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Understanding the Economics of Transportation in Utah

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ABSTRACT

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Understanding the economic impacts of transportation projects in Utah is essential for decision makers, officials, and stakeholders as they determine the best course of action for the state. Economic impacts can guide decisions of future projects and help explain past economic fluctuations. This study develops a process that can be used to identify the economic impacts of transportation projects in Utah and quantify the relationship between transportation and these impacts. Accomplishing the objectives of this study are a product of: 1) performing a comprehensive literature review, 2) collecting data and establishing analysis methods, 3) completing a statistical analysis and breakdown into project type and expenditure values, 4) conclusions and recommendations, and 5) providing possible avenues for future research to further the understanding of the economic impacts of transportation projects in Utah.

This study uses an evaluative (or *ex post*) analysis to assess the generative economic impacts of transportation projects after completion. Both pre- and post-construction data were collected and used to compare the trends of sales tax revenue, employment creation, and vehicle miles traveled (VMT) around transportation projects in Utah over the last 10 years. A plot of the trends before, during, and after construction for each project in the analysis was generated. A formal process was created for completing the analysis for future study.

The results of this study indicate that there is a positive relationship between transportation improvement projects and sales tax revenues. This relationship amounts to approximately a 4.0 percent increase in trends compared to the state overall. Employment demonstrated a 4.5 percent increase compared to the state overall. The VMT analysis showed no statistical difference between the pre- and post-construction trends.

This study has prompted several recommendations intended to help UDOT better understand the economic impacts of transportation projects in Utah. Although this analysis provides a strong foundation, and outlines a process to analyze economic impacts from transportation projects in Utah, additional studies need to be completed.

Keywords: economic impacts, transportation, projects, sales tax, employment, VMT

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1 INTRODUCTION

Researchers have long been known that a link between transportation investment and economic development exists; however, the exact nature of that relationship in the state of Utah has yet to be quantified. Is there a quantifiable benefit in terms of sales tax revenue or employment rates that can be expected from a transportation project? Is there a correlation between average annual daily traffic (AADT) or vehicle miles traveled (VMT) and sales tax? If these types of economic benefits can be understood and accurately predicted, future decisions on potential transportation projects could be partially based on the potential economic development expected from the project. This economic knowledge could be extremely helpful to state department of transportation (DOT) officials as they work to provide quality transportation systems and encourage economic growth throughout the country. The purpose of this research is to provide a framework for understanding the economics of transportation projects in Utah.

This chapter explains the purpose and background of the research, identifies the research objectives, and reviews the organization of the report.

1.1 Purpose and Background

In the *2009 Strategic Direction & Performance Measures* document, John Njord, Executive Director of the Utah Department of Transportation (UDOT) stated the following (UDOT, 2009):

"A good transportation system in Utah does the following:

- *Allows for efficient movement of goods and services to communities within Utah, across the region and throughout the nation.*
- *Provides mobility and accessibility for communities.*
- *Provides opportunities for economic growth.*
- *Provides opportunities to improve the quality of life.*
- *Provides travel options to reduce congestion and energy consumption.*

With the current economic climate, we know that the transportation decisions made today will have an impact on our future. We have many tools at our disposal to help us plan effectively and prioritize properly so that we can address today's challenges and meet the needs of tomorrow."

Over the past several years, UDOT has been developing a support system to help inform their planning efforts. UDOT recognizes that economic analysis is an important component of the decision-support system, and yet it is the least understood and most difficult to quantify. Over the past five years, UDOT has worked with Brigham Young University (BYU) researchers to explore planning alternatives that include economic development impacts in the decision-making process (Schultz et al., 2006) and more recently to establish a set of criteria to aid in the decision-making process with respect to economic development impacts (Schultz and McGee, 2009). Nine measures of effectiveness (MOEs) were recommended from the 2009 research to evaluate the economic growth potential of transportation improvement projects. These nine MOEs were collapsed to four aggregate criteria along with a bonus criterion that would aid in providing input from all areas of the state. The full criteria include: 1) population and education, 2) existing infrastructure, 3) economic attractiveness, 4) tourism, and 5) bonus: economic choke points.

There are still a number of research questions to answer related to transportation improvement projects and economic development impacts that will help to refine this process. There is a need to research the economic development impacts of transportation improvement projects in Utah and to begin to quantify the impacts of transportation improvement projects on the economy.

1.2 Research Objectives

The purpose of this research is to identify types of economic development impacts and to provide a better understanding of the economic development impacts of transportation improvement projects in Utah. The objectives of the study are as follows:

- Identify types of economic development impacts and provide a better understanding of the economic impacts of transportation projects in Utah.
- Identify how transportation affects a community in terms of economic development impacts (e.g., increased sales tax revenue, job growth).
- Identify the correlation (if there is a correlation) between traffic volume and an area or region affected by transportation improvement projects.
- Identify economic impacts that can be measured and the parameters used to measure these impacts.

The objectives of the research will be completed by: 1) performing a detailed national and regional literature review on the tie between transportation improvement projects and economic development impacts, 2) evaluating the sales tax revenue in an area and the effect that a transportation project has on the sales tax revenue, 3) comparing employment around transportation projects both before and after the project is complete to understand the relationship between job creation and transportation projects, and 4) evaluating VMT along the route both before and after a transportation project has been completed. The results of this project can then be utilized to further refine the decision-support system as it relates to the economic development impacts of transportation improvement projects and help to further inform the UDOT planning process.

1.3 Report Organization

This report consists of five chapters: 1) Introduction, 2) Literature Review, 3) Data and Methods Used for Analysis, 4) Relationships between Transportation Improvement Projects and Economic Impacts, and 5) Conclusions and Recommendations.

Chapter 2 is comprised of a comprehensive literature review of previous research in this field. The literature reviews the need for considering economic impacts, types of economic impacts, and classifications of economic impacts. Types and methods of analysis of economic impacts are then covered. Next, the inclusion of economic impacts as part of many state DOTs' project prioritization processes are reviewed. Finally, different studies evaluating economic impacts of transportation projects are covered. Specifically, a study of economic impacts on the Wasatch Front in Utah is discussed. The literature review is meant to provide a foundation and background for the research and analysis. It is also meant to avoid duplicating any unnecessary information.

Chapter 3 discusses the potential metrics that could be evaluated, the data used, and the origin of the data. The methods used to perform the analysis using the data are also discussed. Three different analyses were performed for each project completed by UDOT over the past 10 years. These analyses included sales tax analysis, employment analysis, and VMT analysis.

Chapter 4 discusses the results of the analysis performed for each project. Together these analyses provide a valuable outlook on how transportation projects affect the economy in Utah in terms of sales tax, employment, and VMT. Relationships between the projects and the effect they have on the economy are presented.

Chapter 5 is the final chapter of the report and presents the conclusions and recommendations of the analysis.

Four appendices are included in the report for reference to the reader. These are: A) List of Acronyms, B) Results of Sales Tax Analysis, C) Results of Employment Analysis, and D) Results of VMT Analysis.

2 LITERATURE REVIEW

As new research regarding transportation improvements and their relationship to the economy is being pursued, the literature review provided an opportunity to identify any new knowledge that has been developed since the last two literature reviews by BYU research teams (Schultz et al, 2006; Schultz and McGee, 2009), identify any new analysis or research tools that may have contributed to this study, and avoid overlooking and/or unnecessarily duplicating information. The literature review is an important part of the research process and was invaluable in providing a solid background, introducing helpful tools and methodologies, and supplying new information.

This chapter discusses the need for considering economic impacts, the relationship between investment in transportation and development growth, the different categories and types of economic impacts, standardized economic impacts, and measurement concerns. Then, different types of economic impact analysis, different methods of evaluation, economic development criteria and project prioritization, economic impact studies completed across the United States, and economic impact studies that were completed in Utah are discussed. Finally, a summary of the chapter is given.

2.1 Need for Considering Economic Impacts

According to Weisbrod and Weisbrod (1997), there are two basic reasons why economic impacts should be considered when evaluating transportation projects: 1) guide decision-making to maximize benefits of public investments, and 2) ensure that projects are appropriately designed with recognition of both the positive and negative economic impacts.

The exact relationship between economics and transportation is a concept that will continually be studied; however, it is apparent that there is a connection between the two. Numerous studies and literature exist concerning the economic impacts of transportation projects, with little consensus. Some analysts claim important and major impacts (Adams and VanDrasek, 2007; CSI, 2002; Jarzab, 1986), while others claim that decreasing transport costs and increasing importance of non-material flows make the economic impacts of transportation improvement projects negligible (Boarnet, 1995; Holl, 2007; Jaiyeoba and Quinn, 2005). The traditional view of the relationship between economics and transportation is that key transportation improvements, such as the railroad or canals, were the driving force behind economic booms. However, subsequent studies have found that major transportation improvements are not the only key to economic growth. In fact, some studies suggest that major transport innovations actually lagged behind the original economic growth spurt, instead of preceded them (Button and Gillingwater, 1986). Another concluded that only transportation projects near large cities or areas with some degree of prior urbanization, such as cities with more than 25,000 residents, would see economic benefits (Rephann and Isserman, 1994). In later studies, still other theories were put forth that concluded that economic benefits from constructing highway infrastructure were just relocated from other areas, resulting in an increase around the highway, but no overall net change in the region (Boarnet, 1995). On the other hand, Boyer (1998) directly attributes as much as 20 percent of all economic activity in the United States to transportation. Furthermore, Cambridge Systematics, Inc. (CSI), a leader in transportation economic studies, concluded that “for every taxpayer dollar spent on transit, the economic return on investment is at least four or five to one” (CSI, 2002 p. 16).

Adams and VanDrasek (2007) state that there are two ways that a transportation project can influence the economy:

1. By providing access to jobs, services, and shopping areas for transit-dependent communities, and
2. By providing a catalyst for or support of associated economic development.

Creating access to jobs provides income and a way to access credit. This allows economic growth to occur through home ownership, entrepreneurship, and disposable income. Transportation projects can often be designed in such a way that new development is encouraged. Creating desirable locations for new retail or improving access for existing businesses will become a catalyst for economic development.

In a study completed by Schultz and McGee (2009), several key findings were identified from the literature regarding the connection between transportation improvement projects and the local economy. Six of these findings are presented here:

1. Transportation itself is not enough to induce economic development. There are numerous other factors that must be considered. However, a combination of these factors can greatly influence the economy in an area (Ewing, 2008; Forkenbrock 1990; Gkritza et al., 2007; Rephann and Isserman, 1994).
2. Project type plays a large role in the amount of economic benefit. Overall, investments on freeways or highway functional classes result in a stronger potential for economic development. Generally, the larger the project, the greater the benefit (Gkritza et al., 2007).

3. Location is a major aspect of the potential for a project to produce an economic impact (CSI et al., 2008; Gkritza et al., 2007).
4. If a transportation project provides the opportunity to increase the productivity of a certain business, the project is essentially providing a boost to the competitiveness of that business (CSI et al., 2008).
5. Congestion affects several aspects of the economy and will greatly affect the ability of companies to be competitive (CSI et al., 2008; Schrank and Lomax, 2007).
6. Surveys continually show that job creation and retention are the most critical factors to the public (Gkritza et al., 2007; Schultz et al., 2006; Weisbrod, 2000).

Although there is still considerable debate and uncertainty concerning the exact nature of the relationship between investment in transportation infrastructure and the economy, it is generally accepted that there *is* a relationship. The relationship changes with location, type of project, health of the overall economy, local trends, population, and numerous other variables. Gaining a better understanding of this variable relationship is extremely important in transportation planning and decision-making.

2.2 Relationship between Highway Capital and Industry Growth

One of the first studies to present a statistically valid relationship between the economy and transportation investment was presented in a 1996 report for the Federal Highway Administration (FHWA) by Nadiri. His study looked at the contribution of highway capital to the productivity growth of the private sector. The study demonstrated a statistically valid relationship between highway capital and industry productivity growth. The findings of that study are summarized here (Nadiri and Mamuneas, 1996):

- There is evidence of a mild degree of increasing returns to scale in most industries and at the national level. The marginal products of labor, capital, and intermediate inputs vary across industries. The output elasticity of materials is in general the largest, followed by that of labor and capital inputs. In addition, at both the industry level and the national level, the elasticity of private capital is larger than that of total highway capital by a factor of two times for the entire period and by a factor of about four times for the years 1981 to 1991. This result is in direct contrast to previous studies that imply that an additional dollar of public investment is substantially more productive than a corresponding dollar of private investment.
- Total highway capital contributes significantly to economic growth and productivity at the industry and national economy levels. This contribution varies across industries and over time. The magnitude of the elasticity of output with respect to total highway capital at the aggregate level is about 0.08.
- An increase in highway capital has an initial productivity effect; it reduces total cost for a given level of output for all industries and at the aggregate economy level. This productivity effect induces output expansion in all industries, which in turn increases costs by requiring increases in input demands. When output level is allowed to vary, the productivity gains of highway capital offset the cost increases required by the output expansion.
- Total highway capital has a significant effect on employment, private capital formation, and demand for materials inputs in all industries. The magnitude of these effects varies among the three inputs in a given industry and across industries. Given

a level of output, an increase in highway capital leads to a reduction in demand for labor and materials and an increase in demand for private capital in all industries.

- The marginal benefits of highway capital are positive in all but three fairly small industries. The magnitudes of these benefits, which can be interpreted as a measure of producers' "willingness to pay," varies considerably across industries and over time. The average sum of marginal benefits across all industries is about 0.294.
- The contribution of highway capital to total-factor productivity (TFP) growth is positive in all industries. At the aggregate level, highway capital's contribution to TFP growth is about 0.25.

2.3 Economic Impact Categories

There are many different ways to categorize economic impacts. Often researchers will create their own categories based on a working definition for use in studies. In a study conducted by Weisbrod (2006), two different types of economic benefits were identified: "direct user benefits" and "additional business growth and attraction." The first of these, direct user benefits, is easier to calculate or estimate because metrics for these benefits are concrete. This category of benefits includes measurements such as travel time, convenience, safety, reduced fuel consumption, and reduced air pollutants. Additional business growth and attraction is more difficult to calculate. This category includes measurements such as sales, jobs, and wages.

In an earlier study, Weisbrod and Weisbrod (1997) identified the direct user benefits, along with construction, maintenance, and operations spending as the two major forces driving the "additional business growth and attraction" type benefits. These are shown in Figure 2-1.

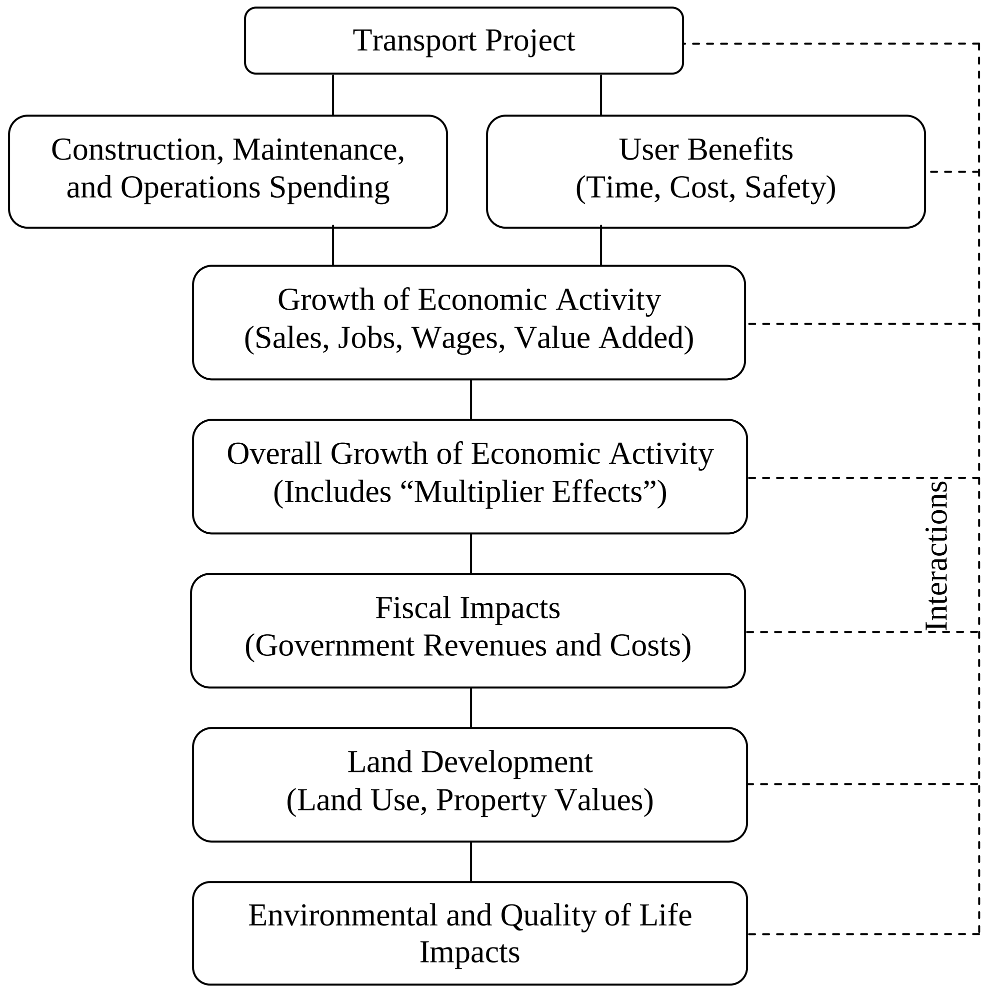

Figure 2-1: Elements of impact (adapted from Weisbrod and Weisbrod, 1997).

Weisbrod and Weisbrod (1997) used the following groupings of measurements:

- Growth of economic activity (sales, jobs, wages, value added),
- Overall growth of economic activity (includes “multiplier effects”),
- Land development (land use, property values, new development),
- Fiscal impacts (government revenues and costs), and
- Environmental and quality of life impacts.

