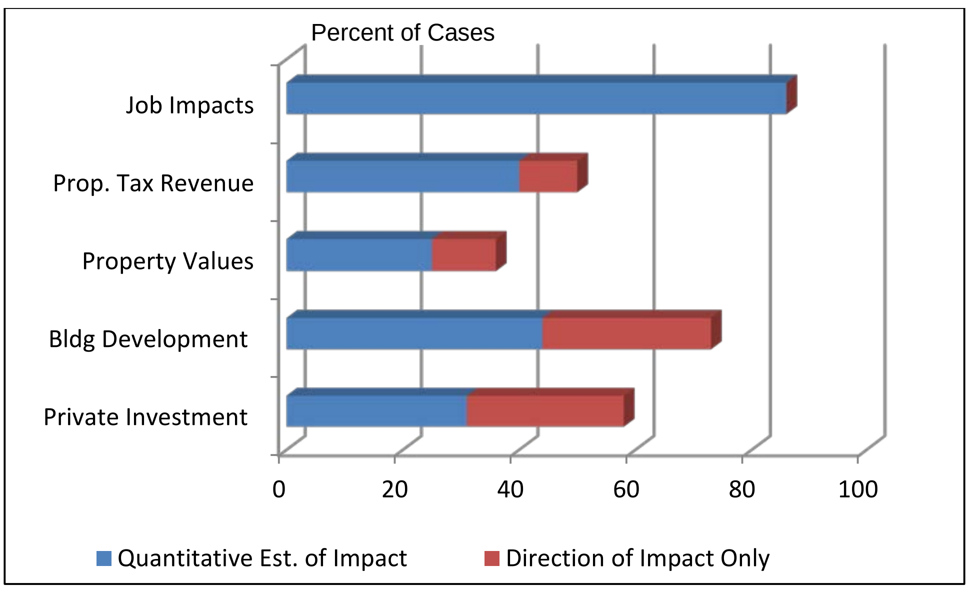

Figure 1. Percent of Cases with Qualitative & Quantitative Impact Measures

Measures of income and business activity (value added or GDP) are also of note because their availability is primarily limited to the larger spatial levels of counties and metropolitan areas. As a result, these measures are commonly used in economic studies that examine the relationship between aggregate levels of highway spending and large area economic growth. And they are sometimes estimated as an indicator of impact for major new highway projects. However, when there are studies of localized impacts of individual projects, then wage and value added (GDP) impacts are most commonly estimated on the basis of the more easily obtainable measures of employment impacts.

Direction of Impact. Table 3 shows the direct of net change resulting from the 100 case studies. Focusing first on the most reliable and widely available impact metric -- employment impact, the results show that 85% of the cases found positive changes in local employment that were at least partially attributable to the highway project. Only one project a net negative impact, while the remaining 14% found evidence of no net impact. The latter finding includes both cases where there was no evidence of job impact and cases where there were both negative and positive impacts that tended to cancel out.

Table 3. Results of Quantitative Economic Impact Measurement

Dimension of Impact	Positive Net Change	Negative Net Change	No Net Change (or No Data Available)
Direct Impact on Jobs	85	2	13
Direct Impact on Investment $	14	0*	86
Direct Impact on Construction	6	0*	94
Direct Impact on Local Tax Revenue	5	0*	95
Direct Impact on Property Values	6	0*	94
Change in Total Business Sales	8	7	85
Change in Property Values	42	5	53

* *measures reflect the net result of positive and negative impacts*

It is important to note that the case study results show only net impacts. It is clear that in some cases, highway projects can cause negative visual, air quality or noise quality impacts on areas that are directly adjacent to them, while providing access benefits to broader surrounding areas. In some cases, highway projects can also cause localized negative job impacts, as would be the case if a highway construction or expansion project required the taking of some property with existing commercial activity. However, in nearly all cases, such takings are only done because the project will also enable new activity to occur somewhere else nearby. The incidence of any such impacts are noted in the case study text discussions, though we cannot make any conclusions on their extent because the empirical database of economic impact measures focused only on measurement of net changes for broader surrounding impact areas.

The incidence of direct impact measures other than jobs was spotty; in other words, the finding of no net change in investment, construction or tax revenue was dominated by cases where no data reliable was available. Another source of data was municipal data on overall community-wide business sales and property tax base. Those measure, when available, tended to show incidence of both positive and negative changes, though we cannot be sure how much of those changes are attributable to the highway project occurring in their areas.

Differences by Project Type. Table 4 shows how the portion of case studies with positive impacts differed by type of project and by type of impact measure. (This includes case studies with both qualitative and cases with quantitative impact measures.) Overall findings are also summarized in Figure 2 on the next page.

Table 4. Economic Impact Incidence by Project Type

Project Type	Total Cases	Number of Cases with Positive Impact				
		Job Impact	Private Investment	Building Construct	Property Values	Tax Revenue
Access road	7	7	4	2	1	3
Beltway	8	8	8	8	2	7
Bridge	10	8	7	7	7	7
Bypass	13	7	6	6	5	8
Connector	8	6	6	6	4	5
Interchange	12	10	6	8	2	4
Major Highway	14	14	13	13	10	11
Widening	9	9	1	7	2	1
Freight Intermodal	10	9	2	9	1	1
Pass. Intermodal	9	7	5	7	2	3
Total (100)	**100**	**85**	**58**	**73**	**36**	**50**

Viewing Figure 2 (below), it becomes apparent that the major new highway, widening, beltway and freight intermodal projects were most likely to show both job and property impacts. The bypass roads were least likely to show either type of impact, as they were most likely to show negligible net impacts in the database, and mixed positive and negative impacts in the case study text details. The local access roads were very likely to show job impacts, but least likely to show property value impacts because those projects were concentrated on serving industrial or office park projects that were already being built.

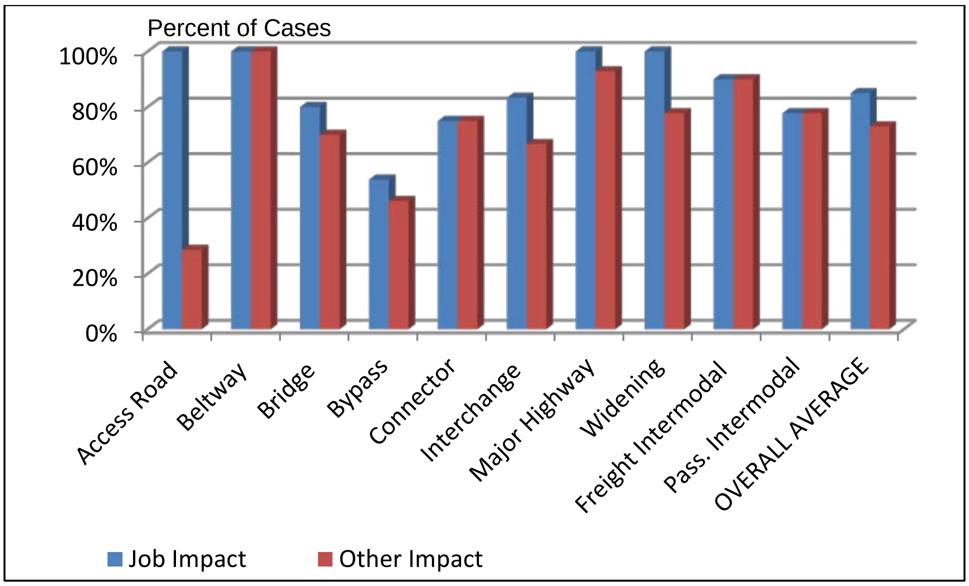

Figure 2. Economic Impact Incidence by Project Type

More detailed analysis of the specific magnitude of employment impacts associated with highway projects is provided in the next chapter on pooled statistical analysis results.

2.3 Project Cost, Duration & Traffic Level

The case study database allows for calculation of typical cost, construction duration and traffic levels associated with different types of highway projects. This information also provides a base of information useful for later statistical analysis of factors affecting economic impact results.

Project Cost. The cost of typical highway projects can be best considered in terms of three classes. Widening and bridge construction projects are typically the most expensive project types at $39 - $46 per mile. Beltway, connector and interchange projects represent an intermediate range of roughly $14-$22 per mile. The least expensive projects are access roads, bypasses and new intercity highways, all of which have been developed in the past for less than $10 per mile.[6] Table 5 shows the median cost per mile for each project type.

Table 5. Median Cost Per Mile

Project Type	Median cost per mile (*millions*)
Access Road	$1.61
Beltway	$18.82
Bridge	$39.22
Bypass	$5.34
Connector	$21.79
Interchange	$14.05
Major highway	$8.79
Widening	$46.17
Freight Intermodal	n/a
Passenger Intermodal	n/a
All Project Types	$14.43

Highway Construction Duration. The mean duration of construction for the 100 case study projects was 81 months, or roughly 6.75 years, and the median was 4.0 years.[7] Twenty-three projects took 10 or more years to complete, of which 22 of these projects are in metropolitan (metro) or mixed regions, with just one in an exclusively rural setting. The lengthy projects indicate that complex urban development yields strong economic outcomes. The 23 projects that took more than 10 years to build generated an average of 10,700 direct jobs (including the one rural project in this category that yielded 2,400 jobs), while the 76 projects that took less than 10 years to develop averaged about 3,200 jobs each.

