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Benefits of Highway Improvements on Rural Communities in Missouri:

Economic Development Considerations

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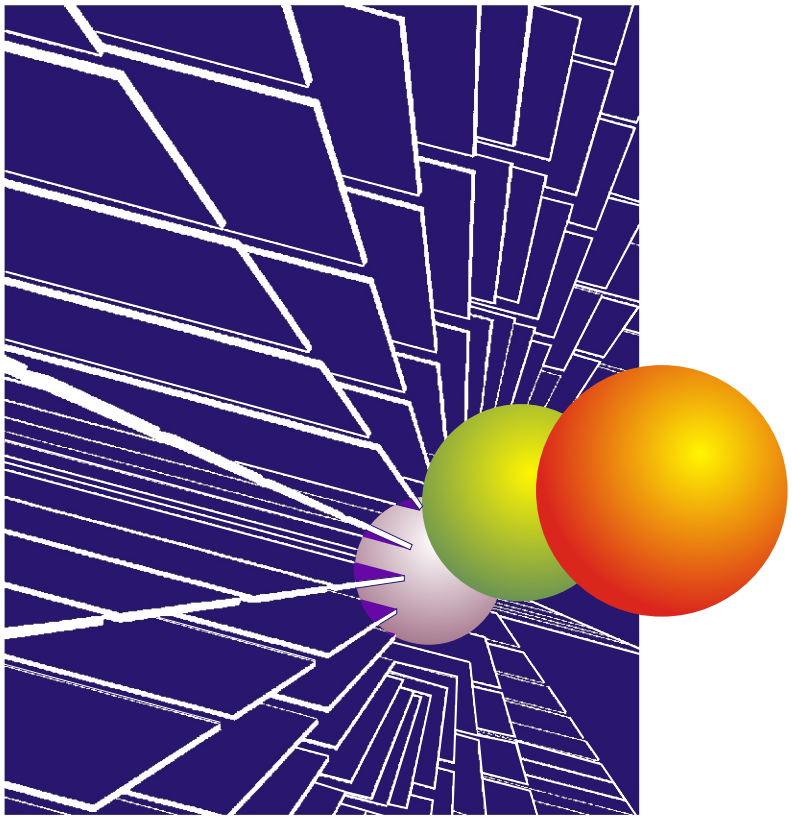

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Benefits of Highway Improvements on Rural Communities in Missouri: Economic Development Considerations

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16. Abstract A brief examination of the effects of highway improvements on the economic sector of rural Missouri counties. Sixty-five rural counties with four lane highways (maintained by MODOT) are included in the regression analysis with multiple indicators of economic change. Results indicate little benefit from highway improvement, as defined for this study, exist for rural counties.			
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General Findings

- At the county level, where this preliminary analysis is completed, the impact of highway improvement on the economic status of rural areas is small. On only a few indicators did an increase in four lane highway mileage have any measurable impact and, even then, the effect was pretty small.

- Based on MoDOT data, forty of 105 Missouri counties classified as "rural" for this study had no four lane improved highways within their borders in 2000.

- There is a highly related cluster of indicators (generally associated with economic development) represented by population change, new business growth, gross sales tax receipts and real estate valuations. These indicators are so highly related to one another as to represent the same economic phenomena rather than different phenomena.

- There is also an interesting set of relationships represented by the differences between the individual-level indicators like average wages earned and household income and the community-level indicators like gross sales tax receipts and real estate valuations. Overall, there appear to be two different dimensions in these relationships among economic development indicators.

- The unemployment rate indicator behaves as expected, recording negative relationships with the positive changes in other economic indicators. In other words, unemployment rates decline as economic conditions improve as would be expected.

- The changes in economic indicators signify general improvements across the board for the past decade. There are indications that some counties in Missouri saw the number of businesses decline along with population and real estate valuations. In some counties the change in unemployment was substantial while in others, significant employment was created (decreasing the change in unemployment rate by over 200%).

- Rural counties without four lane highways appeared to "hold their own" on most measures investigated, but lagged behind those counties with four lane highways on sales taxes generated and real estate valuations.