A report prepared for the Massachusetts Turnpike Authority by the Economic Development Research Group, Inc. (EDRG) (2006) uses an analysis of the economic impacts of past transportation improvement projects such as the Massachusetts Turnpike to evaluate the potential economic impacts of two current projects: 1) The Central Artery and 2) Third Harbor Tunnel projects. Data for the economic growth around these past projects were used to calculate projections for future economic development. Projections for property values were calculated using the percentage change in property values from 1986 (the earliest property value data available) to 2005 (the year the study was completed). This was done for several projects in several different neighborhoods around Boston, and the averaged result was used to project property value increases for the current projects. The same method was used to calculate potential sales tax increases. Other projected impacts in this study include potential new development buildout (in square feet), potential buildout construction costs, potential property tax revenues after buildout, and potential number of new jobs created. The potential buildout numbers and potential number of new jobs created are based on plans for potential projects that have already been submitted to Boston City (EDRG, 2006).

2.4 Types of Economic Impacts

The most common types of measurable impacts that are used in studies of additional business growth and attraction type economic benefits include (Babcock et al., 2010; EDRG, 2006; Gkritza et al., 2007; Weisbrod, 2000):

- Increase (or decrease) in business sales,
- Increase (or decrease) in employment,
- Increase (or decrease) in wages,

- Increase (or decrease) in sales tax revenues,
- Increase (or decrease) in property values,
- Increase (or decrease) in population,
- New development,
- Increase in housing stock, and
- Value added.

Value added is the sum of employee compensation (total payroll including value of benefits), proprietors' income (payments to self-employed individuals), property income (such as rents, royalties, dividends, and corporate profits), and indirect business taxes (excise taxes, property taxes, licenses, fees, and sales taxes paid by business) (Babcock et al., 2010). Weisbrod (1996) suggests that when analyzing the business activity impacts of transportation projects, it is best to measure retail sales, changes in employment, and changes in personal income.

2.5 Standard Economic Impact Types

CSI performed a study for the Transportation Research Board (TRB) to delineate standard practice when analyzing the economic impacts of transit projects. As part of this study, the types of economic impacts were classified into three different categories (CSI et al., 1998). The three categories of economic impacts along with examples of measurements for each category are shown in Table 2-1.

Table 2-1: Categories of Transit Related Economic Impacts (adapted from CSI et al., 1998)

Generative Impacts	Redistributive Impacts	Financial Transfer Impacts
User Benefits (travel time savings, safety benefits, changes in operation costs)	Land Development (e.g., clustered development around transit stations	Employment and income growth related to system construction, operation, or maintenance
Employment and income growth unrelated to system construction, operation or maintenance	Employment and income growth due to land development	Joint development income to local agencies
Agglomeration/urbanization benefits (e.g., higher productivity, lower infrastructure costs)	Increased economic activity within corridor	Property tax impacts
External benefits (e.g., air quality)		
Accessibility benefits (e.g., access to employment		
Reduced development costs due to reduced parking		

The three different categories are summarized as follows (CSI et al., 1998):

- *Generative Impacts* produce net economic growth and benefits in a region such as travel time savings, increased regional employment and income, improved environmental quality, and increased job accessibility. This is the only type of impact that results in a net economic gain to society at large.
- *Redistributive Impacts* account for locational shifts in economic activity within a region such that land development, employment, and, therefore, income occur in a

transit corridor or around a transit stop, rather than being dispersed throughout a region.

- *Transfer Impacts* involve the conveyance or transfer of moneys from one entity to another such as the employment stimulated by the construction and operation of a transit system financed through public funds, joint development income, and property tax income from development redistributed to a transit corridor.

2.6 Measurement Concerns

It is important that economic impacts are measured accurately; thus, there are several potential concerns that require attention throughout the analysis. The first is to avoid double counting benefits. There are multiple benefits that all stem from the same cause and care must be taken to avoid adding these benefits together. It is also important to consider the geographic nature of the impact. A rise in commercial sales in one area may be offset by losses in another. Finally, construction spending impacts could also produce the same effects by being spent on equivalent-cost, non-transportation projects (Weisbrod and Weisbrod, 1997).

In addition to these considerations is the availability and adequacy of statistics used for analysis. Often, necessary data are extremely difficult to obtain or do not exist. Actual earnings, sales tax generation, and other specific financial data are confidential and cannot easily be obtained on an institutional basis. Instead, surveys or other means are often used to gather this type of information. It follows that the availability of reliable statistics will result in a more accurate analysis (Adler, 1971).

2.7 Types of Economic Impact Analysis

In the study done by CSI for TRB, there were two general types of economic impact analysis types. These are predictive (*ex ante*) or evaluative (*ex post*). Predictive economic impact analyses are used to forecast the economic impacts of a potential project. Major investment studies (MISs) or environmental impact studies (EISs) are examples of this type of study.

Evaluative economic impact analysis evaluates a transportation improvement project after it has been implemented. The analysis uses economic indicators both before and after a project is constructed. These types of studies can yield valuable information about the role a project has played in the local economy as well as providing insight when evaluating future projects (CSI et al., 1998).

Economic impact analysis often includes either a modal comparison or a no-build comparison. A modal comparison compares the impacts of one mode versus another, such as a light rail transit (LRT) system versus a bus rapid transit (BRT) system. A no-build comparison contrasts the economic impacts of the proposed project against building nothing.

2.8 Methods of Evaluating Economic Impacts of Transportation Projects

Several methods exist for evaluating economic impacts. The type of method depends upon the economic impact being studied and the data available. Methods for generative economic impacts and whether the methods are predictive or evaluative are shown in Table 2-2. Predictive and evaluative methods are shown for redistributive economic impacts in Table 2-3. Financial transfer impact analysis methods are shown in Table 2-4.

Table 2-2: Methods for Measuring Generative Economic Impacts of Transit Projects (adapted from CSI et al., 1998)

Impacts	Methods					
	Regional Transportation Land Use Models	**Benefit-Cost Analysis**	**Input-Output Models**	**Forecasting and Simulation Models**	**Multiple Regression and Econometric Models**	**Non-Statistical and Statistical Comparisons**
User Benefits[1]	P	P				
Employment and Income Growth[2]			P	P		
Agglomeration / Urbanization Benefits[3]	P			P	E	E

P = Predictive studies
E = Evaluative studies
[1] Includes travel time savings, safety benefits, and changes in operating costs.
[2] Other than growth related to facility construction and operations.
[3] Includes impacts such as improved accessibility for the poor, physically disabled, and elderly.
[4] Includes impacts such as improved air quality and reduced noise pollution.
[5] In particular, reduced parking costs.
[6] Compact, transit-oriented development.

Table 2-3: Methods for Measuring Redistributive Economic Impacts of Transit Projects (adapted from CSI et al., 1998)

Impacts	Case Comparisons	Interviews / Focus Groups / Surveys	Methods				
			Physical Conditions Analysis	Real Estate Market Analysis	Development Support Analysis	Regression Models	Non-Statistical and Statistical Comparisons
Land Development and Re-development[7]	P	P, E	P, E	P	P	P, E	E
Employment and Income Shifts[8]	P	E	P, E		P		E
Increased Economic Activities[9]	P	E					

P=Predictivie studies
E=Evaluative studies
[7] Intra-regional.
[8] Increased Retail sales, for example.
[9] Growth Related to construction, operation, and maintenance of the transit facility.

Table 2-4: Methods for Measuring Financial Transfer Economic Impacts of Transit Projects (adapted from CSI et al., 1998)

Impacts	Case Comparisons	Interviews / Focus Groups / Surveys	Methods			
			Physical Conditions Analysis	Real Estate Market Analysis	Development Support Analysis	(Multipliers from) Input – Output Models
Employment and Income Growth[10]	P	P, E	P, E	P	P	P, E
Tax Impacts[11]	P	E			P	
Joint Development[12]	P	E				

P=Predictivie studies
E=Evaluative studies
[10] Increased revenues from property, sales, income, and other taxes.
[11] Connection fees, impact fees, public-private partnerships, assessment districts.
[12] Increased productivity and/or lower public infrastructure costs.

Many different methods can be used for studying the economic impacts of transportation projects. Although no standard method exists, the U.S. DOT did produce a report outlining the steps to follow when analyzing economic impacts of large-scale freight projects (CSI et al., 2006). This report presented several different methods for the analysis, including some discussed in the following subsections. If data are readily available, an applied data evaluation can be used as outlined by Weisbrod and Weisbrod (1997). If economic data are not readily available, a set of surveys can be used to collect the desired data as was done by Eisele and Frawley (1999). Case studies provide another method for examining economic impacts. Finally, computer models are becoming the most popular method for analyzing economic impacts. Each of these methods is discussed in more detail in the following three subsections.

2.8.1 Applied Data Evaluation of Economic Impacts

Several steps exist that should be followed when assessing different types of economic impacts resulting from transportation projects. These include the following (Weisbrod and Weisbrod, 1997):

1. Identify the type of transportation project:
    a. Identify the mode of transportation,
    b. Identify the scale of the transportation project's service area,
    c. Identify the type of transportation system change, and
    d. Identify the purpose of the transportation project.
2. Identify the purpose of the analysis:
    a. Evaluate the proposed project impact statement,
    b. Evaluate public information,
    c. Evaluate benefit/cost analysis, and
    d. Evaluate relevant research studies.
3. Select the base case and transportation alternatives:
    a. Base case *assumes* change from existing transportation conditions,
    b. Base case *assumes* continuation of existing transportation conditions,
    c. Base case is a *prior time*, before the advent of existing transportation, and
    d. Define alternative scenarios for proposed new services such as the "No Build" base case, "Partial Build" base case, and the "Degradation" base case.
4. Select the appropriate geographic study area,
5. Select the appropriate time period for study,
6. Select the appropriate impact measure,

7. Select the appropriate analysis methods, and
8. Apply data to calculate economic impacts.

These steps are covered in more detail in the Weisbrod and Weisbrod (1997) study entitled, “Assessing the Economic Impacts of Transportation Projects.” This method is used for a single project and compares several alternatives. This is a good method to use when the economic impacts are used as a supplement for analyzing different scenarios and prioritizing different alternatives or projects.

2.8.2 *Using Surveys to Collect and Study Economic Impacts*

Other methods can be used when studying several different projects and comparing their respective economic impacts. In a study done by Eisele and Frawley (1999), the economic impacts of constructing raised medians were evaluated. The methodology used by these researchers involved eight steps. The steps are outlined as follows:

1. Identify sites (cities) with potential corridors,
2. Identify corridor characteristics,
3. Contact sources of information,
4. Inventory businesses and establishments along the subject corridor,
5. Obtain information about businesses,
6. Prioritize businesses to be surveyed,
7. Collect data by personal interviews, and
8. Analyze and summarize data.

In this study, data were collected by interviews, surveys, and site visits. While this can be an effective way to gather data, it can also be extremely time consuming and has the potential to be inaccurate and/or inconsistent. Surveys and interviews rely on business owners and stakeholders to collect and present accurate information. Often, because of personal interest and difficulty, accuracy may be difficult to achieve.

2.8.3 Case Study Comparisons

A common methodology used to determine the economic impacts of transportation studies is case study comparisons. In a study by Burkhardt et al. (1998), the researchers used 22 case studies to examine the economic impacts of rural transit operations. The study calculated the total economic benefits and compared those to the operating cost for each transit system. The average benefit-cost ratio was 3.03 dollars, with the smallest being 1.06 dollars and the largest ratio being 7.56 dollars (Burkhardt et al., 1998). Other studies that used case studies include Adams and VanDrasek (2007), Arndt et al., (2009), Eisele and Frawley (1999), and Lombard (1991).

2.8.4 Using Computer Models to Evaluate Economic Impacts

There are several different computer models available that are designed to estimate and assess the economic impacts of transportation projects. Some of the more popular models include the relatively inexpensive and fairly simple Regional Input-Output Modeling System (RIMS II) (BEA, 2010), produced by U.S. Department of Commerce, the moderately priced and more complex Minnesota Impact Analysis for Planning (IMPLAN) software (Minnesota IMPLAN Group, Inc., 2010), and the more sophisticated and expensive integrated input-output-econometric model developed by Regional Economic Modeling, Inc., called REMI® (REMI®, 2010). Competing with REMI® is a software package called Transportation Economic Development Impact System (TREDIS®) (EDRG, 2010). The Surface Transportation Efficiency Analysis Model (STEAM) and the Highway Economic Requirements System – State Version

(HERS-ST) are two software programs developed by government entities that can also be used to evaluate economic impacts of transportation projects (DeCorla-Souza and Hunt, 2005; FHWA, 2002; FHWA, 2010).

RIMS II was developed by the U.S. Department of Commerce and is used by both public and private agencies. It is based upon an accounting framework called an input-output (I-O) table. These data sources are relatively easy to access. According to Lynch (2000), the accuracy for RIMS II multiplier estimates is very good. They are comparable to extensive survey-based tables. The advantages of using RIMS II are that the input data are easily accessible, the level of industrial detail reduces aggregation errors, model multipliers can be compared across areas because they are based on a consistent set of procedures nationwide, and, finally, the multipliers are updated to reflect the most recent data. The results of the RIMS II model are given in three categories (Lynch, 2000):

1. Earnings (sometimes expressed as wages and salaries),
2. Output (sometimes called economic activity), and
3. Jobs.

The IMPLAN model uses two types of multipliers: Type I and Type III. Type III multipliers are different from Type I in that they are non-linear. IMPLAN builds its data in a top-to-bottom format. National data serve as control totals for state data, and state data work as a control for county data. Results are given in a value-added format (Lynch, 2000). The Kansas Department of Transportation (KDOT) recently completed an economic impact analysis of their transportation funding program over the last 10 years using IMPLAN to complete the analysis (Babcock et al., 2010).

The REMI® model is more complex, more expensive, and provides a more detailed analysis than RIMS II or IMPLAN. There are five basic parts to the model (REMI®, 2010):

1. Output,
2. labor and capital demands,
3. Population and labor supply,
4. Wages, prices, and profits, and
5. Market shares.

REMI® uses national technical coefficients from the Bureau of Labor Statistics (BLS) in the I-O tables (Rickman and Schwer, 1995). The final results are given in a “ratio of real regional value added per unit of input relative to U.S. value added per unit of input” (Lynch 2000 p. 10). A drawback to REMI®, as pointed out by a report prepared for the U.S. DOT, is that the program assumes a closed economy, meaning only the area modeled is taken into consideration in the model. There is very limited provision for international trade impacts, which in some cases can be significant (CSI et al., 2006).

REMI® and other I-O computer models are becoming the most common way to analyze the economic impacts of transportation improvements. Many recent studies have utilized REMI® to obtain results regarding economic impacts (CSI, 2003; CSI, 2005; Lynch, 2000; Perlich, 2004; Pickton et al., 2007).

TREDIS® is web-based software that allows users to conduct economic impact evaluation and benefit-cost analysis for transportation investments. TREDIS® is able to incorporate all types of transportation modes as well as multimodal systems. It is also able to distinguish between generative and distributive effects of growth in the regional economy.

TREDIS® is able to link with geographic information system (GIS) software for data input and to do further analysis (EDRG, 2010).

Another program developed by the FHWA is a planning tool called STEAM. STEAM consists of four modules (DeCorla-Souza and Hunt, 2005):

1. A user interface module,
2. A network analysis module,
3. A trip table analysis module, and
4. An evaluation summary module.

These modules are used to evaluate different transportation project alternatives based upon economic impact. STEAM accepts input in three formats: 1) person trip tables for passenger travel and vehicle trip tables for truck travel, 2) travel time and cost matrices taken from transit networks and from highway networks, and 3) loaded highway network output from traffic assignment. The modules then calculate the user benefits, which take into account weekday person trips, weekday vehicle trips, weekday vehicles miles, annual emissions, and annual fuel use for each scenario of interest. In addition to user benefits, revenue transfers, external cost changes, public agency costs, net annual worth, and risk analysis are calculated. These are then compared in a table of benefits and costs. The total net monetized gain (or loss) can then be compared, and the one with the highest net monetized gain would be the best solution (DeCorla-Souza and Hunt, 2005).

The FHWA created a model called the HERS-ST version 2.0. It is used to identify the most cost effective improvements for a transportation system. The model also provides cost estimates for achieving economically optimal program structures, predicts system conditions, and predicts user cost levels resulting from specific improvements. HERS-ST uses elasticity as a tool to model events such as schedule delay and peak shifting. This is done using short-run and long-run elasticity curves. These curves are also used in modifying demand forecasts (Lee, 2002).

Many economic impact studies rely on computer models to simulate the impacts that may occur. It is important to note that computer models are not the answer to all economic forecasting situations. As pointed out by Weisbrod (2006, p. 2), "A computer model is by definition just 'a simplified representation of processes' that attempts to represent cause and effect relationships in terms of equations." This recognizes that there are limitations to these computer models and that reality is often not reflected in the model simulations. As Weisbrod (2006) maintains, a computer model can be expected to: 1) reasonably well represent some processes driving transportation and economic outcomes, 2) omit other processes because they depend on factors that cannot be easily measured and explained, and 3) poorly represent yet other processes due to difficulty measuring and explaining them. Once the limitations of the model are understood, care can be taken to address deficiencies in the model.

2.9 Economic Development Criteria and Project Prioritization

State DOTs are responsible for prioritizing and acting on potential transportation improvement projects. It is important that any prioritization process include some type of economic benefit consideration. There are several methods currently in use by state DOTs for project prioritization based on economic impacts. In a study done for UDOT by Schultz et al. (2006), a process was developed for project prioritization. In the study, surveys were completed to identify which criteria should be looked at and the relative weight that should be given to each factor. The study compared several tools for evaluating economic impacts and assessed how effective each tool was in evaluating the economic impact. The advantages and limitations of each tool were identified and discussed. The report recommended that a two-tier evaluation system be implemented to help prioritize transportation projects. The first tier would be the primary selection process, with some projects being chosen for additional analysis in the second tier. It was recommended that this process be implemented into UDOT's evaluation program, with cooperation from the Governor's Office of Planning and Budget (GOPB) and/or the Governor's Office of Economic Development (GOED). The Transportation Commission would then be in charge of making final funding decisions (Schultz et al., 2006).