Overall the median length of construction time for an metro/mixed project was twice the length of rural project, six years to three years for development, and the difference calculated by mean average show a difference of 7.8 years (94 months) for projects in metro/mixed settings to 3.25 years (39 months) in rural settings. For mean and median construction lengths, the ratios of direct jobs in metro/mixed to rural projects are 13:1 and 16:1, respectively (Table 6).

[6] Costs have been standardized in 2008 dollars.
[7] Data were not available for one case.

Table 6. Direct Jobs by Setting and Project Time Length

Setting	Number Projects	Mean		Median	
		Construction Months	Jobs	Construction Months	Jobs
Metro/Mixed	76	94	6,254	72	1,600
Rural	23	39	484	36	100
All Projects	99	81	4,927	48	800

The development of major highways, beltways and highway widening projects had a longer average construction time than the other project types. Measured by both mean and median, the average time to complete a major highway project was 15 years and a beltway project was 10 years. On average, road widening took between eight years (median) and 12 years to develop (mean). Thirty-one of the 100 projects fall into one of these three categories, and 29 are in metro/mixed settings with just two in rural areas. Table 7 below shows length of construction by project type.

Table 7. Average Construction Months by Project Type

Project Type	**Projects**	**Construction Period (months)**	
		Mean	**Median**
Major Highway	14	183	180
Beltway	8	120	120
Widening	9	139	96
Connector	8	66	54
Access Roads	7	57	36
Bypass	13	46	36
Interchange	12	40	36
Passenger Intermodal	9	47	36
Bridge	9	40	24
Freight Intermodal	10	59	24
Total	99	81	48

Highway Traffic Levels. The 100 projects studied generate average traffic ranging from 10,000 cars per day to over 100,000. The most traffic intensive project types are interchanges, beltways, widening projects and major highways. The least intensive include access roads, bridges and bypasses, as well as freight intermodal stations, which are heavily oriented to truck traffic (See Figure 3).

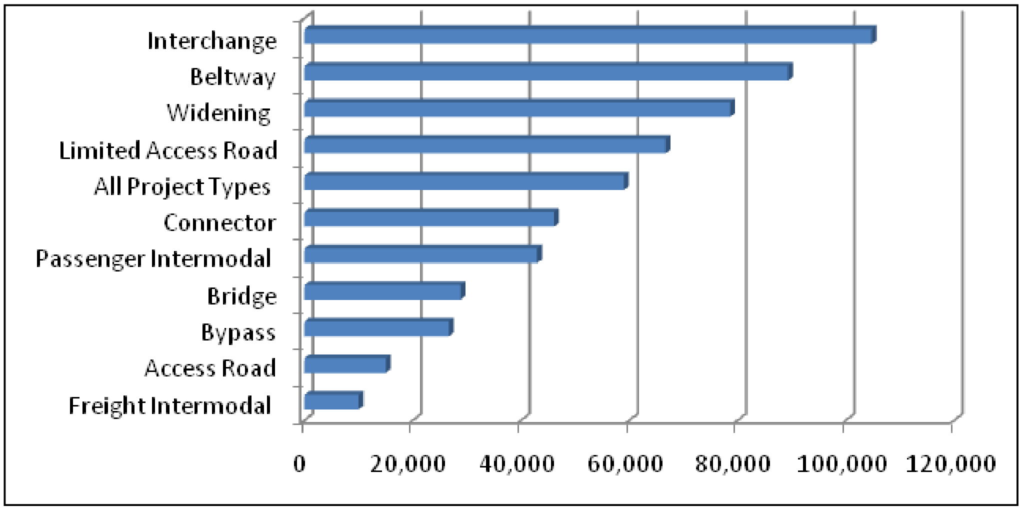

Figure 3. Average Automobile Daily Traffic (AADT)

2.4 Employment Impact Ratios

Ratio of Highway Cost and Job Impact. Overall, the ratio of highway investment cost per direct job documented through the case studies was approximately $140,000. Of course, job creation was not the sole reason for any of these projects nor was the income stream generated by the additional jobs counted as the primary benefit. However, if viewed in terms of those ratios, then it appears that local access roads were the most efficient job generator, as the average highway investment was only $29,000 (in 2008 dollars) per direct job generated. This is not surprising, since access roads are often built to connect an industrial or office park or other form of development that has already been planned.

Bypasses were the least efficient job generator, with an average of $945,000 for each local job generated. Of course, that too is not surprising since bypass roads are typically built to reduce accidents, noise and traffic backups associated with heavy trucks traffic passing through town centers. As such, the most common bypass benefits are either environmental enhancement for the bypassed area, or else speed and travel time savings for freight shippers and consignees who may be located far away from the bypass site. Promoting economic development is seldom a justification for such projects, though there is more often a concern among local residents and businesses about the potential for economic loss in the bypassed area. Table 8 shows the ratio of average highway cost to direct job growth, by project type.

Table 8. Mean Costs and Jobs by Project Type

Project Type	Average for Projects in that Class		
	Project Cost (constant 2008 $)	Direct Jobs	Ratio of Highway Cost to Jobs
Access Road	$13.0 million	443	$29,400
Beltway	$961.5 million	16,319	$58,900
Bridge	$116.2 million	1,709	$68,000
Bypass	$30.2 million	32	$944,600
Connector	$163.1 million	1,990	$82,000
Interchange	$106.3 million	2,192	$48,500
Major Highway	$2,765.4 million	10,868	$254,500
Widening	$1,158.4 million	7,635	$151,700
All Projects	$782.8 million	5,540	$141,300

Effect of Project Setting. When studying cost per job by setting, it is apparent that highway projects in metropolitan areas create more jobs per dollar of project cost than those in rural or partly rural locales (See Table 9).

Table 9. Mean and Median Cost per Project by Setting

Setting	Ratio of Mean Cost Per Job	Ratio of Median Cost Per Job
Metro	$82,800	$110,000
Mixed	$162,000	$201,000
Rural	$136,000	$954,000

Based on 99 cases, the Central Artery Project was omitted from this table because the project has development characteristics not replicated in any other case studies.

The relationship among the settings is considerably different for the median cost per jobs. The median cost per metropolitan job is one-half that of mixed areas and one-ninth of rural areas. To understand these differences, it is important to realize that 6 of the 19 rural projects (32%) had zero job creation and 4 other projects (21%) show less than 100 direct jobs. On the hand, five of 39 metropolitan projects did not create any jobs (13%) and four others generated less than 100 jobs (10%). But, 23 metropolitan projects had an impact exceeding 1,000 jobs (59%). Thus, while more than 50% of rural projects generated 0 – 99 jobs, almost 60% of metropolitan projects generated more than 1,000 jobs, and all mixed area projects generated at least 175 jobs.

Figure 4 and Figure 5 show that, for all categories, more jobs are generated in metro/mixed settings—per $1 million expenditure for highway related projects—than in rural settings.

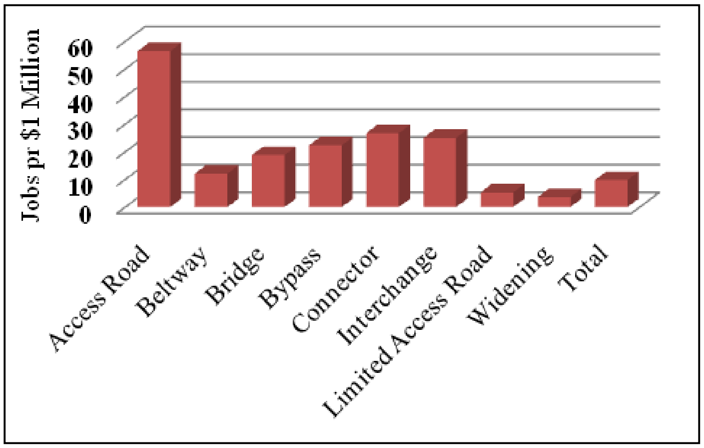

Figure 4. Jobs per $Million Project Cost: Metro/Mixed Setting

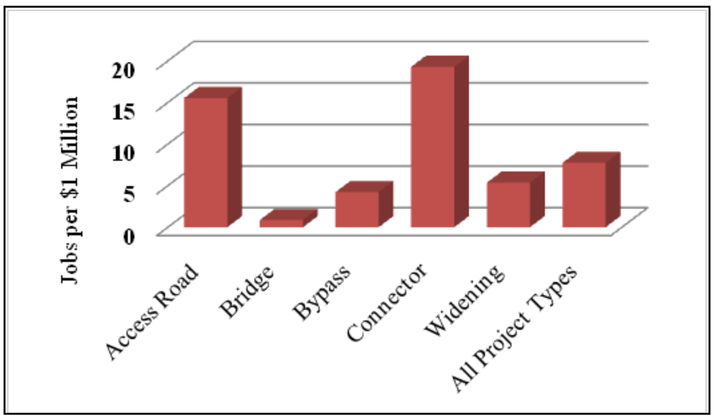

Figure 5. Jobs per $Million in Project Cost: Rural Setting

Effect of Traffic Volumes. With differences in densities of population and jobs prevalent in metro/mixed and rural settings, it is not surprising to observe that more traffic is required to generate jobs in more sparsely populated rural regions than those that have urban attributes. Table 10 shows that every 100 jobs generated by projects in metro/mixed areas required fewer than 1,200 AADT, while jobs generated in rural areas are supported by more than 3,600 AADT.