Impact of Highway Improvements on Rural Communities in Missouri: Economic Development Considerations

Purpose and Design of Study

The question of the impact of highway improvements on the economic status of people living in rural areas is an important one for many reasons. For policy makers and program managers, knowing the likely effects of specific program investments is helpful in allocating scarce resources. University of Missouri researchers on this project were asked to explore, in limited ways, this effect to see if the impacts of improved highways on economic factors could be determined in such a way so as to guide future decision making.

The primary interest of MoDOT was to determine this impact for rural areas of the state. Even though Missouri has several large metropolitan areas, it also has a large rural population living in small communities and in unincorporated rural areas. Such dispersal places a premium on decisions regarding the resources available to MoDOT for highway improvements in these areas as the cost per person served increases at a rapid rate for low density populations.

For the purposes of this report, "highway improvement" was defined as the widening of two lane to four lane roads. Researchers compiled data on the number of road miles of four lane roads in each county in 1990 and 2000. These data were compiled from MoDOT reports. The number of miles used includes interstate highway miles. The rural counties (105) were divided into two groups. One group of 40 counties had less than one mile of four lane highway in 1990. The second group consists of the remaining rural counties (outside the core MoDOT MPO designations). This distribution of mileage data was used to frame the analysis by examining the effect of highway improvements in those counties where four lane highways actually existed in 1990.

Highway improvement is a difficult concept for which to develop useful indicators as the possible interpretations are numerous. As with this study, "improvements" were interpreted as widening a two/three lane highway to four lanes. While certainly an "improvement," there may be other aspects of highway infrastructure that might also constitute an improvement important for economic development purposes such as installing interchanges on a four lane highway previously designed for "at grade" access points. Further, it is reasonable to think that improvements lag behind the "need" so that improvements always follow development activity in time (rather than proceed them). If this were the case, then the kind of empirical study done here is not very useful. Instead, it might be argued that the benefits of highway improvement are directly related to specific (and, hopefully, demonstrated needs) thus making it possible to focus a study design on determining if the specific need documented—and for which the improvement was designed to accommodate—was, in fact, resolved adequately. Nevertheless, in the following study the 1990 figures were used for analysis of 2000 level changes in the context established in the MODOT task order and because we argue it takes at least that long for most of the changes to become manifest on the ground and in the data.

Economic conditions were determined by using a variety of factors. It is generally acknowledged that economic development happens unevenly (when explored between sectors of the economy

and geographic regions). It is also recognized that economic changes can be reflected in the income of workers, the number of businesses in place, the "value added" from those businesses and workers, and a number of other similar factors. Each such indicator measures a slightly different aspect of the economy. Further, while access to transportation infrastructure is considered an important factor in location decisions by commercial firms—and increasingly by a mobile work force that frequently commutes to work—there are many other factors considered by businesses when making a decision to locate in or stay in a location. Such factors might include tax structure, work force availability and skill levels, amenities for managers and workers, relationships with suppliers and markets, as well as many other factors. In sum, considerable research has shown that economic development for rural places is a difficult challenge and one where success is infrequent, especially for those sectors of the economy where new job growth tends to be highest. This is because rural areas are known to lag behind urban areas in the "growth sectors" of the economy such as high technology industries. Instead, rural areas tend to attract commercial firms that are in the "mass production" phase of a technology innovation rather than the "market development" phase. Finally, there is some evidence suggesting that the conventional infrastructure needs for "knowledge economy businesses" is rather low on the list of priority needs considered by commercial firms in making their business decisions.

The selection of all indicators was coordinated with a MODOT advisory panel of agency representatives. Several hours of discussion followed by explorations of the kind of data actually available for use in this kind of study determined that miles of four lane highway (as determined by roadway width) was the best available indicator.

The analysis completed provides only an initial, preliminary effort to determine what impacts the improvement of highways may have on rural communities and regions in Missouri. As the report shows, the effects measured are small. This result likely indicates the need to make a number of improvements to the approach used, including expanding the analysis to include more factors besides highway improvements so as to determine the relative contribution such improved infrastructure makes to economic (social, environmental, fiscal, etc.) conditions in rural areas.