In a follow-up study done by Schultz and McGee (2009), the project prioritization process was refined for UDOT. This process was previously broken down into Tier I and Tier II. Tier II includes all projects over 5 million dollars and uses a "Decision Support System" to provide two summary sheets. These sheets show the scoring of the project and are used to prioritize transportation projects. Tier II includes the top third of projects from Tier I and includes an economic analysis. The exact economic analysis of projects included in Tier II was the subject of the study. Nine measures of effectiveness (MOEs) were identified and a weighting system developed. These measures of effectiveness were aggregated into four criteria and one bonus criterion: 1) population and education, 2) existing infrastructure, 3) economic attractiveness, 4) tourism, and 5) the bonus: economic choke points (which allows UDOT regions to specify a prioritized list of projects that could help increase the economic development potential of an area if those projects are built). Expert feedback and analysis of economic choke points were also included. Finally, an economic ranking could be given to UDOT officials as a resource for project prioritization (Schultz and McGee, 2009).

KDOT also recently reevaluated their project selection process. Their new selection process uses a combination of three selection factors: 1) engineering, 2) local consultation, and 3) economic impacts. It is interesting to note that the economic impacts have such a prominent role in the selection of potential transportation improvement projects. These three categories are weighted depending on the project type. In KDOT's evaluation process, all transportation projects are classified as one of three types: 1) preservation, 2) modernization, or 3) expansion projects. Once the project has been classified, the three selection factors are given a score and weighted according to the project type. Those projects with the highest score are given first priority (KDOT, 2010).

New York City has also developed a project prioritization process. The process involves calculating a score in two categories: 1) transportation benefits and 2) economic development benefits. The scores are then weighted to achieve an overall prioritization rank. The weights were developed using a panel of transportation experts. The highest ranked projects are then given priority (Berechman and Paaswell, 2005).

2.10 Economic Impact Studies

Numerous economic impact studies have been completed looking specifically at transportation projects. There is not a standardized practice, so the methodologies and results vary considerably. Adams and VanDrasek (2007) used case studies to look at the potential benefits that would occur with a major transportation infrastructure investment. One of the case studies used in the study was the Salt Lake City Intermodal Hub. Although specific conclusions about each of the case studies was not discussed, overall "lessons learned" were presented. A few of these include (Adams and VanDrasek, 2007):

- The area surrounding the transportation improvement will in large part determine what kind and how much economic development is induced.
- Overall, transportation improvements to a redevelopment area have a significant impact due to the increase in access.
- The characteristics of the area have three attributes that have a large influence: 1) the population and economic growth rates of the metropolitan area, 2) the current trends and conditions in local land prices and development densities, and 3) the centrality (link to other destinations to the transportation system) of the project.

Lombard (1991) of Purdue University studied the economic impacts of transportation projects in Indiana. Lombard's study found that highway mileage density was significantly related to economic development, with multi-lane highways having an especially high association with economic growth. Based on multiple regression models, the results indicated that regions where a highway was built experienced higher economic growth than the rest of the state. Additionally, the study reported that contract trucking availability and highway access were found to be some of the most important determinants of industry location (Lombard, 1991).

In 2007, Colorado's DOT completed an economic impact analysis of transportation investment. This study compared a "Baseline" scenario, which assumes current transportation revenue would remain constant, and a "Sustain Current Performance" scenario that assumes additional funds can be acquired to keep transportation system performance at current levels. The study showed that under the "Sustain Current Performance" scenario, the generative economic impacts would result in the following (Pickton et al., 2007):

- 10,900 new long-term jobs,
- 0.7 billion dollars in increased personal incomes,

- 28,000 additional construction-related jobs,
- Increased economic competitiveness,
- Improved access to health and human services, and
- Increased visitation to tourist destinations.

Overall, the study found that the economic benefits would exceed the required investment by 11.6 billion dollars (2005 constant values). These generative economic impacts were calculated using REMI®.

A similar study performed in Wisconsin also showed significant economic benefits by investing in transportation. The study showed that for every dollar of additional investment into the transportation system beyond that needed to maintain current conditions, Wisconsin would enjoy 3 dollars of benefit. The study also found that additional transportation investment would result in 4,800 jobs created. Additionally, for every dollar spent on transit improvements, Wisconsin would receive 1.66 dollars in economic benefits, primarily through taxpayer savings. These findings were obtained through the use of REMI® software (CSI, 2003).

2.11 Economic Impact Studies Dealing with Sales Tax

A significant portion of the economic impact of transportation is related to sales tax. This metric can be used to see how business sales grew (or declined) due to transportation improvements. Sales tax provides an indication of the overall health of the economy in an area, and as noted earlier, along with employment or income fluctuations, is an important factor to analyze when studying the economic impacts (Weisbrod, 1996).

Gkritza et al. (2007) found that tax revenue was second only to job creation when considering the most important economic impacts to both citizens and government agencies. A few studies dealing specifically with sales tax are presented in the following paragraphs.

An economic impact study was completed for California using IMPLAN software. A few of the study's results include (CIC, 2004):

- Every 1 billion dollars of transportation spending in California creates approximately 18,000 new jobs in the state.
- For every state dollar spent on transportation projects, the state would see an additional 0.97 dollars in indirect and induced spending in the economy. Many of these additional transactions result in sales tax revenues and additional income for tax payers in the state, creating additional revenue not only for the state, but for local governments as well.

Los Angeles County performed an economic impact study of transportation projects using RIMS II (LACEDC, 2010). The study looked at the effect that an increase in sales tax would have on the county's economy. The study projects that 34.7 billion dollars will be generated by the increase in sales tax and used to fund transportation projects across the county. This extra investment in transportation projects is expected to increase the economic output of the region by 68.775 billion dollars, create 507,500 new jobs, and provide an increase in personal incomes of 22.376 billion dollars. The study also looked at the tax impacts that would occur due to the transportation investment. It was found that over 9.3 billion dollars would be generated in taxes. This would be split between government entities as follows (LACEDC, 2010):

- Federal: 6,586.1 million dollars,
- State: 2,304.8 million dollars,

- County: 271.4 million dollars, and
- Local: 155.1 million dollars.

A nationwide study examining the economic impacts of investing in public transportation produced several interesting results (Weisbrod and Reno, 2009). A summary of these results can be found in Table 2-5. The study concluded that for every billion dollars of average spending on public transportation, 36,100 jobs were created, economic output increased by 3.6 billion dollars, and tax revenues increased by 490 million dollars.

Table 2-5: Economic Impacts of Investing in Public Transportation (adapted from Weisbrod and Reno, 2009)

Economic Impact	Per $ Billion of Capital Spending	Per $ Billion of Operations Spending	Per $ Billion of Average Spending
Jobs (thousands)	23.8	41.1	36.1
Output (Business Sales, $ billions)	$3.0	$3.8	$3.6
GDP (Value Added, $ billions)	$1.5	$2.0	$1.8
Labor Income ($ billions)	$1.1	$1.8	$1.6
Tax Revenue ($ millions, rounded)	$350	$530	$490

A study completed for Dallas Area Rapid Transit (DART) concerning the economic impacts for taxing entities based on the development that would occur around existing and proposed light rail stations produced some interesting findings (Clower et al., 2007). The study showed that the existing and proposed light rail would trigger a large increase in both sales and property taxes. The increases in taxes are presented here (Clower et al., 2007):

1. Increased taxable property values associated with the rail stations have the potential to generate on-going annual tax revenues totaling:
    a. 16.8 million dollars for DART member cities,
    b. Over 46 million dollars for area school districts,
    c. 6.6 million dollars that will be shared by Dallas and Collin counties,
    d. Approximately 2.3 million dollars each year that will be shared by Dallas County Community College District and Collin County Community College District, and
    e. As much as 6.7 million dollars for Parkland Hospital in new annual revenues attributable to DART-related transit-oriented development.
2. The light rail project and associated development will generate over 660 million dollars in annual taxable retail sales boosting local municipal revenues by 6.6 million dollars annually.
3. These same taxable retail sales will generate over 41 million dollars in revenue for the state of Texas.
4. In total, once all announced projects are completed, state and local tax revenues associated with development near DART rail stations will exceed 127 million dollars per year.

Interestingly, while studies have shown that transportation improvement projects generally increase sales tax revenue, other studies have shown that major roadways built to avoid downtown areas, known as bypasses, do not affect the taxable sales in the downtown area. These rural bypasses are meant to improve traffic flow and reduce the number of vehicles traveling through heavily trafficked downtown areas. A study completed in Iowa and Minnesota found “no significant difference in total retail sales for communities with a new bypass versus cities without bypasses" (Otto and Anderson, 1995 p. 3). A similar study, completed in Wisconsin, concluded that, "In most communities, highway bypasses have little adverse impact on overall economic activity. The economies of smaller communities (population less than 2,000) have a greater potential to be adversely impacted by a bypass" (WisDOT, 1998 p. 4).

2.12 Economic and Demographic Impact Studies Completed in Utah

In a study done by Perlich, of the Bureau of Economic and Business Research at the University of Utah, the economic and demographic impacts of federally financed transportation projects along the Wasatch Front were analyzed. Perlich referenced the three types of economic impacts identified by CSI for TRB: 1) generative, 2) redistributive, and 3) financial transfer impacts. Perlich's study focused only on financial transfer impacts of federally financed transportation infrastructure along the Wasatch Front. The study was done using the REMI® computer model and produced the following results (Perlich, 2004):

- The 14.4 billion dollars (constant 2004 dollars) of transportation infrastructure investments planned for the Wasatch Front over the next three decades will significantly influence the region's economic development potential, relative competitiveness, and land use patterns.
- This new capacity construction spending will average 531.6 million dollars per year over the 27-year period and includes average annual spending of 163.4 million dollars by Utah Transit Authority (UTA), 226.9 million dollars by the Wasatch Front Regional Council (WFRC), and 141.3 million dollars by the Mountainland Association of Governments (MAG).

- The federally financed share of these projects increases the size and composition of the regional economy. Federal in-state spending on these construction projects is estimated to total 4.2 billion dollars over the 27-year period. This is an annual average of 155.7 million dollars composed of 45.3 million dollars for UTA, 68.1 million dollars for WFRC, and 42.4 million dollars for MAG.
- Federal dollars funding transportation infrastructure will result in an average annual employment impact of 2,800 additional jobs. This incremental employment will support about 3,900 more people for the duration of the projects than would have been the case without the federal spending. The state's economy, as measured by Gross State Product (GSP), will, on average, be larger by 211.8 million dollars per year. Personal income will be larger by an average of 197.0 million dollars annually, as compared to what it would have been in the absence of the federal spending. Incremental state income taxes will increase, on average, by an estimated 5.9 million dollars on an annual basis.
- The total economic activity (both externally and internally financed) associated with the 27-year construction program is an annual average of about 8,500 jobs, including approximately 3,400 in construction, the majority of which are in the heavy construction sector. The associated impact population averages about 11,600 annually. Average annual personal income associated with the construction projects is 640.4 million dollars, while the average annual GSP associated with this economic activity is 639.9 million dollars. State income taxes generated by this economic activity are, on average, 19.2 million dollars annually.

Another study, completed for Envision Utah, concentrated on the generative economic impacts of expanding public transportation along the Wasatch Front. The study used the 2030 Long-Range Plans (LRP) of WFRC and MAG to complete the analysis. Two scenarios were analyzed: 1) assume that all transit investments outlined in the 2030 LRP would be implemented gradually until 2030 and 2) assume the same transit investments planned for completion by 2012 will be in effect until 2030. The economic analysis was completed using REMI® software. This study produced several interesting results (CSI, 2005):

- In terms of return on investment, benefits associated with the LRP's public transportation investments are expected to exceed costs and result in a benefit-cost ratio of 1.8 when including all state and local costs to Utah. This represents a 1.80 dollar return for each 1 dollar spent and results in a net present value of 1.4 billion dollars over the next 30 years.
- Projected 220 million dollars in direct benefits to users of either the transit or highway system per year by 2030. These benefits are related to increases in ridership, improved transit service and connectivity, reduced highway congestion, and crash reduction benefits.
- By 2030 public transportation investments in the LRP are expected to increase the region's employment by 1,400 jobs, with 105 million dollars in extra personal income and 140 million dollars in additional gross regional product due to increases in the efficiency of business travel.

2.13 Summary

Economic impacts represent an important part of the planning and design phases of transportation projects. Economic impacts should be known and understood to provide a guide for decision-makers so that public investment can be maximized. This understanding will also ensure that projects are designed with recognition of both positive and negative economic impacts. Although economic impacts of transportation projects are an important part of evaluating both past and future projects, there is little consensus on what type of results should be expected, or what methods should be used. The exact relationship between transportation construction projects and the economy is still widely debated, with numerous conclusions being drawn on both ends of the spectrum. However, it is apparent that there is a relationship. A summary of the literature review is presented here:

- It is important to identify the type of economic impact when performing an analysis. Types of impacts vary with different researchers, but TRB has provided a standard classification system of three types of economic impacts (CSI et al., 1998): 1) generative, 2) redistributive, and 3) financial transfer impacts.
- There are two basic types of economic impact analysis (CSI et al., 1998): 1) predictive and 2) evaluative. These two basic types of analysis are broken up into numerous methods for analyzing economic impacts of transportation projects. These methods include case studies, computer models, I-O models, statistical and non-statistical comparisons, surveys, benefit/cost analysis, and others. It is important to identify the correct method and procedure to obtain the desired results.
- Increasingly, computer models are being used to provide results for government agencies. Although these programs can provide useful results for decision-makers, the

accuracy of these results depends greatly on the dependability of the data and the modeler's ability to manipulate the program to correctly represent specific situation(s).

- State DOTs are beginning to incorporate economic impacts into their project prioritization process. This transition to evaluating the economic impacts of a transportation project will allow state DOTs to better maximize the benefit to users and the overall economy (Schultz and McGee, 2009).
- Numerous studies, attempting to identify economic impacts of transportation projects have been completed. Several state DOTs, including New York, Wisconsin, Indiana, Kansas, and Colorado, have completed studies looking at the increase in jobs, cost-benefit ratios, consumer spending and sales tax increases, and other impacts. Effects on sales tax, employment, and personal income are particularly important when attempting to determine the overall impact on the local economy (Berechman and Paaswell, 2005; CSI, 2003; Gkritza, 2007; KDOT, 2010; Pickton et al., 2007).
- Several studies have been completed in the state of Utah regarding the economic impacts of transportation projects. Perlich (2004) focused on the financial transfer impacts of federally funded transportation infrastructure along the Wasatch Front. This study identified the funding for UTA, WFRC, and MAG, predicted jobs created by these funds, and additional jobs. State income taxes and the increase in GSP were also forecast. Envision Utah also funded a study on the economic impacts of expanding public transportation along the Wasatch Front (CSI, 2005). This study estimated the cost-benefit ratio, increase in jobs and personal income, and user benefits to the public. Both studies were completed using REMI® software.

This study focuses on the generative impacts of transportation projects undertaken by UDOT over the last 10 years. Specifically, a sales tax analysis, job creation analysis, and VMT analysis were completed for each project completed by UDOT during this time period.

The next chapter provides an overview of the types of data that were gathered and used to perform the analysis. The methodology used in the analysis is also discussed.

3 DATA AND METHODS USED FOR ANALYSIS

When undertaking an analysis of the economic impacts of a distinct element or change, it is important to use relevant and significant data. Identifying and gathering this type of data is often the most difficult part of the research process. There are numerous metrics that could be identified and used to evaluate economic impacts for any number of scenarios. Once a potential list of metrics has been identified, and an analysis technique chosen, gathering the data becomes the priority. This can be difficult as economic information is often not readily available.

Many studies that have looked at economic impacts of transportation projects have had to resort to using surveys to gather data. For example, because economic data were unavailable, researchers Eisele and Frawley (1999) gathered data using surveys of business owners for their study on economic impacts of raised medians. This method of data collection is extremely time and labor intensive, while being inherently subjective and less accurate. Business owners will often misreport financial information, provide opinions, or refuse to answer at all. In another example, data for KDOT's analysis of economic impacts were also gathered primarily by surveys. The major contractors across the state were surveyed in regards to how much money they were awarded, how much they spent in each market sector, and how much was profit (Babcock et al., 2010). Although surveys are not always entirely accurate, this is still a commonly used method of gathering data because of the lack of available, official, specific, and local financial data.

Although the desired data sometimes exist, government agencies are often reluctant to divulge specific financial details of local businesses. This may make it difficult or impossible to obtain data from certain government agencies. Confidentiality restrictions often result in data that are too general or too aggregate to provide completely accurate results. This study used information gathered from several government entities. Although the economic information was not as disaggregate as was originally desired, the researchers used the data available. Specific databases are discussed in further depth later in the chapter.

This chapter discusses the potential metrics that can be used to evaluate economic impacts and the project data, sales tax data, employment data, and VMT data used to calculate these metrics. Recession concerns and comparisons used to overcome those concerns are also discussed. Finally the methodology used to perform each analysis and data quality concerns are discussed.

3.1 Potential Metrics

Several different metrics were identified as potential indicators of economic development around transportation projects. These metrics are meant to show the health and growth of the local economy around a transportation project, both before and after construction. Comparing the different metrics before and after construction provides insight into how a transportation construction project influences the economy around the project. Considered metrics include the following (CSI et al., 1998; Weisbrod and Weisbrod, 1997; Weisbrod and Reno, 2009):

- Sales tax,
- Jobs,
- Land development,

- Income,
- Property values,
- Business sales,
- Population, and
- VMT / AADT.

After careful consideration of the applicability and accessibility of the necessary data, it was determined for this study that sales tax, jobs, and VMT would be used as economic indicators for the analysis. These indicators were determined to be the most representative of economic growth, as well as the most readily available. Sales tax is important to DOTs and all government entities as a source of income, so the sales tax indicator was chosen. As noted previously, studies have shown that the most important factor to the public is job creation (Gkritza, et al., 2007; KDOT, 2010; Schultz and McGee, 2009). Finally, VMT was chosen because more vehicles on the road encourage more passing motorists to stop and shop, which boosts business sales and overall economic growth. The necessary data acquired to calculate each metric is discussed in the following subsections.

3.1.1 Sales Tax Data

Sales tax data were obtained through the Utah State Tax Commission. The Utah State Tax Commission website contains an economics and statistics link that provides economic data to the public (Utah State Tax Commission, 2010). Unfortunately, the smallest aggregate for sales tax information available to the public is zip code. Attempts to acquire more disaggregate data directly from the Utah State Tax Commission were not successful because the Utah State Tax

Commission does not keep data in a more disaggregate form. The data set includes total yearly sales tax per zip code for the years 1996 to 2009.