Table 10. Direct Jobs by Traffic Generation

Setting	N	Total AADT	Direct Jobs	Jobs/ AADT	AADT per 100 jobs
All Projects	77	4,629,993	382,075	0.083	1,212
Mixed/Metro	59	4,339,983	374,893	0.086	1,158
Rural	18	290,009	7,930	0.027	3,657

Projects exclude passenger and freight intermodal cases, three non-US Cases and the Central Artery Project in Boston as an outlier.

In addition to the difference in settings--metropolitan, mixed metropolitan and rural--there are also apparent differences in project performance based on the economic conditions of a project location (for example, if the area is economically distressed). Table 11 illustrates median jobs per million dollars of capital investment for all 97 US domestic case studies. It also shows that rural impacts are considerably smaller than metro/mixed area impacts in distressed and not-distressed environments and that there is considerable impact in distressed areas per dollar in both metro/mixed and rural settings.

Table 11. Direct Jobs Generated per Capital Investment

by Setting and Economic Condition

Median Jobs per $ million *(constant year 2008 $)*	Not Distressed	Distressed
Metro /Mixed	7.1	9.7
Rural	0.7	3.6

The definition of "distress" is based on unemployment. Areas "Not Distressed" have an unemployment rate at or below the US average. Areas "Distressed" have an unemployment rate greater than the national average.

2.5 Pooling Projects: Job Generation Rates

For statistical analysis, the non-intermodal modal projects were pooled according to travel characteristics: roadway projects – that do not have a specific destination point; and point-to-point projects -- that generally have defined start and end points. Passenger and freight intermodal projects could not be pooled into the larger sets or considered as a single set, because projects oriented toward rail connectivity are significantly different than the highway projects, and rail and passenger intermodal characteristics significantly differ from each other. The pools are shown below:

- Roadway: beltway, bypass, Major highway, widening
- Point to Point: Interchange, access road, bridge, connector road

- Passenger Intermodal
- Freight Intermodal

Of the 100 case study projects currently in the database, 44 are roadway, 37 are point to point, 10 are freight intermodal and nine are passenger intermodal. Overwhelmingly, however, jobs have been generated by roadway projects, which account for more than 370,000 direct jobs or 75% of the 500,000 direct jobs documented by the case studies. By comparison, point-to-point projects account for 96,000 direct jobs (20% of the total), freight intermodal and passenger intermodal account for 14,000 (3%) and 11,000 (2%) direct jobs, respectively (See Figure 6).

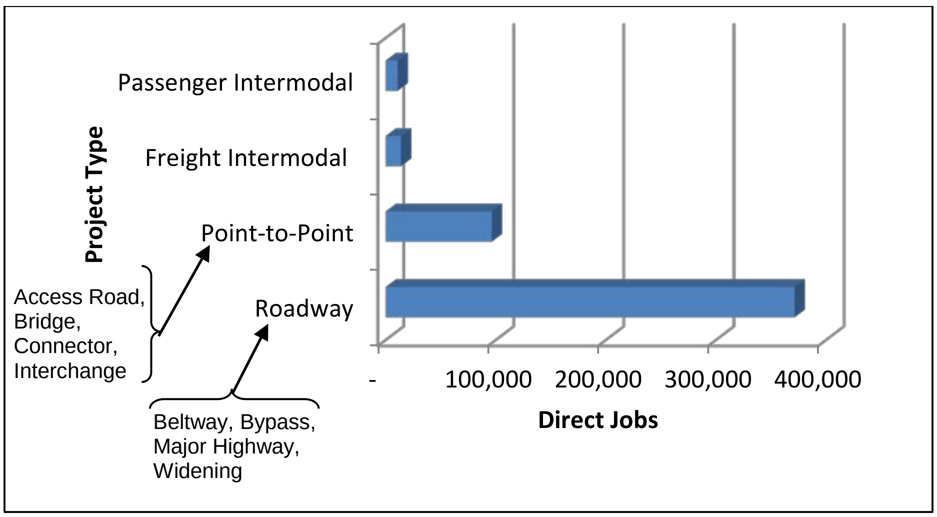

Figure 6. Total Direct Jobs

Cost per jobs that have been generated by development of point-to-point projects is much greater than roadway, freight intermodal and passenger intermodal, which are equivalent (See Figure 7).

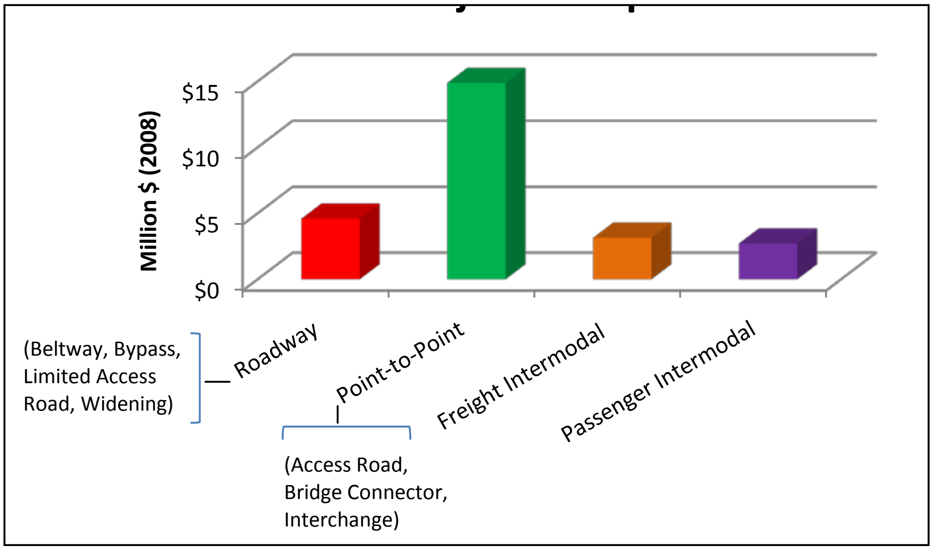

Figure 7. Median Project Cost per Job

Table 12 presents additional comparisons among Roadway and Point–to-Point projects. On average, Point–to-Point projects require twice the level of traffic as Roadway projects to generate 100 jobs. Accordingly, the per-capita income difference three years before and three years after case study projects are $2,000 (mean) and $3400 (median) greater for roadway cases than for point-to-point cases (normalized to $2008). However, the mean and median market sizes for Point–to-Point projects are greater than those for Roadway projects.

Table 12. Roadway and Point-to-Point Comparisons

Project Type	AADT Per 100 Direct Jobs	Market Size		Pre/Post Change in Per-capita Income	
		Mean	Median	Mean	Median
Roadway	790	84,253	62,563	$8,603	$8,855
Point-to-Point	1640	25,381	32,266	$6,406	$5,436

AADT denotes annual average daily (vehicle) trips
Sources: Project Case Studies for jobs and AADT, ESRI-GIS for determining market size and US Bureau of Economic Analysis for per-capita income

3 STATISTICAL ANALYSIS OF JOB GENERATION FACTORS

3.1 Analysis Framework

Analysis Elements. Using the project pools identified in Section 2.3, we classified projects into three groups:

- Roadway: beltway, bypass, Major highway, widening
- Point to Point: Interchange, access road, bridge, connector road
- Passenger and Freight Intermodal

We then developed and tested a series of regression equations for the "roadway" class of projects and the "point-to-point" class of projects, to determine the most important factors that led to creation of direct jobs for case study projects.[8]

The regressions were developed to identify independent variables that were statistically significant in explaining "direct jobs, as defined in the case studies. The job impact measure was defined as the change in total employment attributed to the highway project, as measured at whatever spatial level was deemed most relevant to the project (i.e., this could be local highway corridor, community, county or metropolitan region, depending on the breadth of spatial area spanned by the highway project).

For independent variables, we joined place-specific data gleaned in case study research with data sets from the Bureau of Economic Analysis, Bureau of Labor Statistics, the Census Bureau, traffic data from MPSI TrafficMetrix (via ESRI) and county-based economic data based on federal sources that are contained in the IMPLAN dataset.[9] The results of final equations tested are shown in Table 13.

Classes of Independent Variables. The independent variables that were tested as explanatory factors fall into seven categories:

- *Level of traffic activity* – Those projects with higher levels of AADT (traffic count) or VMT (total vehicle-miles of traffic) are most likely to be

[8] Excluding freight and passenger intermodal projects and foreign projects.
[9] ESRI has products and licenses Arc/Info, a full featured GIS desktop system and IMPLAN is the most widely used input-output system in the United States.

facing congestion delays, which can have particularly important consequences for access and travel time reliability.

- *Scale of Project* – Those projects involving the highest number of lane-miles are most likely to be connecting between urban areas or linking urban activity centers to their surrounding markets.

- *Urbanization* – Those projects set in areas of higher average population density are most likely to be in urbanized areas where congestion is a particularly important consideration.

- *Market Scale* – Those projects with the largest size market (measured in terms of population within a 40 minute drive) are most likely to be within large metropolitan regions, where access is a particularly important consideration. They may also be more likely to have rail and air facilities located nearby, which can also gain from highway access improvements.

- *Terrain* – Those projects in mountain terrain are most likely to face limited route options are higher sensitivity to slow vehicle or accident delays.

- *Economic Health* – Those projects in areas that are already economically healthy (measured in terms of higher income and lower unemployment rates) are more likely to enable economic development without facing other barriers (occurring in economically distressed areas) that need to be addressed before further business investment can occur.

- *Underlying Growth Trend* – Those projects located in regions that are already strong and growing (in terms of income and/or jobs) can be particularly dependent on additional transportation capacity enhancement in order to successfully attract new business.