Distribution Of Four Lane Mileage For Missouri Rural Counties

As in the first column of Table 1, there are forty counties with no four-lane highway mileage present in 1990. In the second column there are sixty-five counties. All the "core" counties in MoDOT's MPOs were eliminated (Boone, Buchanan, Greene, Jackson, Jasper, St. Charles, and St. Louis (city and county) along with Clay and Jefferson counties (as highly urbanizing counties). The map on page 8 of this report illustrates the spatial aspects of the distribution of four lane highways in rural counties.

Table 1. **Distribution Of Four Lane Mileage For Missouri Rural Counties**

Counties <u>without</u> four-lane highways (N = 40)	**Counties <u>with</u> (1 to 55 miles of) four lane highways (N = 65)**	
Adair, Audrain, Barry, Benton, Bollinger, Carter, Cedar, Chariton, Clark, Dade, Dallas, Dent, Douglas, Gasconade, Gentry, Hickory, Howard, Iron, Knox, Maries, McDonald, Mercer, Moniteau, Monroe, Morgan, Osage, Ozark, Putnam, Reynolds, Ripley, Schuyler, Scotland, Shannon, Shelby, St. Clair, Stone, Sullivan, Washington, Wayne, Worth	Andrew, Atchison, Barton, Bates, Butler, Caldwell, Callaway, Camden, Cape Girardeau, Carroll, Cass, Christian, Clinton, Cole, Cooper, Crawford, Daviess, DeKalb, Dunklin, Franklin, Grundy, Harrison, Henry, Holt, Howell, Johnson, Laclede, Lafayette, Lawrence, Lewis, Lincoln, Linn, Livingston, Macon,	Madison, Marion, Miller, Mississippi, Montgomery, Newton, New Madrid, Nodaway, Oregon, Pemiscot, Perry, Pettis, Phelps, Pike, Platte, Polk, Pulaski, Ralls, Randolph, Ray, Saline, Scott, St. Francois, Ste. Genevieve, Stoddard, Taney, Texas, Vernon, Warren, Webster, Wright