3.1.2 Employment Data

Employment data were obtained through the Utah Division of Workforce Services (DWS). Knowledge about this extensive database was obtained during a meeting with the GOPB. While the entire database could not be made available, through a memorandum of agreement (MOA) between UDOT and Utah DWS, a partial dataset was acquired. The information exchange agreement allowed the following pieces of data to be made available: business, mailing address, physical address, and number of employees (Utah DWS, 2010). The number of employees were organized into quarters and given in three subsets (months). This provided the number of employees for every month, for every business in Utah, from 2000 to 2009. This valuable dataset allows a careful analysis of only businesses that would be affected by a nearby transportation project. A before-and-after analysis provides important insight into the job creation indicator for each construction project.

3.1.3 VMT Data

AADT data were provided through UDOT. The dataset includes the route number, beginning and ending milepost, description, and the AADT for each year from 1981 to 2009 (UDOT, 2010b). Later, the zip codes were added by the researchers for each section of roadway. The VMT for each section of roadway was then calculated by multiplying the length of the roadway section (L) by the AADT as shown in Equation 3-1.

$$VMT = L \times AADT \tag{3-1}$$

3.2 Project Data

To analyze the economic impacts of transportation projects, it was necessary to obtain a list of completed transportation projects. UDOT provided a spreadsheet of completed transportation projects occurring from the years 2000 to 2010 (UDOT, 2010a). This dataset included fields for project identification, project description, project location, county, project type, beginning and ending mileposts, functional class, status, award date, and project expenditures. However, many of the projects had incomplete data and were therefore not able to be included in the analysis. The project data included 2,720 projects. Unfortunately, because 2009 projects lacked sufficient post-construction data and many of the projects had incomplete data, only a small portion of the projects were able to be used in each analysis. The number of projects used in the sales tax, employment, and VMT analyses was different depending on the needed information for each analysis. Later, zip code and city data were manually added by the researchers for each project to aid in the analysis. This dataset provided the foundation for the analysis, with all economic impacts relating to one of these projects.

3.3 Recession Concerns

Beginning in 2007, and extending until the present in 2010, the economy experienced a worldwide recession. Unemployment rose while the health of the economy plummeted. Although Utah was not the hardest hit in the United States, the recession has severely influenced the economy in the state.

Dealing with the effects of the recession presents several problems. How does the overall economy affect the results of the analysis? Does a recession negate the positive economic impacts of a transportation project or merely lessen the severity of the recession? What can be done to determine what the sales tax, employment, or VMT trends in a local area would have been without the transportation project? All of these questions affect the results of the analysis and how the results should be viewed and used.

When there are variables that influence the outcome of a comparative study, as the recession does in this study, it is necessary to provide a comparison case study that also experienced the same confounding variable, but did not experience the object of the study, in this case a transportation project. Since the study covers a period of 10 years, it was not feasible to identify a zip code that did not include a transportation construction project at some point during the analysis years. Therefore, the comparison used against each transportation project was the trends for the overall state. Comparing the trends before, during, and after a transportation construction project against the overall state trend provides insight as to how the specific transportation project influenced the economy in that area.

3.4 State Comparisons

In this study of economic impacts of transportation projects, the only variable that has been considered is the completion of transportation projects. However, there are many other variables that will affect the results of the analysis that cannot be accounted for individually. In order to accurately account for the variability of the economy and other variables, the state was used as a comparison for each project in the sales tax, employment, and VMT analyses.

Sales tax trends across the entire state were compared against individual areas that experienced a transportation project. The recession that occurred from 2007 to 2010 caused sales tax numbers to drop dramatically during that period. This means that many areas that experienced the economic benefits of a transportation project still would experience an overall decline in sales tax. However, it can still be investigated whether the economic impacts of a transportation project improved the economic vitality of the area by dampening the effects of the recession. This is done by comparing the overall trend for the state to the trend of the area around each individual project.

It should be noted that the overall economy in Utah, based on sales tax, generally increased until 2000. From 2000 to 2004 the economy was generally steady, and in 2004 it began to increase steadily. Then, in 2007 the economy went into recession, bringing a sharp decline in sales tax revenues. This overall trend can be seen in Figure 3-1, which is a summary of the sales tax revenue in the state of Utah from 1976 – 2010 (GOPB, 2010).

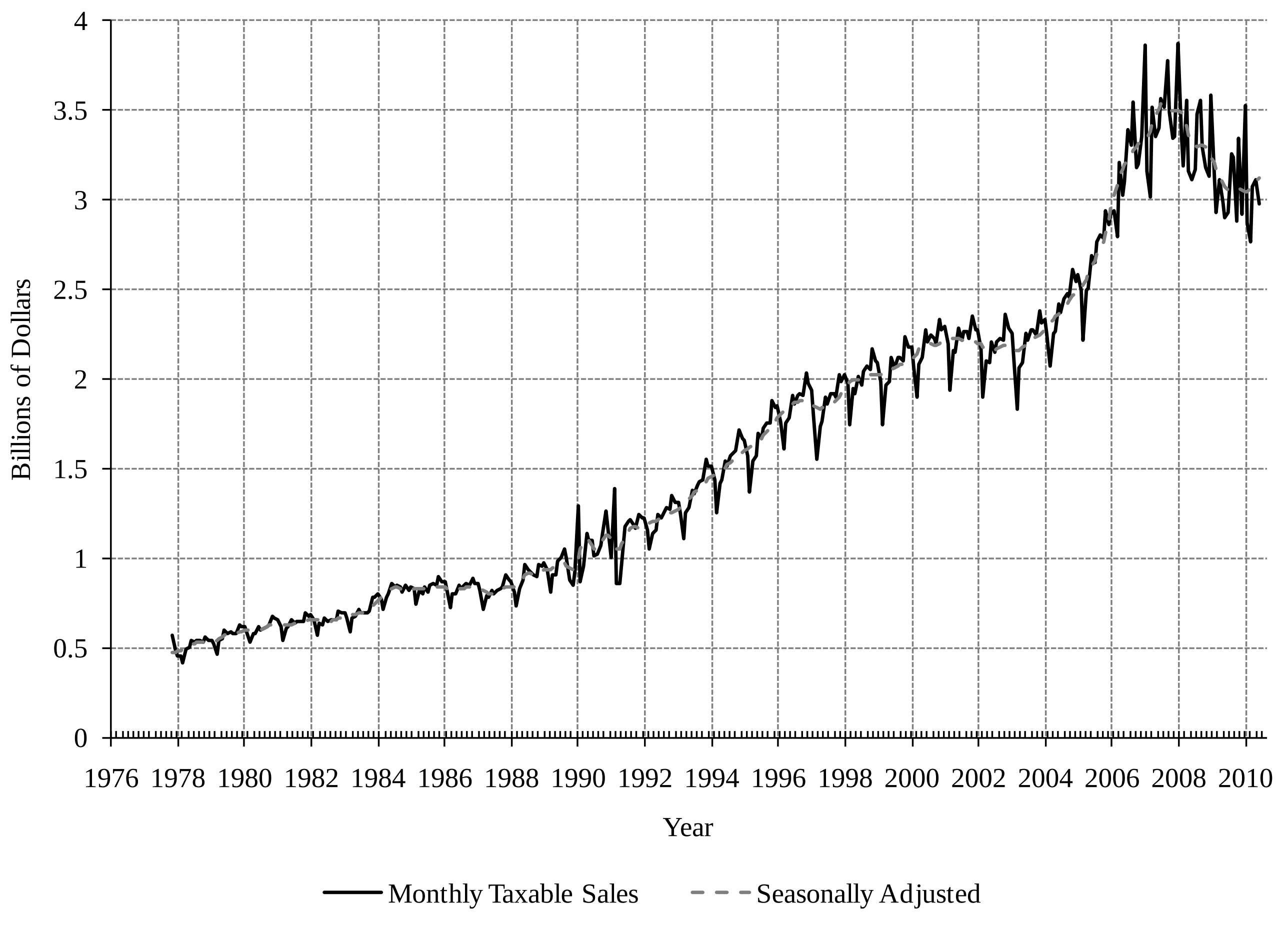

Figure 3-1: Utah state sales tax, 1976 – 2010 (adapted from GOPB, 2010).

In order to account for the variability in sales tax trends across the state, the sales tax numbers associated with each project were normalized (divided) by the sales tax total for the entire state for each year. Normalizing by the state totals gives a ratio representing the total amount of state sales tax that was generated in the area, in this case zip code. So, a ratio of 0.01 for a specific zip code would mean that one hundredth, or 1 percent, of the total state sales tax was generated in that zip code. The same process was used for the employment and VMT data.

Total statewide employment was used as a comparison for the employment analysis. The overall trends are also influenced by the recession, but not to the extent that sales tax was affected. The total number of employees in the state of Utah can be seen in Figure 3-2. This plot shows a slight dip in employment around 2008 to 2009.

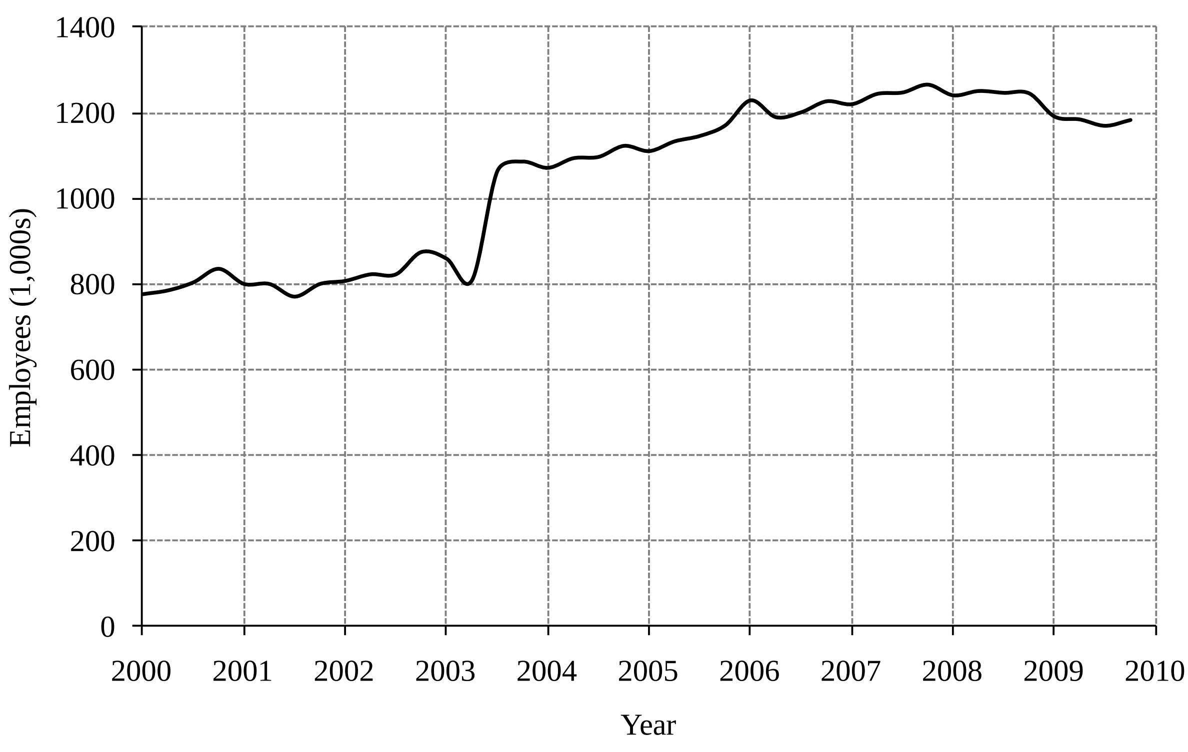

Figure 3-2: Total number of employees in Utah.

The VMT of state roads in Utah were also compared to state totals. Figure 3-3 shows the total VMT for state roads throughout Utah since 1981. There is a pretty constant increasing trend over the last 30 years. Only three years during this period experienced a decline in VMT: 1988, 2003, and 2008. Figure 3-3 shows the AADT of state routes across Utah since 1981. AADT trends follow the same pattern as VMT trends.

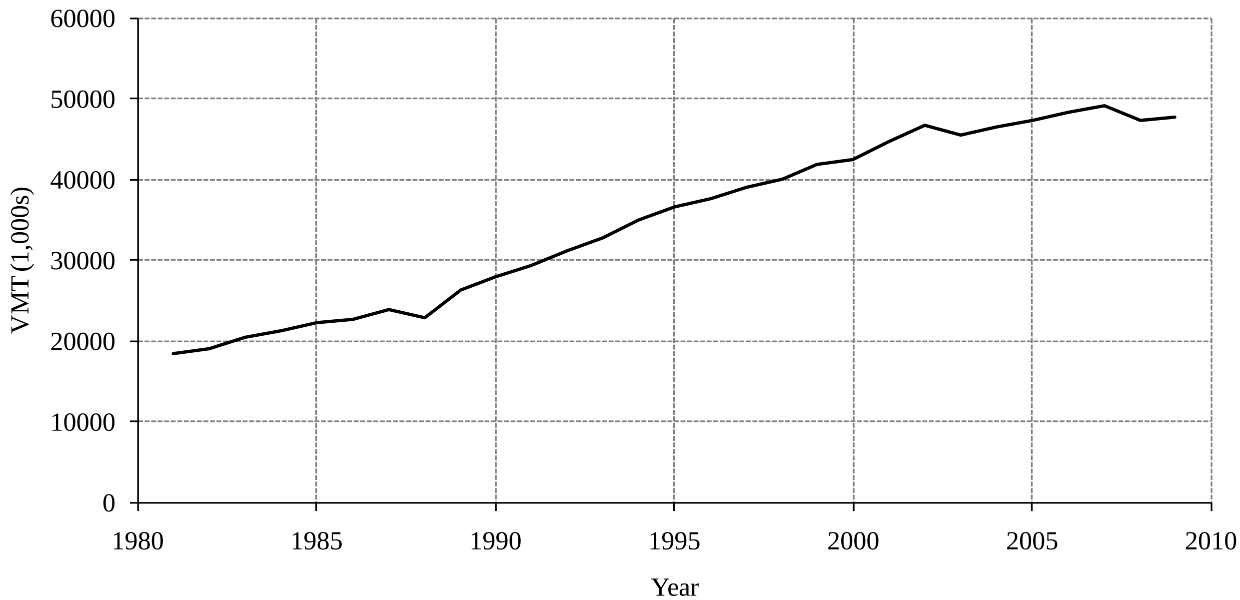

Figure 3-3: Statewide VMT totals.

3.5 Methods

As stated in section 2.7, there are two basic types of economic impact analysis, predictive and evaluative. The analysis presented here is an evaluative analysis. This evaluative (or *ex post*) analysis is an assessment of transportation projects after completion. Table 2-2 in section 2.8 showed the different methods associated with evaluating generative economic impacts. Both pre- and post-construction data were collected and compared to determine the effect that each project had on the local economy in terms of sales tax revenue, employment, and VMT increases. This study uses a statistical comparison to determine if the means of the pre- and post-construction trends are significantly different. The following subsections provide details for each analysis method.

3.5.1 Sales Tax Analysis

Understanding how transportation projects affect sales tax in a given area is very important for government agencies, as this is a large part of their funding. Will improving or reconstructing a roadway in a certain area produce a significant increase in sales tax? What type of return can be expected from this infrastructure investment? These types of questions are valid and should be considered when evaluating potential projects. The sales tax analysis that follows attempts to answer these questions by evaluating sales tax history before (pre-construction) and after (post-construction) a project was completed.

To complete the sales tax analysis, zip codes for the location of each project were identified. Each project was then matched with the corresponding zip code’s sales tax history (1996 to 2009). Matching the project with the zip code was used for this analysis; however, if more disaggregate sales tax data were acquired, this would need to be done in GIS software. For all analyses undertaken in this study, all dollar values have been adjusted for inflation to 2009 dollars (Capital Professional Services, 2010). Only projects that included adequate location data were used in the analysis. Projects that were completed in 2009 were not used due to a lack of post-construction data. Also, projects that took place in areas that had zero sales tax for any of the analysis years were not used because these areas are too rural to have a sales tax base. All sales tax data were then normalized (divided) by state sales tax values. Doing this controlled for the recession and other fluctuations in the economy. When looked at over time, these values show a trend of the local area compared to the state. A flat trend indicates that the local area is growing (or declining) at the same rate as the state. A positive trend indicates that the local area is growing faster than the state, while a negative trend means the area is growing slower than the state. Based upon these trends, a plot was generated for each project. A single project is used here as an example. The example project was a reconstruction project that widened the Redwood Road corridor to four lanes from 9000 South to 10400 South in West Jordan, Utah. Construction took place from 2002 to 2004. Figure 3-4 shows the sales tax plot completed for this project.