3.2 Statistical Analysis Results

Regression Results for Explanatory Use. Findings from the regressions are summarized in Table 13 for various combinations of project class (roadway and point-to-point) and setting (expressed in terms of metro, rural or mixed classification). The results indicate that all seven categories of independent variables have some explanatory power, though the factors that most consistently emerged as important were the level of traffic activity, market scale, urbanization and underlying growth trend.

Table 13. Regression Results: Factors Affecting Job Impact

Projects Tested[10]	Significant Explanatory Variables for Predicting Direct Job Impacts *(those with over 90% statistical significance are listed)* [11]	R^2_{adj}
Rural Projects, Point to Point and Roadway[12]	Level of Traffic Activity (VMT) Market Scale (pop. size) Underlying Growth Trend (per capita income growth) Economic Health (per capita income level)	70.2%
Metro & Mixed, Roadway Projects	Level of Traffic Activity (AADT) Project Scale (Lane Miles) Urbanization (Population Density) Market Scale (pop. size) Underlying Growth Trend (local population & job growth)	80.9%
Metro, Road	Level of Traffic Activity (AADT) Project Scale (Lane Miles) Urbanization (Population Density) Underlying Growth Trend (local population & job growth)	90.9%
Mixed, Road	Level of Traffic Activity (AADT) Project Scale (Lane Miles) Urbanization (Population Density) Market Scale (pop. size) Terrain (Mountain Terrain)	90.9%
Urban, Point to Point	Economic Distress (dummy variable) Underlying Growth Trend (regional job & income growth)	57.5%
Rural & Mixed, Point to Pont	Level of Traffic Activity (VMT) Urbanization (Population Density) Underlying Growth Trend (regional & local income growth) Economic Health (per capita income level)	88.3%

Regression Results for Predictive Use. The underlying economic growth trend is an important factor in understanding why the economic impact of highway projects varies from place to place. However, at the time of project planning, one may not be able to assume that local or regional economies will continue to trend over time in the same way as they have in the past. For that reason, it is also useful to consider regression equations in which the underlying growth trend is not available as an explanatory variable. Accordingly, Table 14 summarizes revised regression results in which only known or planned project characteristics and existing pre-project socio-economic factors are used as explanatory variables.

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[10] Non-US projects are excluded from all analyses and Boston Central Artery project is excluded from al Metro analyses
[11] Variable were tested for multi-collinearity
[12] Excludes projects with negative job creation

While the resulting explanatory power of the regression equation drops, the results still confirm the importance of differences in project class and setting, including factors such as project scale, level of traffic activity, urbanization, market scale and economic health. Those results are also used as a basis for the predictive impact calculator called "My Projects" in the EconWorks web tool, which is further discussed in Chapter 5 of this report.

Additional research conducted as part of the case studies also confirms that the efficacy of the major highway investments requires complementary policies enacted on local, regional and state levels, including those affecting infrastructure availability, land use regulation, and business policies. These factors are discussed in the next chapter of this report (Chapter 4).

Table 14. Regression Results Limited to Present Day Variables

Projects Tested[13]	Variables for Direct Jobs – Present Knowledge Only [14]	R^2_{adj}	Level of Stat. Significance
Rural Projects, Point to Point and Roadway[15]	Project Scale (miles)	42%	88%
All Roadway Projects	Level of Traffic Activity (AADT) Project Scale (Lane-miles) Urbanization (Population Density) Market Scale (pop. size)	41%	70%
Metro and Mixed Roadway Projects	Level of Traffic Activity (AADT) Project Scale (Lane-miles) Urbanization (Population Density) Market Scale (pop. Size)	35%	70%
Mixed, Road	Level of Traffic Activity (AADT) Project Scale (Lane-miles) Urbanization (Population Density) Market Scale (pop. Size) Terrain (Mountain Terrain)	91%	>90%
Rural & Mixed, Point to Pont	Level of Traffic Activity (AADT) Project Scale (miles)	61%	>90%

[13] Non-US projects are excluded from all analyses and Boston Central Artery project is excluded from al Metro analyses
[14] Variable were tested for multi-colinearity
[15] Excludes project with negative job creation

3.3 Relationship of Project Cost and Impact

Objective. It is not surprising that there is a relationship between project cost and resulting economic impacts. That certainly does not mean that spending more money on a project automatically leads to a larger economic impact. Rather, it indicates that, all else equal, larger scale projects do tend to lead to larger scale economic impacts. Furthermore, decisions to fund most major highway projects involve some form of (explicit or implicit) consideration of the benefit relative to cost, so projects that have a high expected cost and low expected benefit are unlikely to ever be built.

While there is a general relationship between project cost and economic impact, it can be useful to identify the nature of that relationship, and the extent to which it is affected by other factors associated with either the project type or setting. Accordingly, the project team conducted a statistical analysis of alternative ways to relate cost and impact.

Framing the Analysis Design. Project costs were approached from multiple perspectives in an effort to explain the relationship of cost to resulting direct jobs generated by the case study projects (see Table 15). The explanatory variables included in the regression estimation included project costs (all dollars were adjusted to $2008 dollars), cost per linear mile to adjust for project size, and costs combined with average annual daily traffic, length and VMT. Those variables were examined for the entire set of projects, for the pooled classes of highway and point-to-point projects, and for classes of rural and metropolitan settings.

Table 15. Perspectives for Estimating Variation of Project Costs

Dependent Variables	Dimensions	Settings
Project Cost Cost per Linear Mile Cost per Lane Mile. Project Cost and AADT Project Cost, AADT and Length Project Cost. VMT	Project set as a whole Split of “Highway” and “Point to point” projects	Metropolitan, mixed and rural

Our statistical analysis shows that we can explain over 80% of the variation in direct job impacts among the 100 case studies, by considering project cost and additional factors, such as project type, traffic level and urbanization of the study area. Projects in urban areas, for example, are more likely to be implemented to reduce congestion than with a primary objective to create jobs. Secondly, certain types of projects are initiated specifically to facilitate job development, such as roads that connect highways with office or industrial parks. In this situation, we can expect the cost of projects to be scaled with job development, i.e., a large highway to access a lot of jobs, but smaller highway investments will be made to facilitate smaller economic development projects.

It should also be noted that jobs are only one way of counting economic benefits of highway development. Expansive (and expensive) projects generally are conceived to generate significant user benefits, including personal time savings for drivers and passengers and household cost savings, although such user benefits are not part of an economic development impact analysis in this report. Similarly, environmental, social and safety impacts may also be important considerations for some or many of the projects studied here. It is reasonable to assume that major highway investments would not be undertaken without assuming that the benefits are equal or greater than the costs involved. However, this project focuses only on job creation impacts and thus is not intended to consider the full range of benefits associated with the case study highway projects.

Findings. When considering the full pool of all case study projects, total cost emerges with a stronger relationship to direct job impact than cost per lane mile. Similarly, total VMT emerges with a stronger relationship to job impact than AADT or AADT plus length. By considering both the cost of a project and its VMT level, we can account for up to 55% of the variation of direct jobs generated by all projects (See Table 16). This is a better fit than when projects with zero jobs, negative impacts and international locations are excluded, which returned constantly lower adjusted R2 values, with similar confidence levels evidenced by T-values as shown in Table 16.

Table 16. Relationship of Cost and Job Impact (All Cases)

Undivided Case Study Set (Prediction of Direct Job Impact)

Dependent Variable(s)	T-Score Variables	T-Score Constant	Adj. R^2 (share of variance explained)	N
Cost	9.14	3.42	.455	100
Cost per Mile	5.50	3.82	.275	78
Cost per Lane Mile	5.36	3.71	.270	76
Cost AADT	8.83 2.06	1.80	.472	100
Cost AADT Length	8.26 2.24. 1.88	1.07	.485	100
Cost VMT	8.98 4.62	2.24	.549	100

To gain a second perspective, the data set was split into "roadway" projects (which do not have a specific destination point); and "point-to-point" projects (that generally have defined start and end points). The 19 intermodal freight projects and intermodal passenger projects were excluded for this analysis.

The analysis again considered combinations of project cost, VMT, AADT and length. Results are shown in Table 17. Results again showed that the strongest statistical relationship was between jobs and total project cost. The regression explained approximately 83% of the variation in job impacts for point-to point projects, but less than 40% of the variation for continuous roadway projects.

Table 17. Relationship of Cost & Job Impact (Pooled Class)

Project Class	Dependent Variable(s)	T-Score Variables	T-Score Constant	Adj. R^2 (share of variance explained)
Point-to Point	Cost	11.83	2.15	.832
Continuous Roadway	Cost	5.66	2.95	.378
Point-to Point	VMT	3.28	1.54	.832
	Cost	5.67		
Continuous Roadway	VMT	0.97	1.59	.480
	Cost	11.69		
Point-to Point	AADT	-0.289	1.99	.826
	Cost	11.63		
Continuous Roadway	AADT	3.21	0.428	.476
	Cost	4.93		
Point-to Point	AADT	-0.21	1.39	.821
	Length	.40		
	Cost	10.95		
Continuous Roadway	AADT	3.49	-0.416	.491
	Length	1.56		
	Cost	4.56		

N= 29 for Point-to-Point projects. N=52 for Continuous Roadway projects

There are several explanations for this difference. After all, "point-to-point" projects generally create access to industrial parks, office parks and other economic development nodes. Moreover, it is likely that state and local area officials are willing to invest to high-cost point-to-point highway development for strong and foreseeable jobs and benefit returns on investments. Continuous roadway projects, in contrast, may be created to relieve congestion – in which case there is a less pronounced job impact, and/or job creation may be generated hundreds of miles from the project investment, or may have a robust local job impact. Therefore, the variation of jobs generated by continuous roadway projects does not reflect investment as smoothly as for point-to-point projects.