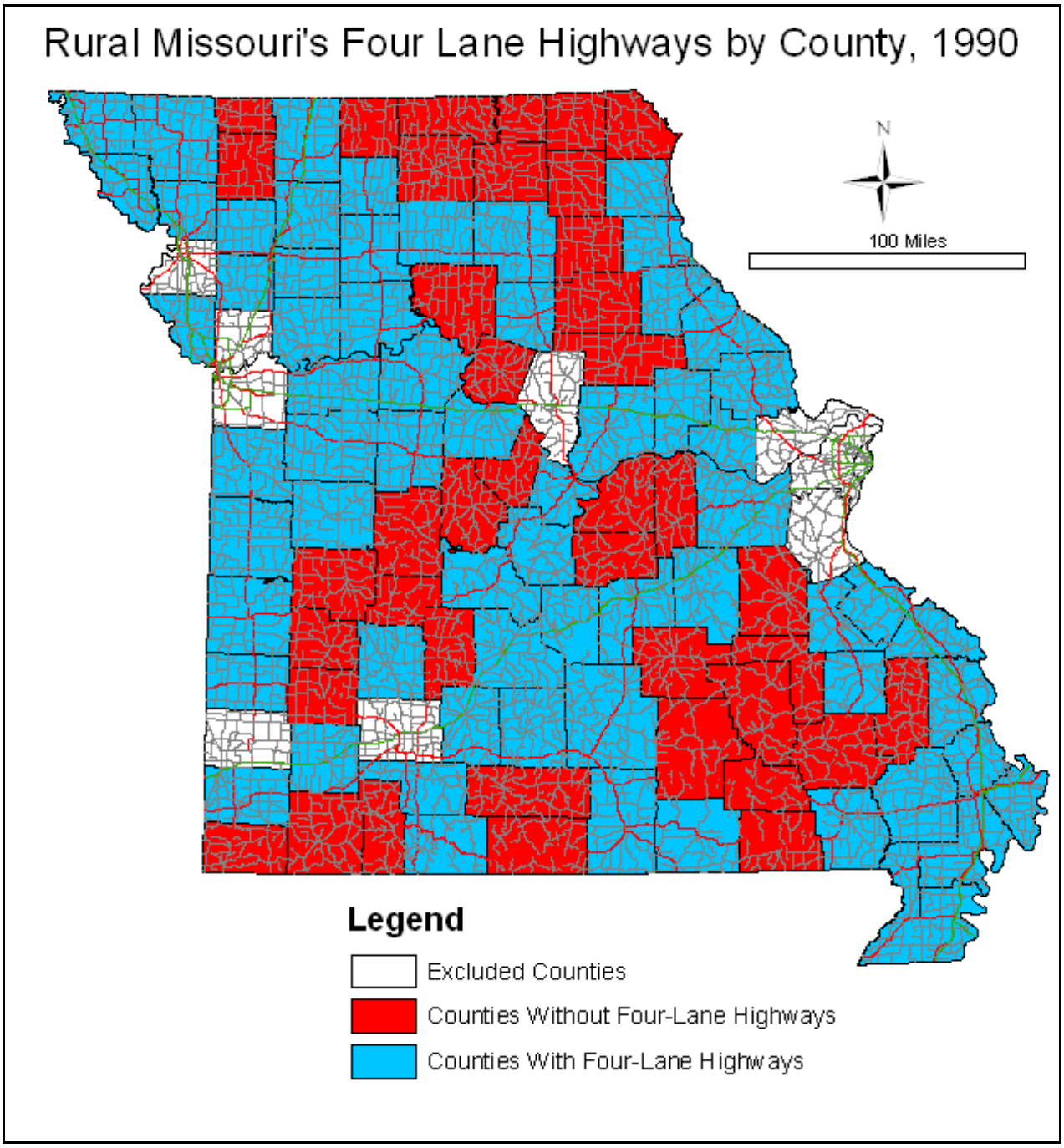
Economic Development Indicators Used in Study

Multiple indicators are used, including income, jobs created, wages, sales tax receipts, new businesses formed, etc., as shown in Table 2.

Table 2. **Economic Development Indicators Employed in MoDOT Study**

Indicators	**Abbreviations Used in Tables**
Population percent change, 1990-2000	***POP***
Household income percent change, 1989-1999	***HHI***
Gross sales tax receipts percent change, 1990-2000	***GSTR***
Real estate valuations percent change, 1990-2000	***REV***
Unemployment rate percent change, 1990-2000	***UER***
Average wage per job percent change, 1990-2000	***AW***
New businesses percent change, 1990-2000	***EST***

These indicators are used throughout the analysis that follows with the abbreviations SHOWN most often included in the tables and charts. These indicators were selected to provide the broadest possible coverage of "economic development."


Rural Missouri's Four Lane Highways by County, 1990
N
100 Miles
Legend
Excluded Counties
Counties Without Four-Lane Highways
Counties With Four-Lane Highways

Economic development indicators are often related: that is, indicators like population, retail sales taxes, new housing starts, are logically and empirically related. As population grows, new housing is built, sales at local commercial establishments increase and the total income in the county increases.

- Population usually increases with increased economic vitality and household income and average wages paid also increases.
- Unemployment rates usually decline as employers hire people to work in new or expanded facilities.
- As population increases, new housing is built and sold at prices higher than previous, resulting in higher real estate valuations.
- Retail sales increases with population and income increases, so gross sales tax receipts also increase.
- New businesses are created to serve the population's needs.

Empirical research has shown these relationships to be quite complicated rather than straightforward as suggested by the common sense approach provided above.

Economic Development: *Changes in County Status*

Table 3 shows how the whole state, measured at the county level[1], performed in economic development. The indicator means (averages for all counties) indicate general improvements across the board for the past decade.