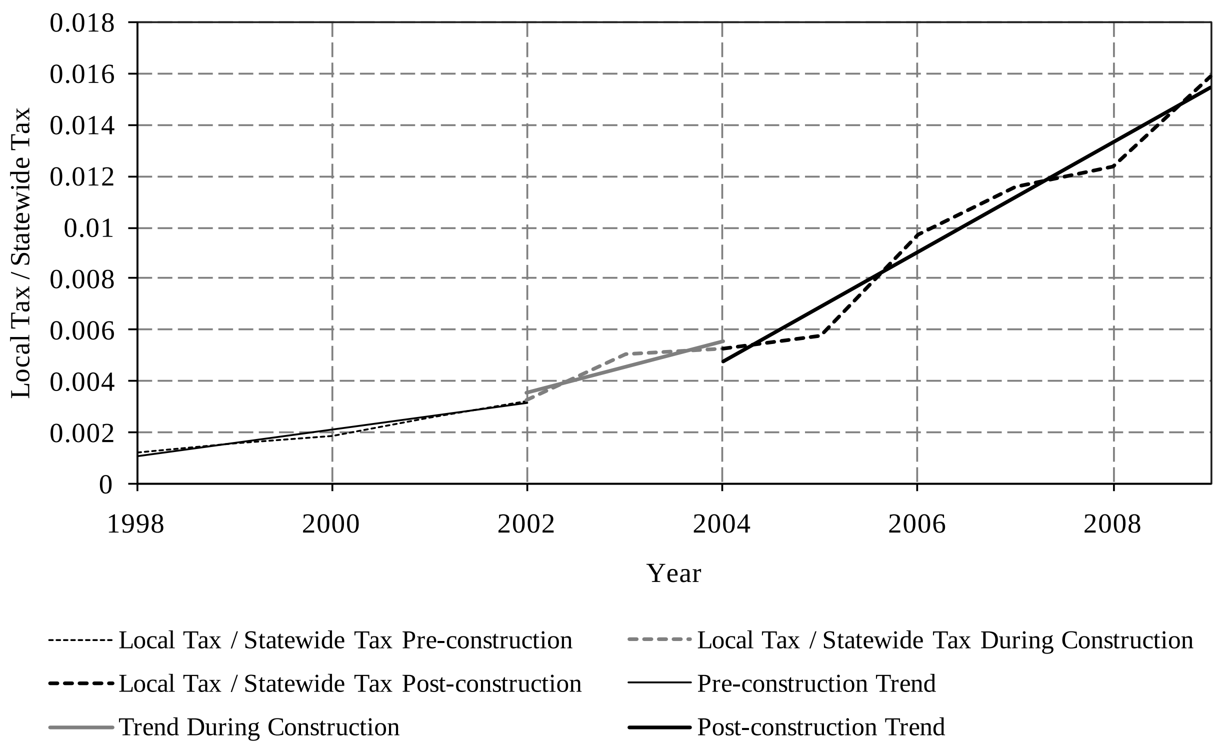

Figure 3-4: Sales tax / statewide tax around reconstruction project on Redwood Road.

The plot shows three trends: 1) pre-construction (four years previous to construction), 2) during construction, and 3) post-construction. Only the pre- and post-construction trends are used in the analysis. Four years was used as the amount of time for the pre-construction trend because this was the longest amount of post-construction data available. This particular project shows a slightly positive trend compared to the state before construction. After the construction is completed, the trend increases, showing that the area along Redwood Road is growing faster than the state after the completion of the project.

Similar analyses were completed for each project. These figures are provided in Appendix B. Using the completed analysis for each project, an overall average percent increase in sales tax after the completion of a transportation project was calculated.

3.5.2 Employment Analysis

The employment data obtained from Utah DWS listed every business in the state of Utah, along with a physical address and the number of employees each month from 2000 to 2009. The physical address provided a means to locate the businesses affected by a transportation project. Using the given addresses, the entire employment database was geo-coded into a GIS format, which resulted in a map of every business in Utah. UDOT projects were also geo-coded and shown on the same map. Only projects that had enough location data recorded could be geo-coded. This amounted to 508 of the 2,720 projects included in the project database obtained through UDOT (UDOT, 2010a).

Using ArcMap (a GIS software package), a model was created that would select each transportation project and create a quarter-mile radius buffer around the project site. Utah city blocks are typically 660 feet. A quarter-mile (1,320 feet) was used to include all businesses that lie within a two block radius of the project. All businesses located within this buffer were assumed to have been affected by the transportation improvement project. Each affected business and its associated employment data were then put into a table that corresponded with the transportation project. Models created in ArcMap are designed in a flowchart-type format. Figure 3-5 shows the model flowchart created in ArcMap to complete the employment analysis. The model was created to iterate this process and generate a new table for each project.

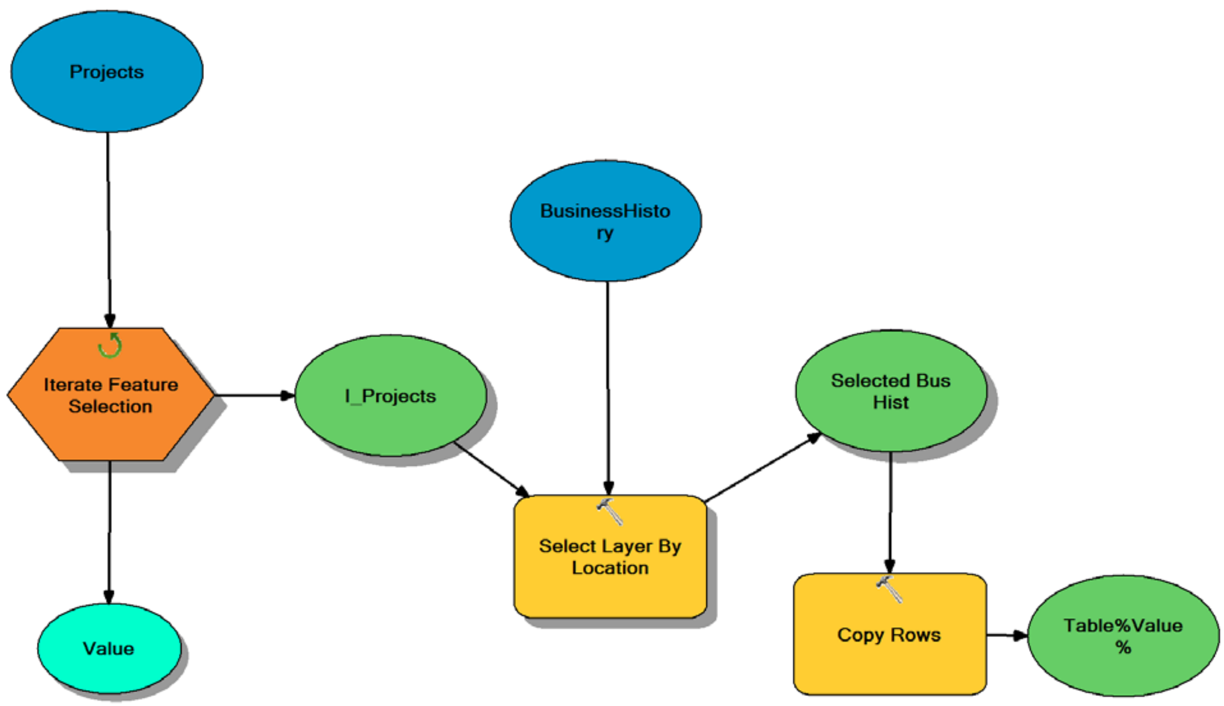

Figure 3-5: Model created in ArcMap used to complete analysis.

Running the model completed the business selection process for each project that was geo-referenced and created a table including all of the businesses that fell within a quarter-mile radius of each project. Using this table the number of jobs for each of these business were then averaged together for each year from 2000 to 2009. This information was then plotted, along with the year the project was completed and the employment trend both before and after the project was completed. A screenshot of the GIS program ArcMap 10.0 is shown in Figure 3-6. The screenshot shows the selected project, the quarter-mile radius buffer around it, and the selected businesses that lie within the buffer. Since the employment database only went through the fourth quarter of 2009, it was determined that projects completed in 2009 would not be included in the analysis because of insufficient post-construction data. This reduced the number of projects included in the employment analysis to 151.

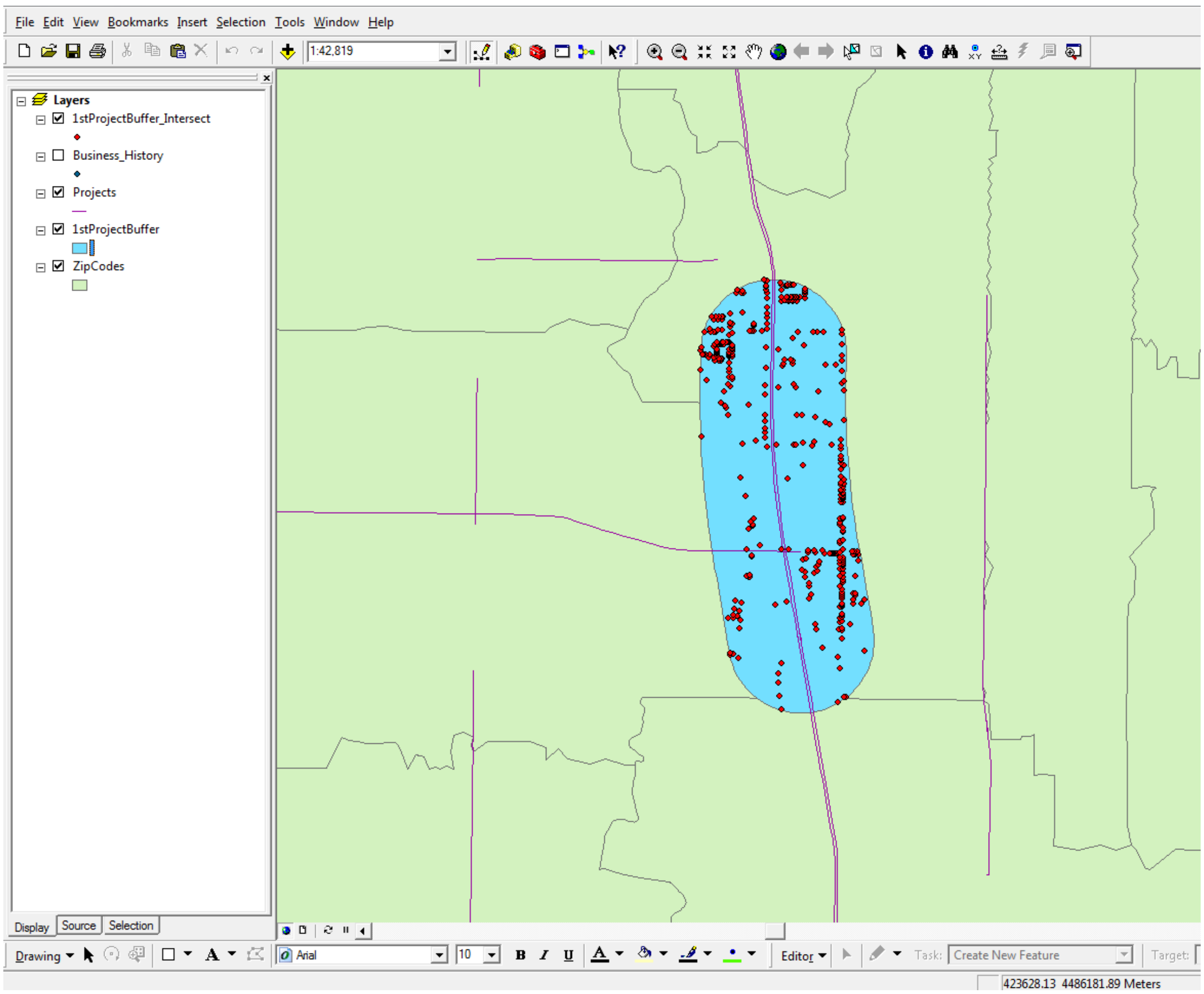

Figure 3-6: GIS Program with buffer and selected businesses.

An example of the analysis completed for each project is shown in Figure 3-7. This plot shows the number of employees over the last 10 years along Redwood Road from 9000 South to 10400 South in West Jordan, Utah. The project was a reconstruction project that widened the corridor to four lanes and is the same project used as an example for the sales tax analysis.

In Figure 3-7, there are three trends presented to describe employment in this area: 1) pre-construction (four years leading up to construction), 2) during construction, and 3) post-construction (four years after construction). Figure 3-7 shows a negative trend in the number of local employees per state employees before the beginning of construction. This means that the local area was experiencing an employment growth that was 3.5 percent less than the state. After the project was completed, this was reduced to just 0.1 percent less than the state.

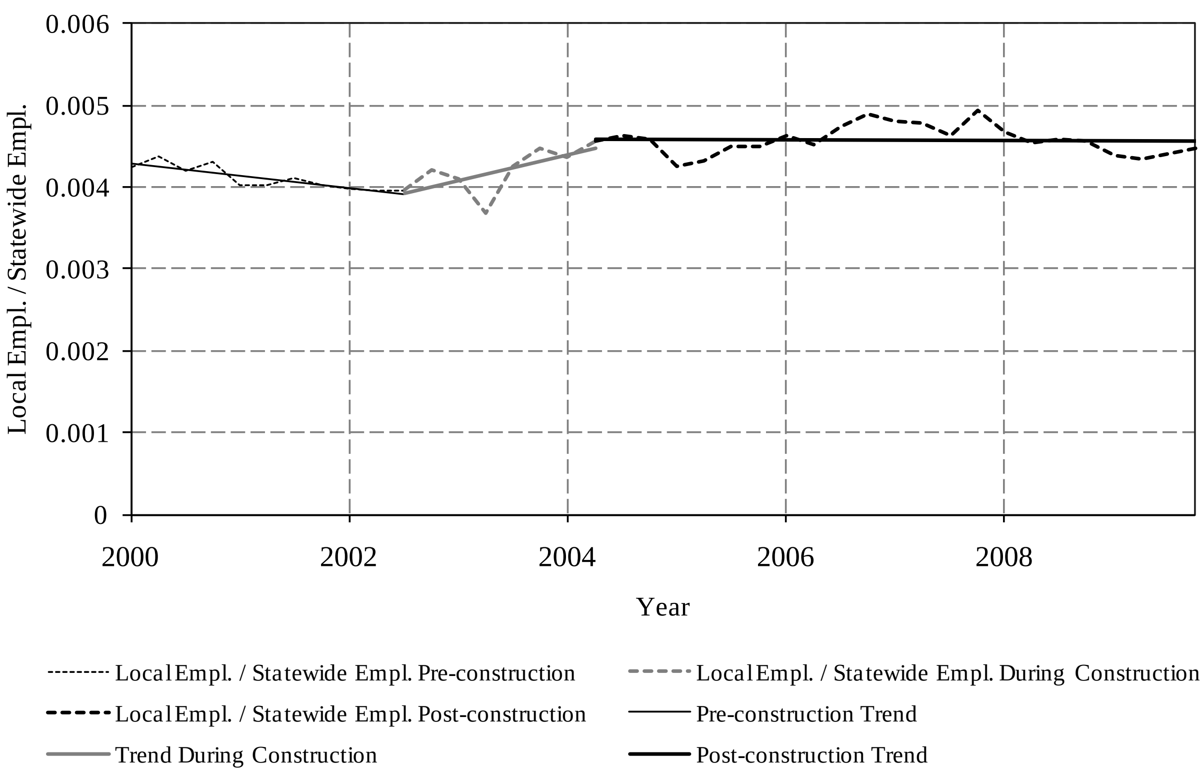

Figure 3-7: Number of employees near reconstruction project on Redwood Road.

The same analysis was completed for each geo-referenced project, and the charts and plots for each project are given in Appendix C. Using the completed analysis for each project, an overall average percent increase in employment after the completion of a transportation project was calculated.

3.5.3 VMT Analysis

The VMT data were used to determine the effects a transportation project would have on the amount of vehicular traffic on the roadway. More traffic will boost sales and create a more desirable location for retail outlets. AADT data obtained from UDOT (UDOT, 2010b) were used to calculate VMT and find the VMT data values that corresponded to specific transportation projects. This was done by writing an algorithm that would look up the route number and beginning and ending mile postings to determine which section of roadway was affected by the construction project. The corresponding VMT values were then gathered and plotted, normalized by the state totals. Since only projects in the project database that contained the route number and beginning and ending mileposts could be used, only 140 projects were analyzed.

The same reconstruction project used as an example in the sales tax and employment analyses will also be used to illustrate this methodology. The project was the reconstruction and widening to four lanes of Redwood Road in South Jordan, Utah. The VMT trends along this route were plotted, with trends describing the VMT: 1) pre-construction (four years leading up to construction), 2) during construction, and 3) post-construction. These three trends are depicted in the plot of VMT along this section of Redwood Road in Figure 3-8.

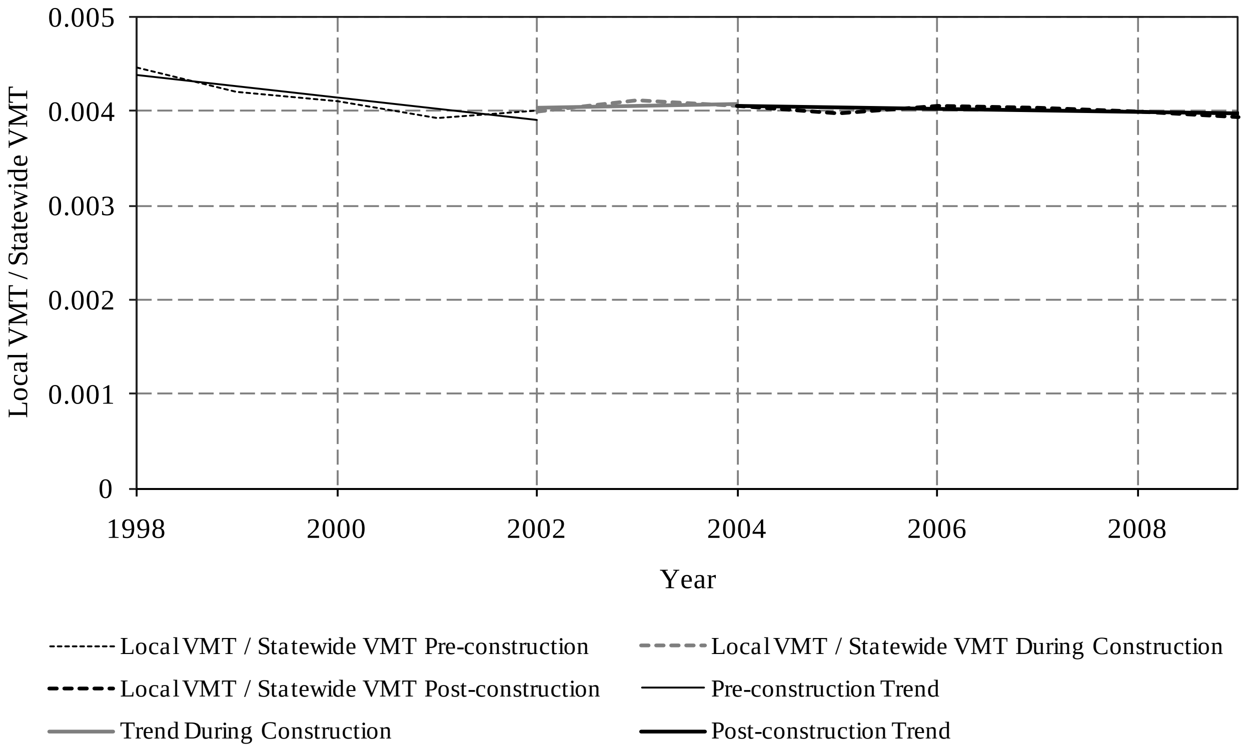

Figure 3-8: VMT totals for Redwood Road.