Projects were further divided into metro and rural as a third test to account for the relationship of project cost and direct jobs.[16] Similar to the pooled project analysis, tests were run using the same explanatory variables. Those results are shown in Table 18. Results showed that the regression of cost and jobs explained between 44% and 50 of the variation in job impact. However, the addition of highway VMT level raises the explanatory power up to 71%, but only for rural projects. VMT adds little explanatory power for urban projects. It is likely that this difference is due (at least in part) to the fact that some of the urban projects are aimed more at congestion relief than new job generation, and construction in a built environment is more expensive that in rural areas (even after adjusting for topography differences).

Table 18. Relationship of Cost & Job Impact (by Urban Setting)

Urbanization Setting	Dependent Variable(s)	T-Score Variables	T-Score Constant	Adj. R^2 (share of variance explained)
Metro	Cost	7.82	3.56	.44
Rural	Cost	4.76	1.41	.50
Metro	VMT	3.85	2.41	.53
	Cost	7.73		
Rural	VMT	4.10	1.05	.71
	Cost	5.86		
Metro	AADT	1.35	2.09	.45
	Cost	7.63		
Rural	AADT	0.04	1.0	.47
	Cost	4.64		
Metro	AADT	1.55	1.37	.46
	Length	1.53		
	Cost	7.11		
Rural	AADT	-0.26	0.82	.69
	Length	3.94		
	Cost	5.72		
Metro	Length	1.33	2.81	.45
	Cost	7.37		
Rural	Length	4.02	0.87	.71
	Cost	5.86		

N= 77 for Metro and Mixed Metro and Rural projects.
N=23 for Rural projects

Overall, these findings confirm the role of project type, project size, traffic level and regional economic setting, as important predictors of highway project impact.

[16] The metro category includes projects exclusively in metropolitan areas and those that share both metro and rural locations. The rural category is made up of projects exclusively in rural areas.

4 KEY INDICATORS OF IMPACT

This chapter discusses the role of non-job impacts, and the additional non-highway factors affecting observed impacts.

4.1 Projects with No Job Growth Impact

This report has concentrated on analyzing job impacts facilitated by highway projects. However, the case studies found that 15 of the 100 projects generated no net job growth. These 15 projects include six bypass projects, including two with net negative job impact. This is not a surprising outcome. Past analysis of bypasses, including the data analysis for the California Bypass Study[17] show that job creation is generally slightly positive or negligible in bypassed communities. Similarly, the other project types among those that did not yield positive direct jobs include bridges, highway connectors, interchanges, and passenger and freight intermodal projects. With the exception of the single freight intermodal project, the list of non-job yielding projects is comprised of projects that are generally not designed to yield direct jobs. (See Table 19.)

Table 19. Types of Projects with No Job Growth Impact

Project Type	**Number**
Access Road	0
Beltway	0
Bridge	2
Bypass	6
Connector	2
Interchange	2
Major Highway	0
Widening Project	0
Freight Intermodal	1
Passenger Intermodal	2
Total Project with No Job Growth	**15**

[17] California Department of Transportation, California Bypass Study: the Economic Impacts of Bypasses; 2006.

A wide range of economic data were collected in the course of conducting the case studies and data analysis that provide evidence of economic activity related to these 15 projects. The ability to mine data on economic performance other than new direct jobs demonstrates that no individual measure stands by itself, and that a variety of measures are needed to properly assess the economic impacts of projects. In the 15 case studies that document zero jobs or indicate a job loss, other data show indications of economic activity. These data include:

- 8 case studies that document post project business sales on a county level.
- 10 case studies that document the differences of local per capita income before project constriction and after completion
- 9 case studies record levels of economic distress before project construction and after completion.
- 6 case studies document project impacts on local property values
- In addition, county and state data sets address changes in per capita income, population and economic distress for 14 projects (one of the projects in this data set is international).

4.2 Role of Project Motivation

Nine different motivations were considered for each project. Eight are related to economic development, including improving access to other transportation modes, international borders, labor markets and delivery markets, and facilitating on-site development or tourism. The ninth potential motivation is congestion management which may stand alone as an environmental need or be part of an economic development motivation (for example, increase speed to a desired destination).

In the case study interviews, local planning officials and business representatives were asked to identify project motivations and they were allowed to choose multiple motivations. Overall 66 of the 78 projects were motivated by at least one economic development factor, 11 were motivated by congestion management alone and one did not report a motivating factor. Of the 77 project proponents reporting motivational factors, 56 selected more than one motivation and 21 selected not more than one. The motivations to mitigate congestion and facilitate site development are the two factors most often selected. Table 20 summarizes project motivation by factor.

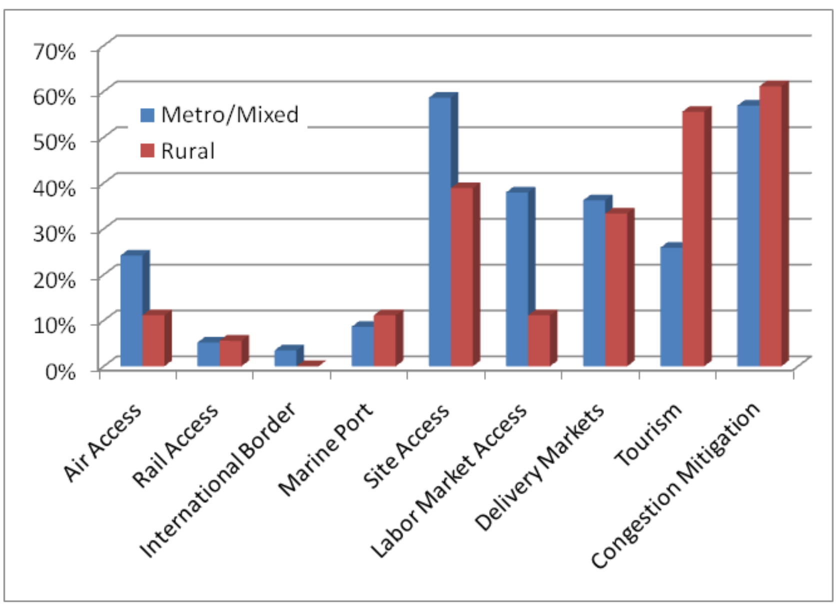
Table 20. Motivation for Projects

Motivation	Number of Times Selected		
	Highway	Freight Intermodal	Passenger Intermodal
Improve Access to Airports	18	2	0
Improve Access to Rail	4	6	0
Improve Access to International Border	2	1	0
Improve Access to Marine Port	7	2	0
Facilitate Site Development	42	2	8
Improve Labor Market Access for Employers and Workforce	26	0	4
Improve Access to Delivery Markets for Shippers	29	3	0
Facilitate Tourism	26	0	0
Mitigate Congestion	46	0	7

Figure 8 shows the percent of all projects in metro/mixed, rural, and all areas by stated motivation. Projects can have more than 1 motivation, so they do not sum to 100%. This figure shows that the most common project motivation for projects in both rural and metro areas was congestion mitigation. After congestion mitigation, site access and delivery market access were top reasons in both metro/mixed and rural settings, while tourism was an important motivator in rural areas and labor market access was key in metro/mixed areas.

Figure 8. Project Motivations

(Percentage of Total Cases with Each Motivation, excluding Intermodal Projects)



4.3 Role of Non Highway Factors

Job creation attributable to many highway projects was actually the result of leveraging highway investments with other infrastructure and/or complementary economic development policies like appropriate zoning or financial incentives. In many cases, it has been the synergy among multiple factors that that has created the positive economic development climate that leads to job creation. On the other hand, in retrospect, the lack of complementary infrastructure or development policies has led to disappointing job creation. Overall, 49 cases included at least one positive complementary aspect to the highway projects and 13 included negative aspects. Four cases included both positive and negative, while 20 did not report any positive or negative infrastructure development or policies. Table 21 shows the ancillary development factors for the 58 projects that reported positive or negative influences of leveraging non-transportation factors.

Table 21. Factors that Influenced Job Creation

Number of Projects Reporting Each Factor		Highway	Freight Intermodal	Passenger Intermodal
Positive Synergies	Infrastructure (sewer, water, broad band, transit, etc.)	20	7	6
	Land Use Management	30	6	9
	Financial Incentives/ Business Climate	33	8	5
Lack of Appropriate Synergies	Financial Incentives/ Business Climate	4	0	1
	Infrastructure (sewer, water, broad band, transit, etc.)	9	0	1
	Land Use Management	4	0	2

Table 22 shows total jobs breakdowns by projects that reported positive synergies, impeded due to lack of other synergies and that did report one way or the other. Note that there is slightly more jobs per case (by mean average) for highway projects developed with synergies of other factors than projects impeded by lack of supporting development or policies. This narrowness is misleading due to one project – Interstate 26 in South Carolina that reported almost 31,000 jobs, and yet local officials claim that the project never reached its full potential due to lack of adequate infrastructure and land use management. If this project is excluded, the average job creation is 850 from projects where the lack complementary infrastructure or policies inhibited economic development, compared to almost 6,100 where positive factors are reported.