Table 3. **Change in Economic Development Indicators for Missouri**

Indicator	N	Mean
Avg. wage	115	8.9%
Gross sales tax	115	48.3%
Household income	115	15.2%
New business	115	9.9%
Population	115	8.7%
Real estate valuations	115	14.0%
Unemployment rate	115	-65.3%

[1] This report treats St. Louis City as one unit with the same status as the County of St. Louis.

There are, however, some indications that some counties in Missouri actually saw the number of businesses decline along with population and real estate valuations. In some individual counties the change in unemployment, for example, was substantial while in others significant employment was created (decreasing the change in unemployment rate by over 200%). Table 4 shows how the economic indicators for the two groups of counties used in this study and designated as "rural" changed over the same decade, 1990-2000.

Table 4. **Changes in Selected Economic Status Indicators for Rural Missouri Counties, 1990-2000**

Economic Indicator	N	Mean	% change '90-'00	N	Mean	% change '90-'00
Average Wage	40	**$19,649**	**46%**	65	**$21,753**	**45%**
Gross Sales Tax Rev	40	**$1,766,225**	**1.8%**	65	**$5,956,000**	**195%**
Real Estate Value	40	**$66,584,000**	**53%**	65	**$185,000,000**	**70%**
Household Income	40	**$28,373**	**21%**	65	**$32,752**	**17%**
Population	40	**12,305**	**13%**	65	**28,479**	**14%**
Unemployment Rate	40	**4.83**	**-25%**	65	**3.94**	**-41%**
New Businesses Est.	40	**263**	**12%**	65	**694**	**18%**

Comparing the columns that show the per cent change from 1990-2000 in Table 3 indicates where there are differences between those counties with four lane highways (1-55 miles in 1990) and those where there are no such highways. Especially as regards sales tax revenues and real estate valuations there is a substantial difference in the growth indicated. Comparing the actual means however, better indicates just where the two groups of counties are different: in the group without four lane highways population is smaller, unemployment rates are higher, and the number of new businesses, real estate values and sales tax revenues are substantially lower. The wage and income figures are different, but not so different to account for the other changes. It appears that other factors, not included in this table, may be affecting the situations in both groups to create these differences and their magnitudes.

Readers should note that, because we use all the counties in Missouri that fit our definition of "rural," the differences in these economic development indicators between the two groups of counties—those with four lane roads and those without—are "statistically" significant. However, given the nature of the data and the population under study, differences of one or a few percentage points is hardly "significant" in the practical sense. It is best to compare the means in looking for differences that mean something regarding the effect of highway improvements. For example, it is useful to note that the counties without four lane roads are also generally smaller and poorer by almost all economic measures.

Since there are forty counties without highway improvements, as defined for this study, we shifted our focus in the analysis to those counties with such improvements and conducted an analysis of the effect different degrees of improvement had on the economic indicators. In the

remaining sixty-five counties with four lane highways, there are, of course, different amounts of mileage present. As shown in Table 5, the number of miles of four lane highway in 1990 ranged from one mile to over fifty. By 2000, about twenty miles of four lane highway had been added at the highest end of the distribution. At the same time, the mean number of four lane highway miles increased by about nine miles, or almost 600 miles of improvements were added in this decade. These differences provide the opportunity to compare the economic status of rural counties according the number of miles of four lane highway present in each. We use a type of statistical analysis that is often called "dynamic analysis," because the routines treat the indicators as "continuous" rather than static. This analysis is also known as "regression analysis" for reasons it is not necessary to go into here.

Table 5. **Four Lane Mileage for Counties, 1990 & 2000**

Year	N	Maximum	Mean
1990	65	53.42	18.3009
2000	65	73.09	27.7393

Analysis of Effect of four lane roads (1990) on Economic Development in Rural Counties

With the degree of variation present in the number of miles of four lane highway in the sixty-five rural counties under investigation, it is desirable to treat this indicator as continuous and use it in appropriate analysis routines. It could be treated categorically, that is the counties distributed to different sub-groups based on arbitrary divisions based on mileage but, being an arbitrary choice, there is no way to determine where to make the divisions. So, a dynamic analysis that takes into account the degree of variation is most useful.