The VMT increase just before the project is -2.2 percent per year. After the project is completed the percent increase changes to -0.2 percent increase per year. This means that before the project was built, the VMT was growing at a rate 2.2 percent less than the state trend. After the project was completed, this was reduced to only 0.2 percent less than the overall state trend.

The same analysis was completed for each project in the project database that had the route name as well as beginning and ending mile postings of the construction project. Only 140 projects included the route name and beginning and ending mile postings recorded in the correct fields. The analyses for each of these projects are included in Appendix D.

3.6 Data Quality Concerns

The greatest difficulty encountered throughout the project was the lack of sufficient complete data available to the researchers. The project database provided by UDOT is an example of this. The database contained a list of 2,720 projects that were completed since the year 2000. When a project is completed, the project manager at UDOT is required to input relevant project information into a project database known as Electronic Program Management (ePM). This electronic database is used to track projects until they are closed. However, since the data input into the system by the project managers have not historically been checked for accuracy, there are numerous errors and missing information. A common error found in this database is the lack of complete location data. This is likely due to the fact that the project managers already know exactly where the project is because they have been working on it, and ePM is not typically used to locate projects. For these reasons, project managers often did not fill in the fields for beginning and ending mile posts or just entered 0 for both fields. This makes it very challenging to go back and locate the exact location of the project. The accuracy of recorded data has improved over time, so most of the usable projects come from the last 5 years.

The lack of location data prevented the researchers from geo-coding many of the projects into a GIS format. Of the 2,720 projects in the original project list, only 508 projects included enough information to be geo-coded into GIS. From there, all of the 2009 projects were eliminated due to insufficient post-construction data. This resulted in only 164 projects being included in the employment analysis. This sample was not randomly selected and may not be indicative of the state as a whole.

3.7 Summary

This chapter discusses the data and methods used to complete the analysis. The analysis presented in the chapter is an evaluative (or *ex post*) assessment of transportation projects after completion. A summary of the data and methods presented in this chapter is given here:

- There are numerous metrics that could be used to evaluate the economic impacts of transportation projects. For the purposes of this study the metrics used were: 1) sales tax, 2) employment, and 3) VMT.
- Sales tax data were acquired through the Utah State Tax Commission (Utah State Tax Commission, 2010). Employment data were obtained through Utah DWS (Utah DWS, 2010). VMT data were calculated from AADT information provided by UDOT (UDOT, 2010b). Project data were also obtained through UDOT (UDOT, 2010a).
- The recession and variability in the economy made it difficult to analyze pre- and post-construction trends on a project basis. This problem was accounted for by normalizing all data by totals for the state of Utah.
- The quality of the data was also discussed. Since the projects analyzed were not randomly selected, the results may not be indicative of the state as a whole.

The next chapter provides an in-depth look at the results of the analysis presented in this chapter as well as the relationship between transportation improvement projects and economic impacts.

4 RELATIONSHIPS BETWEEN TRANSPORTATION IMPROVEMENT PROJECTS AND ECONOMIC IMPACTS

Using the methodologies outlined in the previous chapter, an analysis was completed for each transportation improvement project. This chapter presents a summary of the findings for the sales tax analysis, the employment analysis, and the VMT analysis. A statistical analysis to determine if there is a significant difference between pre- and post-construction trends is also presented. These findings will then be broken down into project type and expenditure amounts. Since this study will provide a foundation for future assessment of the economic impacts of transportation projects, the process used to obtain the results is of significant importance and is discussed in detail.

4.1 Sales Tax Results

The sales tax results include an analysis of 331 total projects. The average, standard deviation, minimum, and maximum percent increase in sales tax before construction of the project (four years leading up to construction), as well as after the completion of each project, were calculated for each analysis. As much post-construction data as was available was used to calculate the post-construction trend (between 2 and 4 years). A summary of the results for all 331 projects analyzed is provided in Table 4-1. A list of all of the projects and their results used in the sales tax analysis is provided in Appendix B.

Table 4-1: Summary of Sales Tax Analysis

Sales Tax Analysis			
Number of Samples	331		
Measurement	**Average Pre-construction Trend**	**Average Post-construction Trend**	**Mean Difference**
Average	-0.89%	3.14%	4.03%
Standard Deviation	75.7%	39.6%	36.1%
Minimum	-1130.4%	-193.8%	936.6%
Maximum	158.3%	505.1%	346.8%

Table 4-1 indicates that the average sales tax trend increased from -0.89 percent before a transportation project was completed to 3.14 percent after a transportation project was completed. This means that a hypothetical project with these pre- and post-construction trends would have experienced a growth in sales tax that was 0.89 percent less than the state as a whole was experiencing in the four years before a transportation project was undertaken. After the project was completed, the sales tax in that area would have grown at a rate 3.14 percent faster than the state as a whole.

To determine if the results of this analysis were statistically significant, a statistical analysis was performed. A paired *t*-test was used to determine whether there was a difference between the pre- and post-construction trends. A paired *t*-test was used because the trends before and after construction are compared for a certain location. A plot of the trends before construction versus the trends after construction for each project is given in Figure 4-1. The plot shows there are a couple of outliers, but most were grouped tightly around 0 percent.

The null and alternative hypotheses of the paired *t*-test are as follows:

- H_o: Pre-construction trend = Post-construction trend
- H_A: Pre-construction trend < Post-construction trend

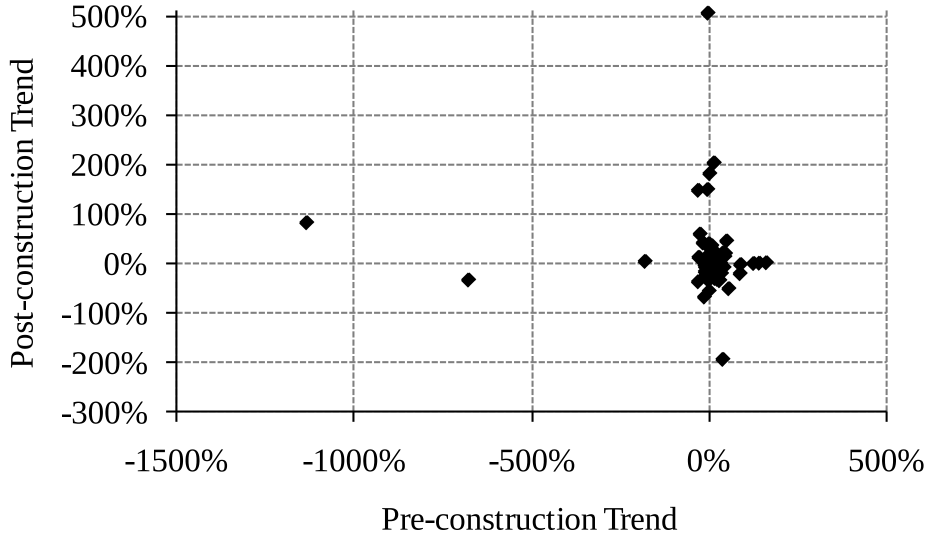

Figure 4-1: Plot of pre- and post-construction sales tax trends.

The results of the statistical analysis are summarized in Table 4-2. The estimates of both the pre- and post-construction trend values are the same as the averages reported in Table 4-1. The mean difference between the two is 4.03 percent. The *p*-value is 0.2039 and the confidence interval for the mean is between -5.54 percent and 13.60 percent. Since this confidence interval includes 0, it is possible that there actually is no difference between the two trends. The calculated *p*-value indicates that there is a 20.39 percent probability that the null hypothesis is true (which means there is a 79.61 percent probability that the alternative hypothesis is true and the post-construction trend is greater than the pre-construction trend).

Although this is not significant at a 95 percent confidence level, it still suggests that the local economy experienced a boost in sales tax revenues compared to the trend of the state as a whole. Economic variables fluctuate greatly, which often results in higher *p*-values in economic studies.

Table 4-2: Summary of Sales Tax Statistical Results

Measure	Value	Measure	Value
Estimate of Pre-construction Trend	-0.89%	N	331
Estimate of Post-construction Trend	3.14%	Correlation	-0.088
Mean Difference	4.03%	*t*-Ratio	0.8289
Standard Error	4.86%	Degrees of Freedom	330
Upper Confidence Level	13.60%	Probability H_o is True	20.39%
Lower Confidence Level	-5.54%	Probability H_A is True	79.61%

4.2 Employment Results

The employment results were derived from an analysis of 151 total projects. The average, standard deviation, minimum, and maximum percent increase in employment before construction of the project (four years leading up to construction) as well as after the completion of each project were calculated for each analysis. The employment increase per dollar spent on the project was also calculated for each project. A summary of the results for all 151 projects analyzed is provided in Table 4-3. A list of all of the projects and their results used in the sales tax analysis is available in Appendix C.

Table 4-3: Summary of Employment Analysis

Employment Analysis			
Number of Samples	151		
Measurement	**Average Pre-construction Trend**	**Average Post-construction Trend**	**Mean Difference**
Average	-3.45%	1.08%	4.53%
Standard Deviation	73.6%	11.5%	62.1%
Minimum	-828.1%	-30.5%	797.6%
Maximum	295.6%	59.1%	-236.5%

Table 4-3 shows that the average employment trend increased from -3.45 percent before a transportation project was completed to 1.08 percent after a transportation project was completed.

To determine if the results of this analysis were statistically significant, a paired *t*-test was used to determine whether there was a difference between the pre- and post-construction trends. A paired *t*-test was used because the trends before and after are paired for a certain location. A plot of the trends before and the trends after construction for each project is shown in Figure 4-2. The plot shows that there is only one outlier, while the rest of the samples cluster around 0 percent.

The null and alternative hypotheses of the paired *t*-test are as follows:

- H_o: Pre-construction trend = Post-construction trend
- H_A: Pre-construction trend < Post-construction trend

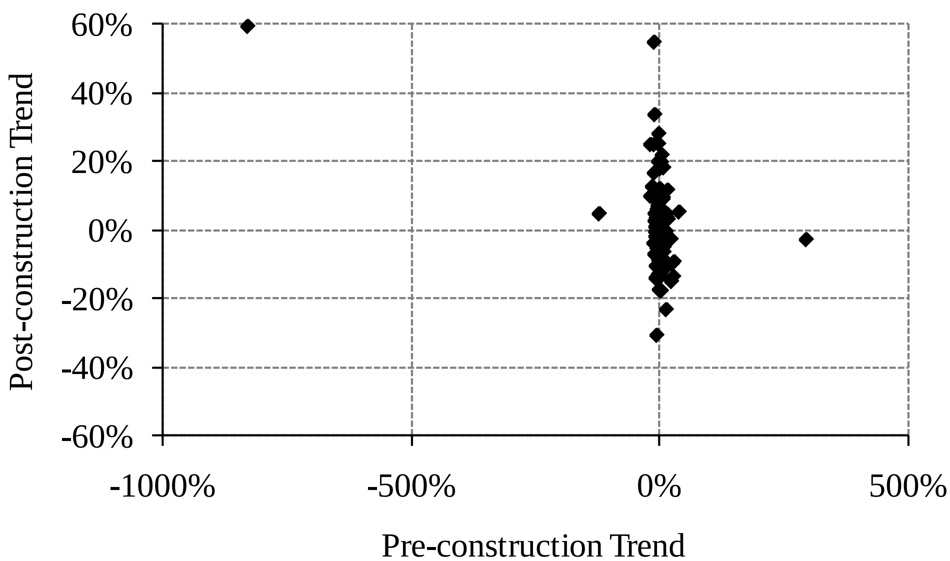

Figure 4-2: Plot of pre- and post-construction employment trends.

The results of the statistical analysis are summarized in Table 4-4. The estimates of both the pre- and post-construction trends are the same as the averages reported in Table 4-3. The mean difference between the two trends is 4.53 percent. The *p*-value is 0.2413 and the confidence interval for the mean is between -8.19 percent and 17.26 percent. Since this confidence interval includes 0, it is possible that there actually is no difference between the two trends. The calculated *p*-value indicates that there is a 24.13 percent probability that the null hypothesis is true (which means there is a 75.87 percent probability that the alternative hypothesis is true and the post-construction trend after is greater than the pre-construction trend).

Although this is not significant at a 95 percent confidence level, it again suggests that the local economy experienced a boost in employment compared to the state. Economic variables fluctuate greatly, which often results in higher *p*-values in economic studies.

Table 4-4: Summary of Employee Statistical Results

Measure	Value	Measure	Value
Estimate of Pre-construction Trend	-3.45%	N	151
Estimate of Post-construction Trend	1.08%	Correlation	-0.42
Mean Difference	4.53%	*t*-Ratio	0.7039
Standard Error	6.44%	Degrees of Freedom	150
Upper Confidence Level	17.26%	Probability H_o is True	24.13%
Lower Confidence Level	-8.19%	Probability H_A is True	75.87%

4.3 VMT Results

The VMT results were derived from an analysis of 140 total projects. The average, standard deviation, minimum, and maximum percent increase in VMT before construction of the project (four years leading up to construction), as well as after the completion of each project, were calculated for each project. A summary of the results for all 140 projects analyzed is provided in Table 4-5. A list of all of the projects and their results used in the sales tax analysis is available in Appendix D.

Table 4-5: Summary of VMT Analysis

VMT Analysis			
Number of Samples	140		
Measurement	**Average Pre-construction Trend**	**Average Post-construction Trend**	**Mean Difference**
Average	0.11%	0.09%	-0.02%
Standard Deviation	6.7%	7.3%	-0.6%
Minimum	-22.9%	-40.5%	-17.6%
Maximum	41.7%	35.2%	-6.5%

Table 4-5 shows that the average VMT trend stayed almost constant at around 0.11 percent both before and after a transportation project was completed.

To determine if the results of this analysis were statistically significant, a paired *t*-test was used to determine whether there was a difference between the pre- and post-construction trends. A paired *t*-test was used because the pre- and post-construction trends for a certain location. A plot of the pre- and post-construction trends for each project is given in Figure 4-3. The plot shows that there are no major outliers found in this analysis.

The null and alternative hypotheses of the paired *t*-test are as follows:

- H_o: Pre-construction trend = Post-construction trend
- H_A: Pre-construction trend < Post-construction trend

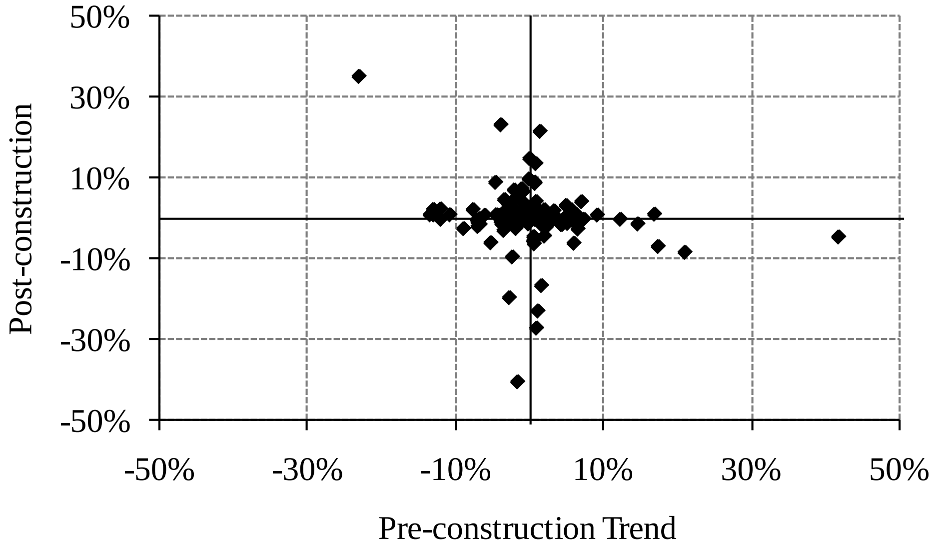

Figure 4-3: Plot of VMT pre- and post-construction trends.

The results of the statistical analysis are summarized in Table 4-6. The estimates of both the pre- and post-construction trend values are the same as the averages reported in Table 4-5. The mean difference between the two trends is essentially 0. The *p*-value is 0.5089 and the confidence interval for the mean is between -1.85 percent and 1.81 percent. This analysis shows that there is no difference between the pre- and post-construction trends in VMT. This is unexpected because it was anticipated that a transportation construction project would encourage additional vehicles on the road after completion. However, based on the analysis of the dataset used, VMT did not increase significantly in relation to overall VMT trends across the state after a project was constructed. It is expected that with a larger data set the VMT trend after a construction project may be larger than the state VMT trend.

Table 4-6: Summary of VMT Statistical Results

Measure	Value	Measure	Value
Estimate of Pre-construction Trend	0.11%	N	140
Estimate of Post-construction Trend	0.09%	Correlation	-0.21
Mean Difference	-0.02%	*t*-Ratio	-0.0222
Standard Error	0.92%	Degrees of Freedom	139
Upper Confidence Level	1.81%	Probability H_o is True	50.89%
Lower Confidence Level	-1.85%	Probability H_A is True	49.11%

4.4 Project Type Analysis

To better understand the trends associated with each project analysis, the trends were broken down into project type. UDOT officials identified six different categories of transportation projects. The project types, along with the subcategories that fit in them, include:

1. Signal and Light – Signal and Light
2. Maintenance – Grade and Drainage, Surfacing or Resurfacing, Roadway Work
3. Safety – Safety, Sign
4. Bridge – Bridge-Major Structure, Bridge-Minor Structure, Struct-Minor Structural Rehab
5. Reconstruction / Capacity – Reconstruction
6. Other – Other, Not Applicable, Railroad Related, Emergency Repairs, Sidewalk

4.4.1 Project Type Sales Tax Analysis

All 331 projects analyzed in the sales tax analysis were grouped into one of these six categories. The pre- and post-construction trends of each project were then averaged and are summarized in Table 4-7. Again, the trends represent the growth in the local area compared to the state as a whole. The table shows that reconstruction/capacity projects had the largest increase in trends compared to the state; however it also had the smallest sample size. Figure 4-4 shows the average change in trend for each project type in the sales tax analysis.