Table 22. Job Creation by Complementary Factors
– US Domestic Highway Projects

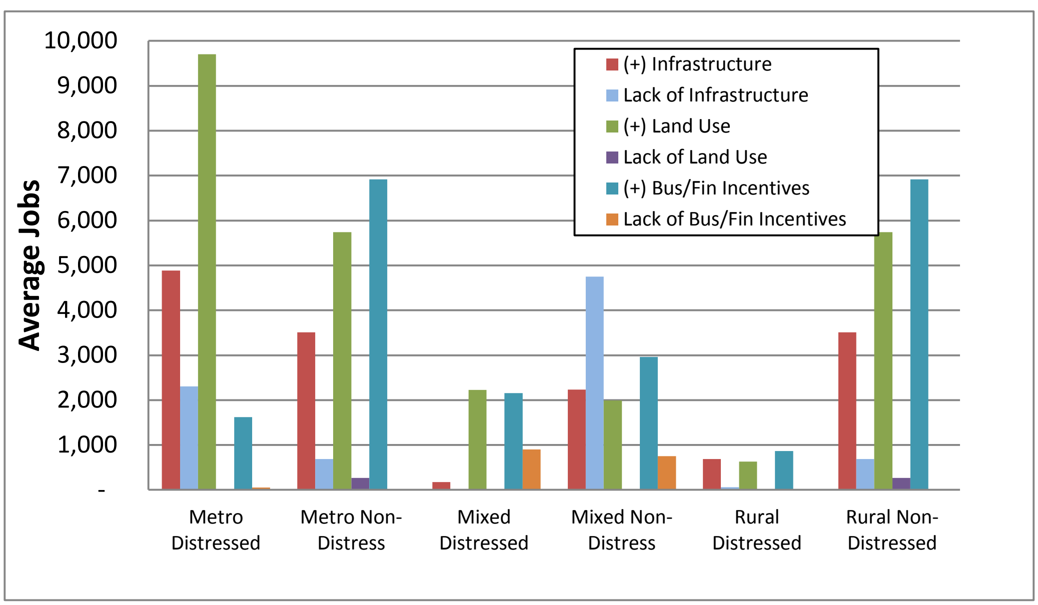
Non-Transportation Factors	Number of Cases	Total Direct Jobs	Mean Average Direct Jobs
Positive	45	273,358	6,075
Negative*	9	37,608	4,179
Both Positive & Negative	4	11,600	2,900
Not Reported	20	109,566	5,478
Totals	78	432,132	5,540

** Excluding Interstate 26, this row would read: 8 projects, and 6,812 jobs, for an average of 852 jobs per project.*

In addition, 14 of the 19 freight and passenger intermodal cases included positive policy factors that supported project development, without any negative factors. These 14 projects generated a per-project average of almost 1,700 direct jobs. Average direct job creation was less than 200 for the four intermodal case studies where both positive and negative factors were reported. One intermodal case study with 514 jobs did not report supporting or undermining policy factors.

The influence that these policies have on economic outcomes is more apparent when grouped by metro/rural and economic distress categories as illustrated in Figure 9. Metro areas where supportive land use and business/financial incentive policies complemented the highway investments resulted in higher job impacts. Projects that occurred in Rural, Non-Distressed areas were also highly influenced by positive support of all three of these policies.

Figure 9. Role of Infrastructure, Land Use & Financial Incentives
(by class and distress level)



4.4 Hard-to-Collect Factors

Collecting the wide range of data elements necessary to understand the economic impacts of transportation investments is no small task. Some data are readily available and relatively straight forward to collect, the availability of some data varies from project to project, and some data are elusive for all projects.

Level of effort needed to collect each data element varies by project type and scale, but certain elements are elusive for all project types. The following topics tend to include the more elusive data elements:

- Complementary actions
- Interventions
- Land use policies
- Future development capacity
- Financial incentives/business climate
- Other planning considerations
- Safety
- Sprawl
- Congestion
- Emissions
- Environment
- Property values
- Property tax revenue
- Investment
- Commercial space
- Cargo volume

Though the project team researchers set out to collect data covering all of these topics as part of the wider data collection effort, it remained elusive in many cases, as researchers encountered the following challenges:

Time Series Not Available - Though planning and land use context information is often available in database form, it is not generally available as time-series data. A researcher interested in a particular project could obtain current land use information from the planning department covering the project's jurisdiction (if the project crosses city or county lines, the researcher would have to visit several planning departments). It would be unlikely that the planning department would be able to provide land use data covering previous periods, making before/after changes to land use difficult to determine other than anecdotally.

No Centralized, Consistent Source – Economic development intervention and support policies are a perfect example of information that is difficult to collect because it is not housed in a centralized source. Within the US, and even within states, there is no single entity charged with economic intervention or provision of financial/business attraction incentives. In fact, such efforts often come from multiple levels of government with varying degrees of coordination (and sometimes no coordination at all). Furthermore, economic development intervention and support policies are heterogeneous, ranging from streamlined permitting processes, to shovel-ready sites, to tax credits and direct cash transfers. A retail center at a major highway visible site created by a transportation investment could receive various incentives from any number of sources. Sometimes such support is tracked either formally or informally by an economic development agency, but because support can come in so many forms and from so many different entities, it can be difficult for a researcher to identify all of the agencies with relevant information. Certainly, the interview process can help with this task, but if the information is scattered across numerous agencies, the level of effort needed to obtain this piece of data can increase exponentially.

Data covering property values and property taxes can be obtained from a centralized source - the local property tax assessor's office - but neither assessed value nor are tax collections data consistent across jurisdictions. First, obtaining property value from the tax assessor is problematic because each jurisdiction assesses property value differently. In some jurisdictions assessed value is meant to represent the full market value of a property, and when updated regularly, generally reflects market values. However, if properties are not routinely re-assessed, over time values in the assessor's database will deviate from market values. Some jurisdictions use a percentage of market value as assessed value, while others, such as those in California, are statutorily limited in how much value may increase from year to year, which tends to artificially hold assessed values far below market values.

Therefore, it is not enough for a researcher to simply collect property value data from a local assessor's office. The researcher would also need to understand the local fiscal system including how property values are assessed (full, partial, statutorily) and how often assessed values are updated. In addition, collecting property tax data from the tax assessor can be problematic. Though most assessors' databases can capture time series data, property tax rates are subject to change from year to year. Thus, in addition to property tax associated with a particular property or total property tax for a jurisdiction, the researcher would also need to know the prevailing tax rate for each time period for which data is collected, to ensure that fluctuations are the result of actual changes in underlying property value and not simply a change in tax rates.

Data Availability/Accessibility Limitations – Some data elements exist but cannot be readily accessed the way researchers interested in studying the impacts of transportation impacts need them. Remaining with the example of property value and property tax data, while it may be relatively simple to obtain jurisdiction-wide totals for assessed values or taxes paid, sub-jurisdictional or parcel-level data may not be available. While some jurisdictions have sophisticated GIS-based database systems and are willing to do specialized data runs, others have very basic systems for which sub-area data runs would be an overly time consuming imposition upon assessor's department staff.

In the case of the commercial space data discussed above, market and sub-market definitions used by the data source may not match those relevant to the project of interest and the private firms that collect the data may not be willing or able to do specialized data runs, or may charge a fee for the service.

Collection of some data elements is stymied by a combination of the above. Data tracking total commercial space before and after a project lacks a centralized source and lacks consistency. Commercial real estate broker firms often collect data for the larger real estate markets reflecting total space, rents and vacancy levels by product type. However, they do not typically maintain time-series data, nor do they cover smaller, non-metropolitan markets. Broker interviews can be used to get a general sense of current property values, but few brokers track property values over long periods of time.

Scale of the Data Collection Effort - All of the above must be considered in the context of the larger data collection effort. The researcher collecting each of the above will also be collecting dozens of other pieces of data from a broad range of sources, sometimes from multiple jurisdictions, sometimes at the sub-jurisdictional level, for many projects across the country, all under time and budget limitations. Then multiply the entire effort by the number of case study projects and the challenge is clear.

It is also clear that significant efficiencies could be achieved by integrating the data collection effort into the larger project design and implementation process. These efficiencies would streamline the entire data collection effort, and improve collection of the difficult-to-collect elements described above. These issues are further discussed in the *Handbook for Practitioners.*

5 CALCULATIONS IN ECONWORKS PROJECT TOOLS

5.1 My Projects

Factors identified by regression analysis were used to create a job estimation calculator in the "Assess My Project" section of the EconWorks web site. Users can enter data characteristics of their project ideas and be provided with a rough calculation of the likely ranges of economic impacts typically associated with that type of project, and estimates of likely range of project cost and traffic volume associated with those projects (based on available case studies).

Users are also able to adjust complementary regional economic development factors (other infrastructure, land use policies and to business climate) to reflect their regions and/or reflect a total economic development program that includes but is not limited to a planned strategic highway investment. In turn, these adjustments lead to changes in expected economic impacts the highway projects.

Assess My Project – Economic Calculations

The following tables of data were pulled by taking the means and medians by project type for all cases excluding (bridges and international projects due to lack of sample size). This section is seen as a "road map" for practitioners as they use the expert system and digest output from the system. While database and user tools are discussed in the EconWorks *Web Tool Users Guide*, it is important to note that any form of case-based reasoning or related form of rules-based expert system must also draw from a base of findings about relationships among variables. The analysis findings, as reported in this report and the *Handbook for Practitioners*, can also be used to derive and report key "rules" about relationships among impacts and factors variables.