As noted, the analysis used below is known as regression analysis or dynamic analysis. The statistical approach asks what effect one indicator has on another in a population of observations or measurements. In this case we are asked to determine the effect of highway improvements on rural economic development where development is determined as the level of selected economic indicators in 2000 and highway improvement is determined to be the number of miles of four lane highway present in each county. If we determine a point in a chart where one axis represents the number of miles of improved highway and the other axis represents the level of economic development using specific indicators (e.g., income or real estate valuations), we can represent each county by a point in a chart space. Plotting each county's related values on two indicators gives us a "scatter plot" of points placed in the chart space a comparable distance from the origin established by the minimum values for each of the two indicators (e.g., miles of improved highway and household income).

The second task in a regression analysis is to determine if there is any relationship in the population as represented by the resulting plot of values for each county. This is accomplished by an iterative process in which a computer generates a straight line and computes the distance (squared) between the line and each of the sixty-five points plotted on the chart. The results of each individual computation are added together. When an optimum (minimum) value is reach in the iteration, the statistical process ceases and the resulting straight line established as the "best fit" to represent the scattered points in the chart. The line now has a point of intersection with the vertical axis and a slope (e.g., it likely tilts upward or downward from the point of intersection).

This slope represents the degree of relationship determined statistically in the establishment of the straight line representation of the data points

In the figures below the reader will note the points scattered in the chart space according to the values of the indicators being considered for each county and a straight line selected statistically to represent these points. The reader will also find a simple equation printed in each figure in which the first value on the right side of the equals sign (=) represents the intersection of the line with the vertical axis (i.e., the value of the indicator at that point) and a number and letter in the second term. The number represents the slope of the straight line and may be interpreted as the additional amount (dollars, people, etc.) that is added for each mile of improved highway present in a county. Also printed on the figure is a value labeled "R-Square." This value represents the amount of total variation among the sixty-five counties explained in the economic development indicator by changes in the number of four lane highway miles.

For example, Figure 1 below shows the relationship between the miles of improved (four lane) highway in each county and the average wages earned by workers in each county. The small circles in the figure represent the point determine by the values for a specific county of these two indicators. The straight line is the representation of the overall relationship considering the plots for all sixty-five counties. The R-square value indicates that about 24% of the variation in the average wages earned indicator can be explained by the number of miles of four lane highway in the counties. This is certainly one area in which "other factors" can make a substantial difference in the amount of wages earned. Education, work skills, availability of skilled jobs, and other factors will affect the level of compensation paid to employees.

The relationship between average wages earned in 2000 and the presence of four lane highways in 1990 is modest as is seen in this figure. Interpreting the results of the statistical analysis indicates that, for each mile of four lane road added in a county, average wages increased less than $100 ($98.77) per worker. Adding 10 miles of four lane road would increase the average wages per worker by an estimated $1,000 ten years after the road improvements were completed.

Similar analyses were performed for the remaining indicators of economic status used in this preliminary study as outlined below.

The effect of improved highways (1990) on the number of new businesses established in 2000 was small. As shown in Figure 2, a portion of the small circles (data points) are located fairly close to the straight line (regression line), but there are also a substantial number of cases whose values are much farther away from this line, meaning that the line is not a very good representation of the overall distribution of values. The fact that the R-square is .15 means that 15% of the variation in the number of new businesses created can be explained by the number of miles of four lane highway in the county. Completing one mile of four lane road increased the number of businesses established by just over 16 commercial firms in 2000. Obviously, without further investigation, we cannot comment on what kinds of firms these might be—retail, wholesale, financial, agricultural, manufacturing, etc.—but, when combined with other data such as changes in gross sales tax receipts, we may find some gross indication of the nature of these businesses. Whether the kinds of businesses created represent real economic development is a subjective judgment.