Table 4-7: Project-Type Sales Tax Analysis Summary

Type of Project	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
Signal and Light	12	5.4%	2.7%	-2.7%
Maintenance	132	5.4%	-0.9%	-6.3%
Safety	66	-3.8%	-2.1%	1.7%
Bridge	38	4.9%	22.6%	17.6%
Reconstruction / Capacity	11	-103.3%	15.3%	118.7%
Other	72	1.9%	3.4%	1.5%

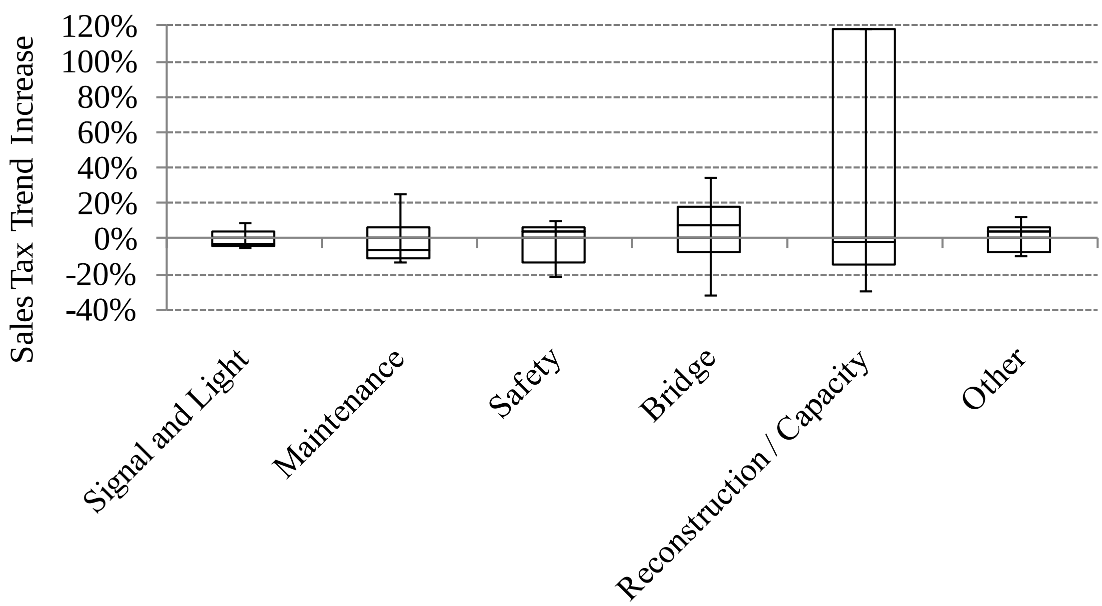

Figure 4-4: Sales tax project type change in trend results.

Figure 4-4 shows a box plot representing the mean and the 25th and 75th percentiles. Most of the project types showed a small and relatively equally sized box plot. However, the reconstruction/capacity project type included outliers that caused the average to be quite high. This project type requires additional samples to decrease the large variability shown in Figure 4-4.

4.4.2 Project Type Employment Analysis

The same project categories were used to sort the trends for the 151 projects analyzed in the employment analysis. The trends for local employment compared to state employment is shown in Table 4-8. The "Other" project category shows the greatest trend increase when looking at employment. "Signal and Light" and "Safety" project types also show a highly positive change in trends. Figure 4-5 shows the change in trend for each project type in the employment analysis and again shows box plots to depict the variability of the data. The "Other" project type showed the greatest amount of variability in the employment analysis.

Table 4-8: Project-Type Employment Analysis Summary

Type of Project	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
Signal and Light	2	3.9%	23.0%	19.1%
Maintenance	93	4.3%	0.9%	-3.4%
Safety	17	-8.7%	-0.4%	8.3%
Bridge	8	2.2%	-8.6%	-10.9%
Reconstruction / Capacity	6	2.6%	0.1%	-2.6%
Other	25	-32.5%	4.3%	36.8%

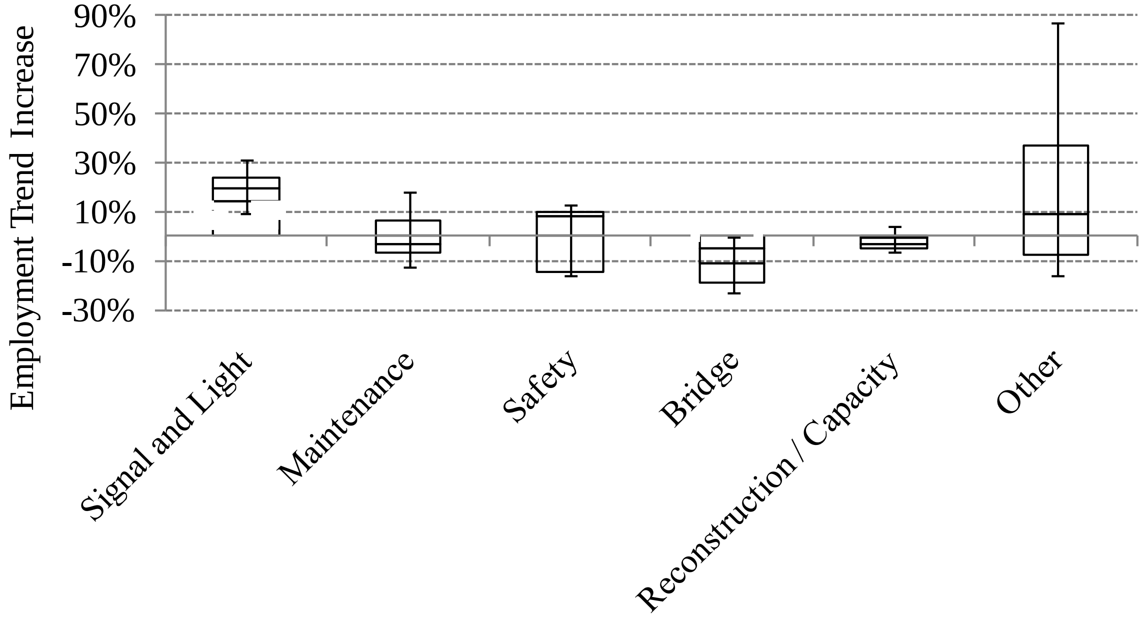

Figure 4-5: Employment project type change in trend results.

4.4.3 Project Type VMT Analysis

The 140 projects analyzed in the VMT analysis were also broken down into project categories. This is shown in Table 4-9. As noted in section 4.3, no significant difference was found in VMT trends before and after the completion of a transportation project. The values in Table 4-9 reflect this finding. Figure 4-6 shows the change in VMT trends with project type and depicts box plots to show the variability of the data. All of the project types show approximately equal variability and small ranges. All of the box plots show values above and below zero, indicating the true mean could fall somewhere in this range.

Table 4-9: Project-Type VMT Analysis Summary

Type of Project	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
Signal and Light	1	5.2%	-1.2%	-6.4%
Maintenance	83	-0.6%	-0.3%	0.3%
Safety	21	1.6%	1.0%	-0.6%
Bridge	5	1.8%	-3.5%	-5.3%
Reconstruction / Capacity	5	-0.6%	-4.6%	-4.1%
Other	25	0.7%	2.2%	1.5%

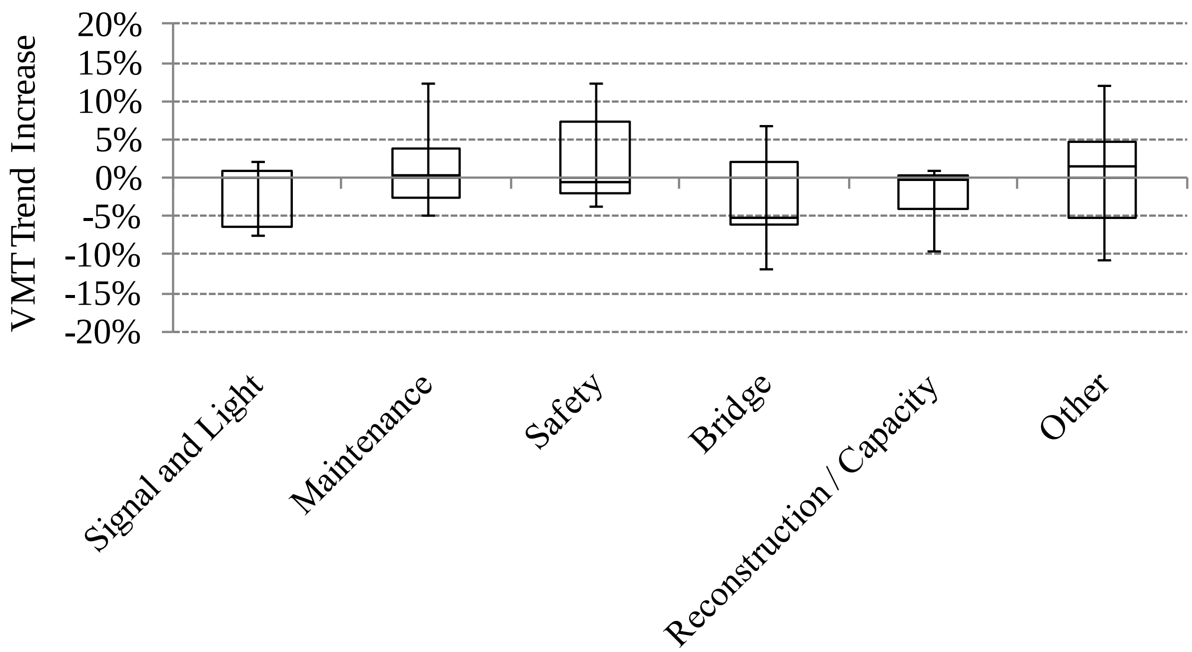

Figure 4-6: VMT project type change in trend results.

4.5 Expenditure Totals Analysis

The trends found in each analysis were also broken down into expenditure categories. This was done to determine whether a more expensive project would have more of an effect on the local economy. Larger expenditures indicate larger projects with potentially more influence on the surrounding area. The expenditures were broken down into four groups:

1. Expenditures of less than 2 million dollars
2. Expenditures between 2 million and 5 million dollars
3. Expenditures between 5 million and 20 million dollars
4. Expenditures greater than 20 million dollars

4.5.1 Expenditure Totals Sales Tax Analysis

All 331 projects analyzed in the sales tax analysis were categorized into one of the four categories identified. The average pre- and post-construction trends compared to the state were calculated for each project. The average change in trend was also calculated. These values are shown in Table 4-10. The largest trend increase is shown in projects with expenditures between 2 million and 5 million dollars. All categories showed an increase except for projects with expenditures greater than 20 million dollars. Although this is unexpected, it may be due to the small sample size of projects that were analyzed (only 10). It is expected that with a larger sample size, the change in sales tax trends would become positive for projects with expenditures greater than 20 million dollars. The results of the expenditure amount categories for employment are shown in Figure 4-7.

Table 4-10: Expenditure-Amount Sales Tax Analysis Summary

Expenditures	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
< 2,000,000	222	2.8%	4.1%	1.2%
> 2,000,000 and < 5,000,000	64	-15.4%	-1.1%	14.2%
> 5,000,000 and < 20,000,000	35	1.2%	6.6%	5.4%
> 20,000,000	10	2.2%	-1.9%	-4.1%

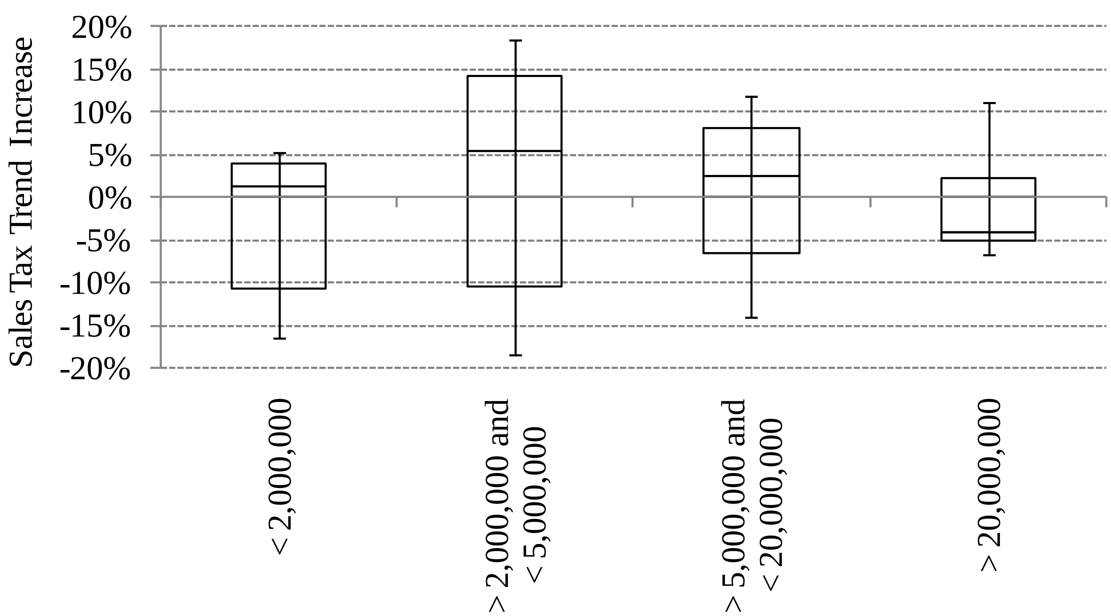

Figure 4-7: Sales tax expenditure amount results.

4.5.2 Expenditure Totals Employment Analysis

The same expenditure categories were used in grouping the 151 total projects included in the employment analysis. The trends compared to the state before and after construction were calculated, as well as the trend increase for each category. These values are shown in Table 4-11. Projects with expenditures smaller than 2 million dollars experienced the greatest trend increase with almost 10 percent difference. Box plots for the results of the expenditure amount categories for employment are shown in Figure 4-8 and depict little variability. The project expenditure category of less than 2 million dollars shows the greatest spread.

Table 4-11: Expenditure-Amount Employment Analysis Summary

Expenditures	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
< 2,000,000	83	-8.4%	1.4%	9.8%
> 2,000,000 and < 5,000,000	35	4.1%	0.3%	-3.8%
> 5,000,000 and < 20,000,000	25	0.3%	0.8%	0.5%
> 20,000,000	8	0.9%	1.6%	0.7%

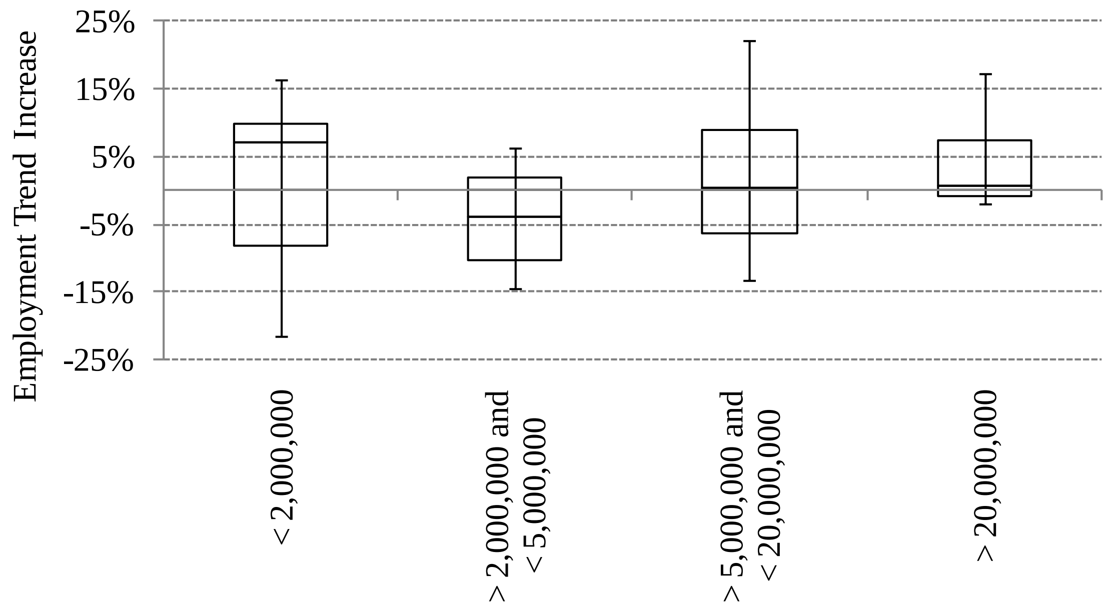

Figure 4-8: Employment expenditure amount change in trend results.

4.5.3 *Expenditure Totals VMT Analysis*

The same process was used to analyze the 140 projects included in the VMT analysis. The average pre- and post-construction trends compared to the state were calculated. The trend increase was also calculated. These values are shown in Table 4-12. The projects with the greatest expenditures saw the greatest increase in traffic compared to the state, which was expected. The category of projects with less than 2 million dollars in expenditures was the only category that saw a slight decrease in trends. The results of the expenditure amount categories for employment are shown in Figure 4-9. The box plots indicate that there is very little variability in the VMT results. The spread for each expenditure category is relatively small, with the less than 2 million dollars in expenditures category showing the largest spread. The entire spread for the greater than 20 million dollars in expenditures category was completely above zero, indicating that the true mean for this category is almost certainly positive.