The economic impact estimation function of Assess My Project is divided into six modules that consist of interaction of user inputs and data calculations. The modules are: (1) initial user entry; (2) initial system feedback; (3) preliminary economic impact calculations; (4) user adjustment to project; (5) user adjustments for economic development context; and (6) governors that limit job impacts to hedge against generating unrealistically high estimates. Each of these modules is discussed below.

Table 23. Key Means and Medians

Project Type	Median Costs Per Mile	Median AADT	Median Jobs/AADT	Mean Jobs Per Mile
Access Road	$1,609,742	5,502	0.019	227
Beltway	$30,682,462	88,000	0.115	1,472
Bridge	$39,222,928	23,600	0.046	2,042
Bypass	$5,335,886	19,774	0.006	191
Connector	$21,789,886	16,910	0.041	804
Intermodal (Freight & Passenger)	N/A	10,367	0.009	N/A
Interchange	N/A	53,450	0.037	N/A
Major Highway	$8,789,730	39,725	0.082	60
Widening	$46,168,037	24,000	0.114	381
Total	$10,865,593	23,717	0.041	504

Initial User Entry. With the EconWorks web tool, the user enters:

- Project Type
- Region
- Setting: Metro/Rural/Mixed
- Designation of economic distress (yes/no), and
- Length of the project.

Initial System Feedback. From one these user specifications, the system then estimates: (1) AADT; (2) Project Cost; and (3) Economic Impacts (based on Direct Jobs).

Preliminary Economic Development Calculations. AADT is taken from the median AADT for each Project Type shown in Table 23. The system assumes the median AADT for the type entered by the user and then adjusts it up or down based on the metro/rural status (no change for "mixed" status) using the following factors (which are based on the average AADT for metro and rural compared to all projects) in the table below.

Projects in metro areas show a higher AADT while rural projects show a lower AADT than the median. (See Table 24) The user may also toggle with the AADT after the system offers a prediction. This acts as one scale factor in estimating the direct jobs (the other being length).

Table 24. AADT adjusted for Regional Setting

Setting	AADT Factors
Metro	2.21
Rural	0.42
Mixed	No change

Project Cost[18] is calculated using the median cost per mile per project type multiplied by the length entered by the user. This amount is adjusted based on the whether the project is in a distressed or non-distressed area using the factors (average costs per mile for distressed and non-distressed cases compared to the all projects) in the Table 25 below.

Table 25. Relative Impact of Economic Distress

Economic Distress	Impact Ratio
Non-Distressed	1.33
Distressed	0.89
All Cases	1.00

Direct jobs are calculated based on the predicted AADT and the length entered by the user, and if the project is in a distressed or non-distressed area.

The factors below are based on averages gleaned from the case studies for distress level. These are used along with the last two columns on the first table to estimate the direct jobs—taking an average of both AADT and length methods (Table 26).

Table 26. Length and AADT

Adjusted by Distressed and Non-Distressed Areas

Distress Status	Length		Traffic	
	Median Jobs per Mile	Relative to ALL	Median Jobs per AADT	Relative to All
Non-Distressed	77	1.48	.0549	1.31
Distressed	45	0.86	.0388	0.93
All Cases	52		.0418	

Direct job estimates are made using the following formula:

[18] Users are enabled to adjust project costs if they wish, but, by itself, this adjustment should not be allowed to affect the economic impacts.

Distressed Area

$$Direct\ Jobs\ Project_{ij} = .5*((L*\ mean\ jobs\ per\ mile*.86) + (AADT*median\ jobs\ per\ AADT*.93))$$

Non-Distressed Area

$$Direct\ Jobs\ Project_{ij} = .5*((L*\ mean\ jobs\ per\ mile*1.46) + (AADT*median\ jobs\ per\ AADT*1.31))$$

Where

j is the type of project (bypass, widening, etc…)
L=Length of project
i = specific project
AADT is Average Daily Traffic

Exceptions. Three exceptions are Access Roads, Interchanges, and Major highways and Widenings with length of 100 miles or more (Table 27).

Access Roads only work off mileage (AADT was not available for any cases) and Interchanges work off AADT only (mileage was not available). Therefore:

a. For access roads:

$$\text{Direct Jobs Project}_{i\,=}\ (L*\ \text{mean jobs per mile}*(.86\ \text{or}\ 1.46));\ \text{and}$$

b. For interchanges:

$$\text{Direct Jobs Project}_{i\,=}\ (AADT*\text{Median jobs per }AADT*(.93\ \text{or}\ 1.31))$$

c. For widenings and major highways that users indicate will equal or be longer than 100 miles, use the following factors and formulae:

Table 27. Factors for Major highways & Widening

With Length 100 Miles or More

	Jobs/AADT	Jobs/Length
Major highway	0.17	62
Widening	0.28	20

Direct Jobs Major Highways>=100 miles:

$$(AADT*.17*.5) + (Length*62*.5)$$

Direct Jobs Widenings>=100 miles:

$$(AADT*.28*.5) + (Length*20*.5)$$

Direct wages and output are calculated from a lookup table based on region selected, initially.[19]

Ranges for direct jobs, wages and output are calculated as "plus and minus" 25% of calculated totals:

- Low estimate: Direct x 0.75
- High Estimate: Direct x 1.25

Total jobs, wages and output for "high and "low" estimates are calculated from a lookup table based on region selected, initially.1 Calculations (by region) are as follows:

- By Region

  Total Jobs = Direct jobs x jobs multiplier

  Total Wages = Direct wages x wage multiplier

  Total Output = Direct output x output multiplier

Adjustments to Initial Direct and Total Impacts. AADT can be adjusted with a slider. The maximum on the right is 100% increase (roughly 1 standard deviation from the mean AADT after discarding outliers). The minimum on the left is an 80 decrease, leaving 20% of the calculated AADT. Length can be adjusted by the user typing in any length desired.

Recalculation – High and low estimates for direct and total jobs, wages and output can be recalculated based on (1) changes in AADT and/or Length; and (2) methodology outlined in Step 3, above. (Cost will not change job estimates.)

Economic Development Policy Levers. Users have three opportunities to estimate effects of policies that support transportation investments by using up to three policy levers regarding:

- Additional infrastructure including water, sewer and connecting transportation facilities
- Land use policies that facilitate or discourage economic development
- Supportive business policies, including availability of financial incentives to support job attraction/retention

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[19] Wages and value added are available by state. Output and multipliers are available for a partial set of states, at this time. We have output in-hand by state for projects in the case study database and miscellaneous other states. Therefore output can be developed by BEA region, but cannot cover each of the 50 states (Tyler, please confirm). Alternatively, state by state GDP and wages per job can be downloaded from the BEA web site.

Direct jobs were recalculated based on the direct job calculation described in Steps 3 and 4, above, according to the following:

- Infrastructure: -40% to +32%
- Land Use Policies: -34% to +24%
- Business Climate: -12% to +20%

Results are compounded, so a project in region without infrastructure, with land use policies that discourage economic development and a poor business climate show a result:

> *Final Direct Jobs = Direct jobs from Steps 3 and 4 *(-(1.40*1.34*1.12)) or a drop of about 65%*

Similarly, a project where there is strong complimentary infrastructure, land use policies and business climate show a result equaling:

> *Final Direct Jobs = Direct jobs from Steps 3 and 4 *(1.32*1.24*1.20) or additional impacts of 96%*

If a user chooses to ignore one or more policy levers, the calculation assumes no change at 1.0, e.g.:

> *Final Direct Jobs = Direct jobs from Steps 3 and 4 *(1.0*1.0*1.20) or additional impacts of 20%. In this example, no adjustments are made to infrastructure or land use policy, but a maximum positive adjustment is made to business climate.*

A slider allows users to adjust the level of supportive infrastructure, land use regulation and business support to either existing or envisioned levels of service:

Infrastructure

Not Available -40% | Adequate | All-inclusive & state-of-art 31%

Land Use Policy

Restrictive -34% | Adequate | Strongly supportive of economic development 24%

Business Climate

Negative Adequate Positive
-12% 20%

High and low estimates for direct and total jobs, wages and output will be recalculated based on use of the policy levers. Cost and AADT, however, will not change.

Maximum Job Impact

Direct jobs are capped at multiples of the maximum value of direct jobs found in the case studies. Estimates of direct jobs that exceeded these criteria are automatically capped at 1.2 times the largest value per project type (See Table 28). The purpose of establishing a cap is to guarantee that in the event of anomalous occurrences, the predicted values do not become hijacked and throw off output – much like a safety net.[20]

Table 28. My Project Tools: Maximum Direct Jobs by Project Type

Project Type	Maximum Direct Jobs from Case Study	My Projects Cap by Project Type
Access Roads	2,000	2,400
Beltways	50,000	60,000
Bridges	7,000	8,400
Bypasses	17,100	20,600
Connectors	7,400	8,880
Interchanges	14,000	16,800
Major Highways	30,800	37,000
Widenings	34,000	41,000

Display. The following rounding are shown for both direct and total impacts:

- **Jobs** are rounded to the nearest "100" unless total or direct jobs are less than 90. In that case, jobs are rounded to the nearest "10." Jobs are shown as a whole number (e.g., 300 jobs or 70 jobs)

[20] As an alternate approach, the multiple could be altered so that the upper bound is expressed as a function of the standard deviation. Both achieve the same results, with the multiplier being slightly easier to work with, and the standard deviation cap as a more common statistical representation.