Figure 1. **Effect of four lane roads (1990) on Average Wage Earned by Place of Work (2000)**

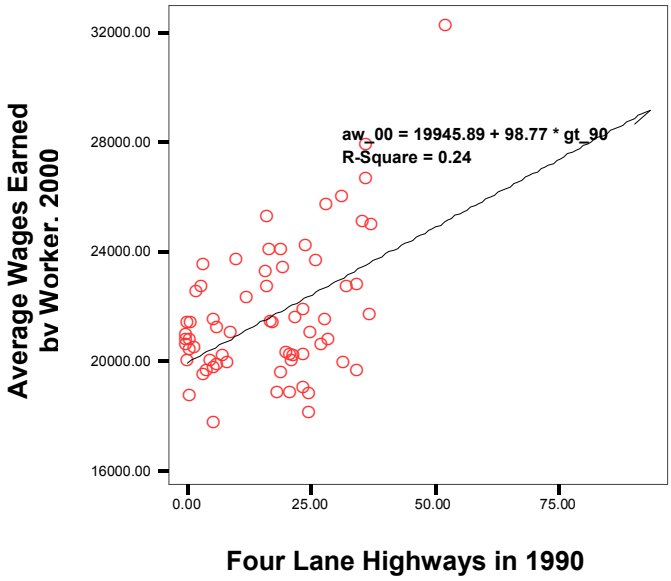


Figure 2. **Effect Of Four Lane Highways (In 1990) On The Number Of New Businesses Established (2000)**

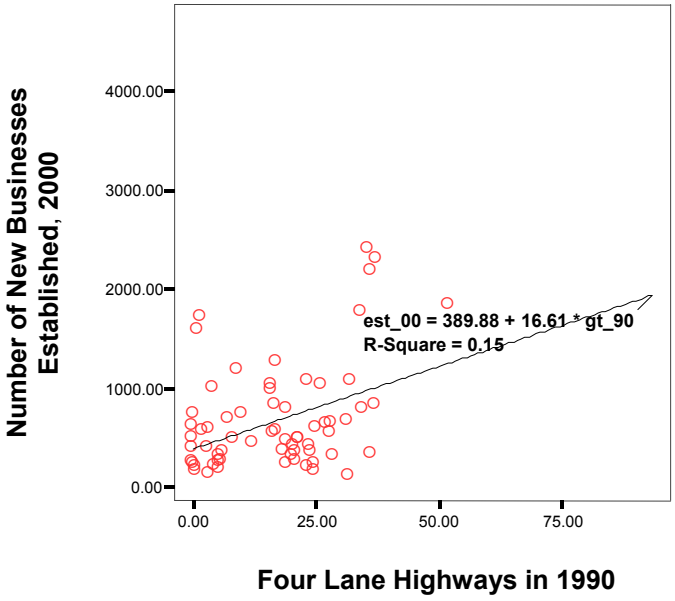
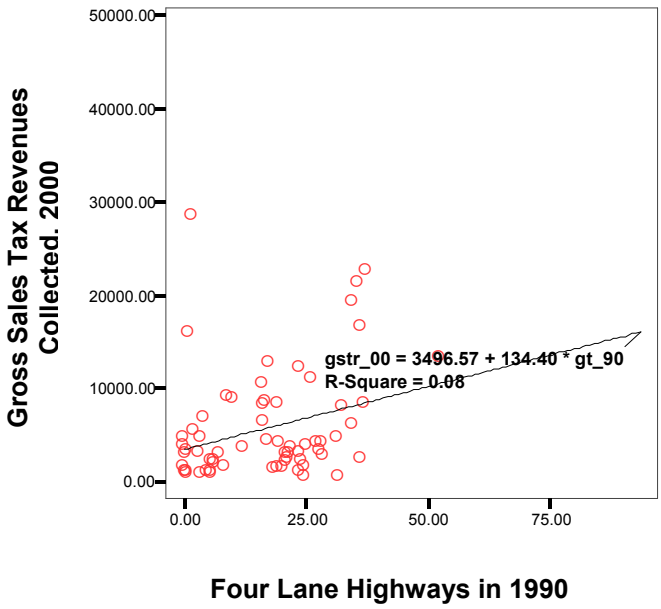


Figure 3. **Effect Of Four Lane Roads (1990) On Gross Sales Tax Revenue Collections (2000)**



As with the number of new businesses established, the amount of sales tax revenues collected in a county in 2000 showed only a slight relationship to the number of miles of four lane roads in 1990. With a value for R-square as shown, just 8% of the variation in the amount of sales tax revenues collected was related to the amount of four lane mileage in a county in 1990. Interpreting the statistical relationship in the equation above, we can see that adding one mile of four lane road in 1990 increases the 2000 sales tax collections by $134,400, or an average of $13,440 annually.