Table 4-12: Expenditure-Amount VMT Analysis Summary

Expenditures	Number of Projects	Pre-construction Trend	Post-construction Trend	Trend Increase
< 2,000,000	90	0.6%	0.0%	-0.7%
> 2,000,000 and < 5,000,000	21	-0.4%	0.1%	0.5%
> 5,000,000 and < 20,000,000	23	-0.7%	0.3%	1.0%
> 20,000,000	6	-2.5%	1.4%	3.9%

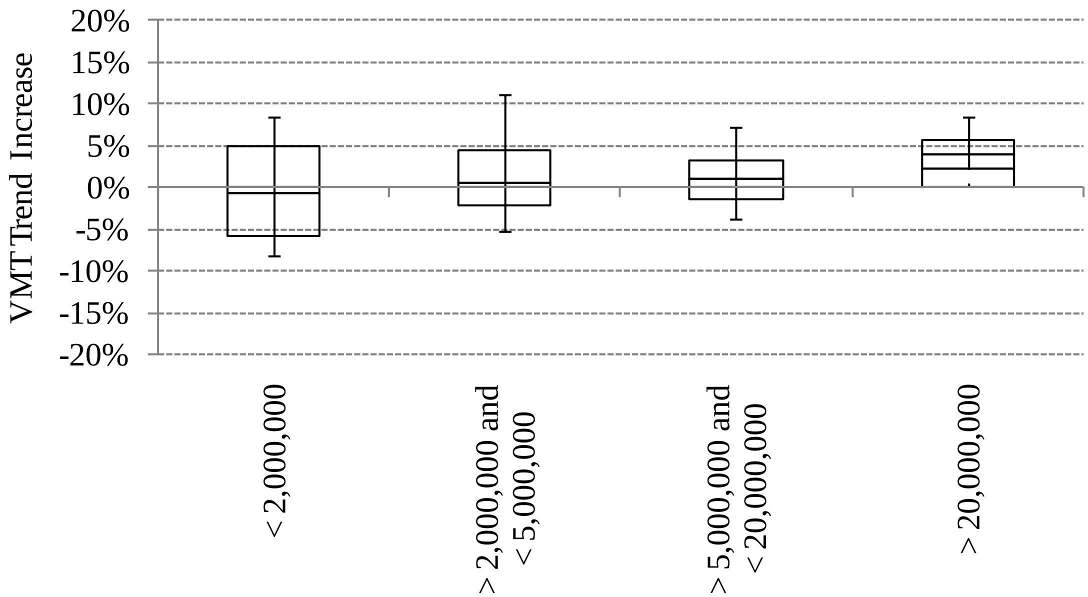

Figure 4-9: VMT expenditure amount change in trend results.

4.6 The Analysis Process

The analysis presented in this chapter provides a strong starting point to understand the economics of transportation in Utah. The results, however, are limited by the availability of complete data sets for analysis. As such, in addition to reports on the findings of the analysis performed, it is important to establish a formal process by which the economic impacts of transportation projects in Utah can be understood.

The process developed in this study can be used to further improve the understanding and refine the relationships found in this study between transportation and economic impacts. As more complete data are acquired, this analysis process can be followed again to gather more refined results.

The sales tax, employment, and VMT analyses performed in this study followed similar steps. These steps have been defined, and a flow chart has been created that outlines these steps. Although the sales tax and VMT analyses did not require the use of GIS to complete the analysis in this study, future analyses with more disaggregate data would be more easily completed in GIS. Figure 4-10 shows the flowchart outlining the steps followed in the analysis. The six steps that should be followed in each analysis are outlined as:

1. Collect economic impact metric data and project information,
2. Geo-code the metric data and project information into a GIS database,
3. Use GIS model to gather all metric data located within a locally specified (quarter-mile in this analysis) radius of each project,
4. Normalize the metric data by state data to account for variability in the economy,
5. Calculate pre- and post-construction trends of transportation project using a timeframe determined by the local jurisdiction (four years in this analysis), and
6. Compare trends for singular project analysis or use matched pairs *t*-test for multiple projects to determine if the trend after completion is significantly different from before construction.

The correct data is very important for future analyses. Sales tax on a disaggregate level would be extremely helpful and employment information is also vital for future analyses. It is recommended that UDOT maintain a relationship with the Utah State Tax Commission and Utah DWS to ensure access to these valuable databases.

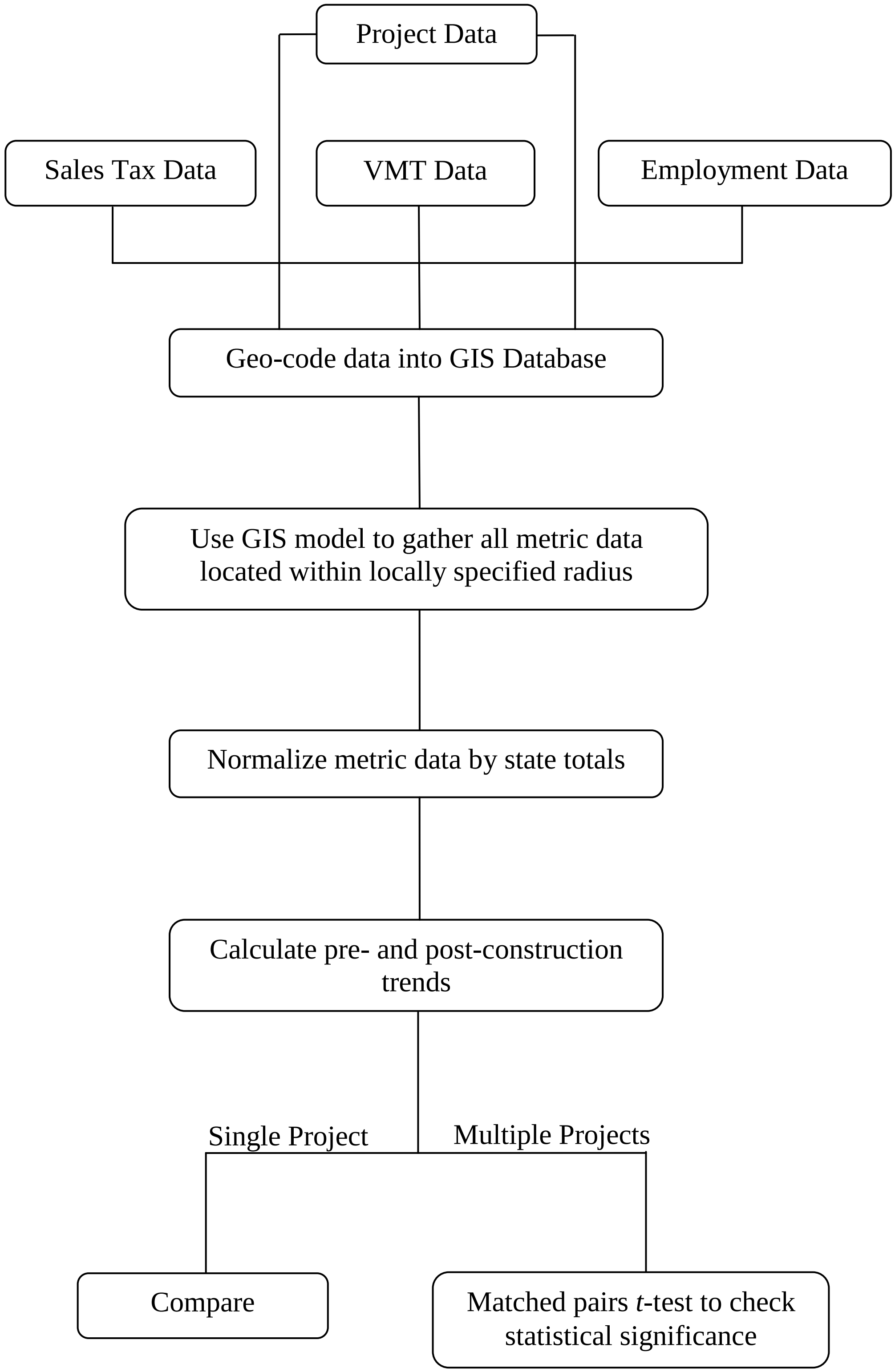

Figure 4-10: Flowchart of analysis process.

VMT is important to business owners because more traffic that passes the business means more revenue and exposure. Although the analysis completed in this project did not indicate a difference in VMT before and after a transportation project is completed, VMT is still important in the economic local economy and should be included in future evaluations. It is expected that with a larger data set an increasing trend compared to the state in VMT after a project is completed would be found. UDOT already collects AADT information, which can be quickly converted to VMT.

Once access to these datasets is acquired, the simplest method would be to input each dataset into a GIS database. This was not done for sales tax and VMT in this study because sales tax was only available by zip code, which allowed the researchers to associate sales tax to project by the corresponding zip code, and VMT was easily determined by route.

Once all of the data are in a GIS database, a model can be created that will include all pertinent information in a quarter-mile (or other locally determined) radius around the project. This corridor-specific information will allow for much more accurate analysis. The metric data should then be normalized by the state totals to account for variations in the economy. Three to four years previous to the construction of the project and three to four years after the project is completed is necessary to calculate accurate trends. A simple comparison of pre- and post-construction trends will show how the local economy was affected by the transportation project. If numerous projects are analyzed, a matched pairs *t*-test can be used to determine if there is a significant difference between the trends before construction and after construction.

The key to this process is having the correct data. The importance of the sales tax data has already been mentioned. Quality project data are also essential. Without good information on each project, an accurate analysis is not possible. This includes route number, mile postings, expenditures, construction begin and end dates, project type, and additional information required by ePM. Requiring Global Positioning System (GPS) coordinates would make geo-coding the projects even simpler.

UDOT is currently entering AADT information into a system called UPlan, a web-based application that allows users to view environmental, social, historical, and transportation-related data. UPlan looks and works similar to a GIS program; however, complex analysis is not yet possible with this application. If the appropriate analysis capability is developed for UPlan, then this application could be used to complete the sales tax, employment, and VMT analyses. If not, GIS software should be used to complete the analysis as shown in the outlined steps.

4.7 Summary

This chapter outlines the results of the analysis presented in Chapter 3 and identifies some general relationships between transportation projects and the economy. A summary of the findings are presented here:

- The sales tax analysis found a 4.03 percent increase between the trend before and the trend after a project was completed compared to the state trend. A matched pairs *t*-test on the difference between the trends resulted in a *p*-value of 0.2039.
- The employment analysis found a 4.53 percent increase between the pre- and post-construction trends. A matched pairs *t*-test on the difference between the trends resulted in a *p*-value of 0.2413.
- The VMT analysis found that there was no significant difference between the pre- and post-construction trends compared to the state trend. A matched pairs *t*-test on the

difference between the trends resulted in a *p*-value of 0.5089. An increasing VMT trend compared to the state is expected with a larger sample size.

- A summary of the results is shown in Table 4-13.

Table 4-13: Statistical Findings Summary

Statistical Analysis					
Analysis	**Number of Samples**	**Average Pre-construction Trend**	**Average Post-construction Trend**	**Mean Difference**	***p*-value**
Sales Tax	331	-0.89%	3.14%	4.03%	0.2039
Employment	151	-3.45%	1.08%	4.53%	0.2413
VMT	140	0.11%	0.10%	-0.01%	0.5089

- The project type sales tax analysis showed the largest trend increase compared to the state in the “Reconstruction / Capacity” type projects.
- The project type employment analysis showed the largest trend increase compared to the state in the “Other” type projects.
- The project type VMT analysis showed minimal trend increases compared to the state.
- The expenditure-category sales tax analysis showed the largest trend increase compared to the state in projects with 2 million to 5 million dollars in expenditures.
- The expenditure category employment analysis showed the largest trend increase compared to the state in projects with less than 2 million dollars in expenditures.
- The expenditure category VMT analysis showed the largest trend increase compared to the state in projects with greater than 20 million dollars in expenditures.

- A major part of this study is to establish a formal process by which the economic impacts of transportation projects in Utah can be understood. Complete and accurate data are important to ensure the accuracy of the results.
- The analysis process is outlined in the following six steps:
    1. Collect economic impact metric data and project information,
    2. Geo-code the metric data and project information into a GIS database,
    3. Use GIS model to gather all metric data located within a locally specified (quarter-mile in this analysis) radius of each project,
    4. Normalize the metric data by state data to account for variability in the economy,
    5. Calculate pre- and post-construction trends of transportation project using a timeframe determined by the local jurisdiction (four years in this analysis), and
    6. Compare trends for singular project analysis or use matched pairs *t*-test for multiple projects to determine if the trend after completion is significantly different from before construction.

The final chapter provides conclusions and recommendations from this study.

5 CONCLUSIONS AND RECOMMENDATIONS

Transportation projects influence the economy in a variety of ways. Understanding the economic impacts of transportation projects in Utah is essential for decision-makers, officials, and stakeholders as they determine the best course of action for the state. Economic impacts can guide decisions on future projects and help explain past economic fluctuations. It is important to follow an accurate process that can be used to identify the economic impacts of transportation projects and further refine that process to increase the understanding of economic impacts of transportation projects in Utah. The objectives of this study were:

- Identify types of economic development impacts and provide a better understanding of the economic impacts of transportation projects in Utah.
- Identify how transportation affects a community in terms of economic development impacts (increased sales tax revenue, job growth).
- Identify the correlation (if there is a correlation) between traffic volume and an area or region affected by transportation improvement projects.
- Identify economic impacts that can be measured and the parameters used to measure these impacts.

Accomplishing the objectives of this study are a product of: 1) performing a comprehensive literature review, 2) collecting data and establishing analysis methods, 3) completing a statistical analysis and breakdown of data into project type and expenditure values, 4) developing conclusions and recommendations, and 5) providing possible avenues for future research to further the understanding of the economic impacts of transportation projects in Utah.

5.1 Conclusions and Recommendations

The results of this study indicate that there is a positive relationship between transportation improvement projects and sales tax revenues. This relationship amounts to approximately a 4 percent increase in trends compared to the state overall. Employment also showed a positive relationship with transportation improvement projects. Employment demonstrated a 4.5 percent increase compared to the state overall. As further analysis with more complete data is done, the exact nature of these relationships can be refined. The VMT analysis showed that there was no difference in the pre- and post-construction trends. Again, further analysis should be done to examine the effects of transportation projects on VMT.

This study has prompted several recommendations intended to help UDOT better understand the economic impacts of transportation projects in Utah. Although this analysis provided a strong foundation and outlined a process to analyze economic impacts from transportation projects in Utah, additional studies need to be completed. Recommendations include the following:

- UDOT should continue to refine the data input process for the ePM database to ensure that accurate project information and complete location data are being entered into the system.
- UDOT should require that GPS coordinates be gathered for each project and recorded in the ePM database. This would provide exact and accurate location data and simplify the geo-coding process.

- UDOT should continue to develop and strengthen their relationship with Utah DWS. Extending their current MOA to exchange employment information would be extremely beneficial to UDOT in continuing their analysis of the economic impacts of transportation projects in Utah.
- UDOT should develop and cultivate a relationship with the Utah Tax Commission that would allow UDOT to have access to sales tax data at a more disaggregate level to improve the accuracy and relevance of the sales tax analysis.
- UDOT should continue to collect AADT information on all state routes and record this in UPlan. VMT information should be calculated from AADT and recorded as well.
- UDOT should geo-code the sales tax, employment, and VMT data into a GIS database for further analysis. If appropriate analysis capabilities were developed for UPlan, this could be done directly in UPlan.
- Once a large sample of complete data have been collected for three to four years previous to the beginning of a transportation project of interest and three to four years after completion, the sales tax, employment, and VMT analyses should be completed as outlined in this report.

5.2 Future Research

The analysis and process developed in this report provide a strong foundation and basic understanding of the economic impacts of transportation projects in Utah. As an analysis of this type has never been completed for the state of Utah, it is inevitable that changes and improvements should be made to the process. Some ideas for future research on this subject include the following:

- Continue to monitor the economics of the state of Utah as well as economic studies produced by other states to determine if additional variables should be analyzed and if changes need to be made to the analysis process.
- Develop a complete and accurate method to calculate the sales tax revenue increase per dollar spent on a transportation improvement project.

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APPENDIX A. LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
BYU	Brigham Young University
BRT	Bus Rapid Transit
CD	Compact Disk
CSI	Cambridge Systematics, Inc.
DOT	Department of Transportation
EDRG	Economic Development Research Group, Inc.
EIA	Economic Impact Analysis
EIS	Environmental Impact Study
ePM	Electronic Program Management
FHWY	Federal Highway Administration
HERS-ST	Highway Economic Requirements System-State version 2.0
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
GOED	Governor’s Office of Economic Development
GOPB	Governor’s Office of Planning and Budget
GSP	Gross State Product
I-O	Input-Output
KDOT	Kansas Department of Transportation
LRP	Long-Range Plan
MAG	Mountainland Association of Governments
MIS	Major Investment Study
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
REMI®	Regional Economic Modeling, Inc.
RIMS II	Regional Input-Output Modeling System
STEAM	Surface Transportation Efficiency Analysis
TFP	Total-Factor Productivity
TRB	Transportation Research Board
TREDIS®	Transportation Economic Development Impact System
TTI	Travel Time Index
UDOT	Utah Department of Transportation
UTA	Utah Transit Authority
v/c	Volume to capacity ratio
VMT	Vehicle Miles Traveled
WFRC	Wasatch Front Regional Council

APPENDIX B. RESULTS OF SALES TAX ANALYSIS

The sales tax analysis was completed using Microsoft Excel, with a single file for each project. Due to the large number of projects analyzed, these Excel files are stored on an attached compact disk (CD) on the back cover. Appendix B is found in the folder entitled Appendix B: Results of Sales Tax Analysis. The folder is organized first into year (2004 – 2008) and then into project type (bridge, maintenance, other, reconstruction-capacity, safety, and signal and light). For electronic copies, this information can be found in the BYU Harold B. Lee Library - Special Collections.

APPENDIX C. RESULTS OF EMPLOYMENT ANALYSIS

The employment analysis was completed using Microsoft Excel, with a single file for each project. Due to the large number of projects analyzed, these Excel files are stored on an attached CD on the back cover. Appendix C is found in the folder entitled Appendix C: Results of Employment Analysis. The folder is organized first into year (2004 – 2008) and then into project type (bridge, maintenance, other, reconstruction-capacity, safety, and signal and light). For electronic copies, this information can be found in the BYU Harold B. Lee Library - Special Collections.

APPENDIX D. RESULTS OF VMT ANALYSIS

The VMT analysis was completed using Microsoft Excel, with a single file for each project. Due to the large number of projects analyzed, these Excel files are stored on an attached CD on the back cover. Appendix D is found in the folder entitled Appendix D: Results of VMT Analysis. The folder is organized first into year (2004 – 2008) and then into project type (bridge, maintenance, other, reconstruction-capacity, safety, and signal and light). For electronic copies, this information can be found in the BYU Harold B. Lee Library - Special Collections.