- **Wages** are rounded to the nearest $1,000, and shown with three zeros at the end (e.g., $320,000).

- **Output** is rounded to the nearest $1,000, and shown with three zeros at the end (e.g., $810,000).

- **AADT** is rounded to the nearest 1,000 and shown with three zeros at the end (e.g., 113,000).

- **Project cost** is rounded to the nearest $100,000 and shown in millions of dollars with one decimal place (e.g., $53.7 million)

4.2 Comparison of My Tools and Case Study Findings

In order to test whether the predicted values of direct jobs fell within a reasonable range of error, we constructed a confidence interval around the actual data by first calculating the mean and standard deviations for each project type's actual direct jobs. For each project type, the mean and standard deviations were calculated from archived data. A confidence interval was constructed around the mean, as a function of some specifiable number of deviations with one standard deviation corresponding to a confidence interval of 68%, two at 95% and three at greater than 99% (See Figure 10).

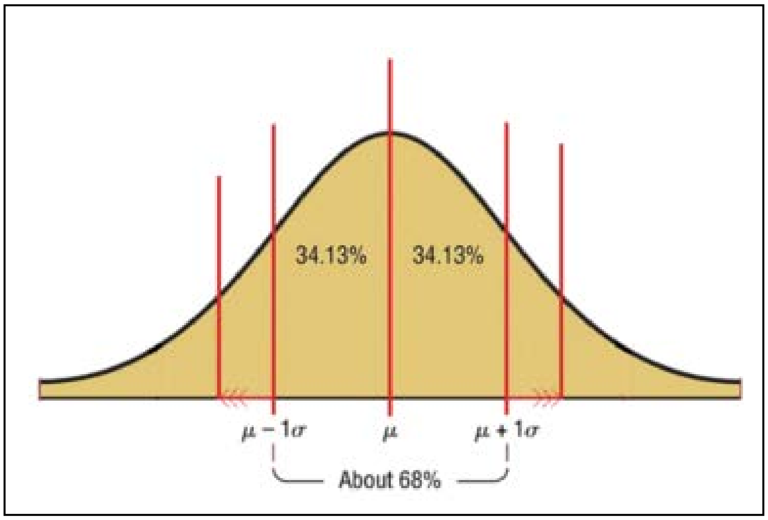

Figure 10. Illustration of Central Tendencies

The volume of predicted values enclosed by a single standard deviation (68% confidence interval) is 88% of case study projects (excluding transit oriented development, freight intermodal, international projects and the Central Artery Project). Figure 11 below is a box and whisker plot summarizing the data.

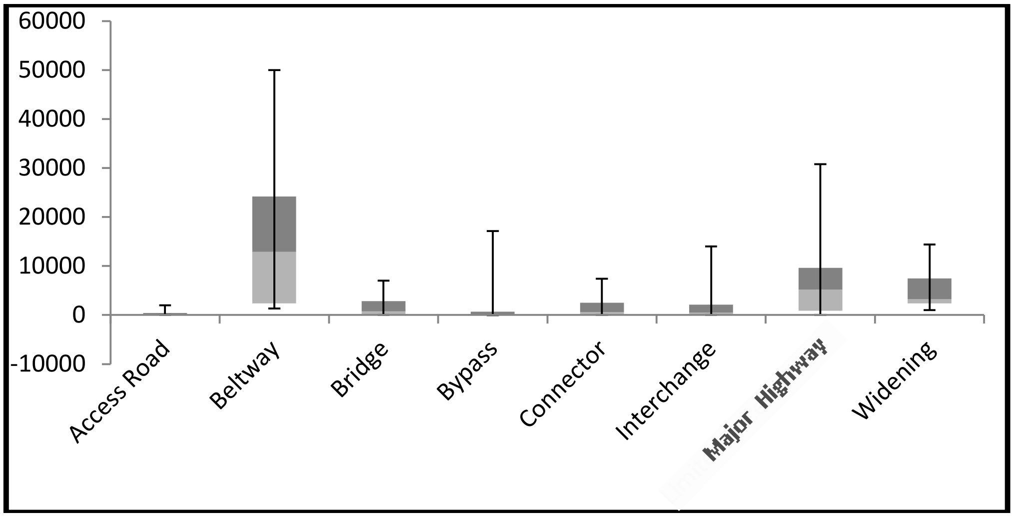

Figure 11. Illustration of Mean Direct Jobs by Project Type

To capture the effect of local and state economic development policy on estimated project impacts, policy multipliers were established to adjust for domestic conditions regarding the areas of: Infrastructure, Land use, and Supportive Business Climate (see text box). These are based on observations in the case study data bases by comparing project jurisdiction that reported that policies supported economic impacts of highway investments, or that lack of policies obstructed economic development despite the highway investments.

Economic Development Support

Local interviewees for case studies were asked if the presence or co-terminus development of complementary infrastructure (water/sewer, local transportation), supportive land use regulations, and/or a supportive business climate (including development incentives) added to job creation realized from the highway project. They were also asked if the lack of any of these tools detract from potential job creation.

These local/state policies serve to increase or decrease the estimated impact on jobs from the project. The policy lever was assumed to be a topical treatment in that it did not affect the mean, or standard deviation for the confidence interval of a given project category. Conceptually this method further extends the outer bounds of the confidence interval by an amount equal to the absolute value of the impact on direct jobs. The magnitudes of the shifts therefore are dependent on the maximum extreme values for policy alterations. Having established an appropriate confidence interval from actual data, the next step was to test whether or not a given project's direct jobs estimate fell within the interval. The results of which are shown below in Table 29.

Table 29. Estimates of Case Study Projects After Applying My Tools

Project Type	Estimates of Case Study Projects		
	Jobs Estimates within 1 Standard Deviation	Maximum Application of Policy Factors	Observations
Access Road	100%	100%	7
Beltway	63%	63%	8
Bridge	78%	78%	9
Bypass	100%	100%	11
Connector	75%	88%	8
Interchange	100%	100%	12
Major Highway	100%	100%	13
Widening	78%	100%	9
% within Range	88%	92%	77
Number Within Range	68	71	
% Out Of Range	12%	8%	
Number Out Of Range	9	6	

Of the 100 cases, 94 were found to have job impacts within the confidence interval of prediction. Only 6 cases were found to have fallen outside of the confidence interval, after accounting for potential effects of policy factors (See Table 30). The difference in magnitude between actual and predicted values is such that there are no extreme values, on the part of the model. In cases where the difference between actual and predicted is very small and the observation still fell outside of the interval, the nature of the population mean and standard deviation relative to the observation in question played a role (despite the robustness of the model).

Table 30. Cases that Fall Outside of One Standard Deviation

Observation ID	Project Type	Actual	Predicted Direct Jobs (After Application of Policy Levers)	
			Lower Bound	Upper Bound
40	Beltway	53,570	0	48,598
6	Beltway	58,858	0	48,598
57	Beltway	67,366	0	48,598
80	Bridge	8,763	0	5,676
85	Bridge	6,200	0	5,676
50	Connector	8,745	0	6,739

6 CONCLUSION

Highway projects do not automatically lead to economic impacts. They can create conditions for business attraction and expansion by increasing the productivity of areas that they serve, but additional factors also play a role in either enhancing or reducing the nature of those impacts. Thus, it is not surprising to find that there was a wide variation observed in economic impacts among the 100 projects. That variation, even within categories of similar project types, is due to a range of explanatory factors examined in this report. This leads to the following key findings:

- The economic context of the study area is a critical factor. Projects tended to succeed in economic terms where the local area and/or regional economies were expanding, and struggle in areas where the contextual economy was in a downturn and distressed.

- Project location matters. More jobs were generated by project in metro settings than in rural settings. Case studies show that metro projects are more complex and have a longer development timeframe than rural projects. Though rural projects take less time to build than those in metro settings, job development in rural areas generally takes a longer time to mature than in metro areas.

- Motivations for developing projects differ, and projects without an economic development "push" generally do not facilitate jobs at the same rate as those so conceived. Some projects are planned and constructed for reasons other than economic development, including environmental considerations, congestion relief and safety improvements.

- Roadway projects designed to assist traffic flows, such as connectors between major highways, may generate jobs, which are disbursed hundreds of miles from project sites. In these instances, job development is not documented as part of the case studies.

- Local or regional factors, on occasion, undercut the economic objectives of some projects. These could be a regional economic downturn, or local factors, such as counter-productive (from economic development standpoint) land use policies, poor complementary infrastructure or competing project sites elsewhere in the same market. Please see the case study descriptions for discussions of these factors.

- Projects thrived in situations where they were part of a coordinated economic development program that included land use policies, other infrastructure development and a positive business climate.[21] These projects are described in the case studies.

Additional findings from the case studies are discussed in a separate volume, also produced as part of this study, entitled: *Description and Interpretation of Case Studies: Handbook for Practitioners*.

[21] "Business climate" is an inexact term that relates to local, regional and state governments setting policies that encourage inward investment through supportive services including worker training, development subsidies, "business ambassador" efforts and sometimes also local tax incentives.

Prepared by:

Economic Development Research Group, Inc.

In association with:

ICF International Cambridge Systematics, Inc.
Wilbur Smith Associates, Inc.
Susan Moses & Associates

Texas Transportation Institute

Susan Moses & Associates