The effect on household income (in 2000) of increased mileage of four lane roads (in 1990) is modest, as it was with average wages. The value of R-square (.15) indicates only a small portion of the variation in household income (15%) can be explained by the number of miles of four lane highway in a county. Increasing mileage by one mile of improved roadway means an increase in average county household income of under $200 ($194.72) annually.

Real estate valuations in 2000 reflect highway improvements (in 1990) but not substantially. Each additional mile of four lane road present in a county (in 1990) meant an additional $11 million dollars (or more) of increased value of real property as a base for county taxes and the small value of the R-square statistic means only 17% of the variation in real estate valuations is explained by the number of miles of four lane highway in rural counties.

Figure 4. **Effect Of Four Lane Roads (1990) On Household Income Level (2000)**

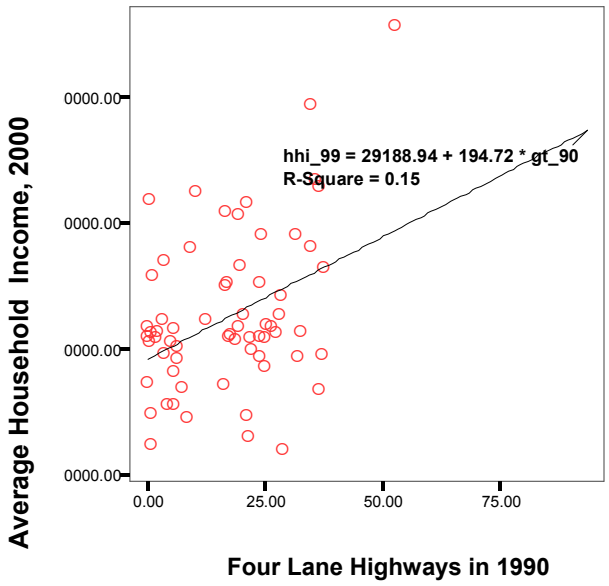


Figure 5. **Effect Of Four Lane Highway (1990) On County Real Estate Valuations (2000)**

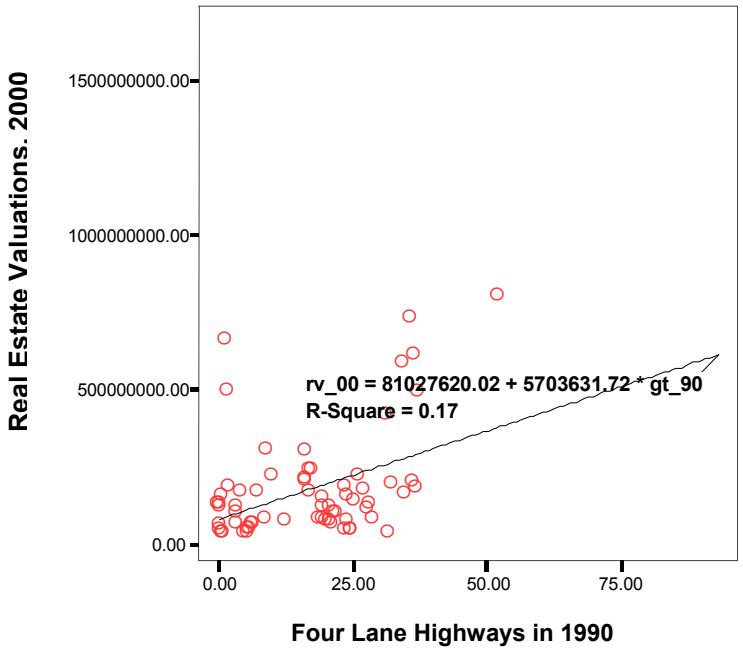
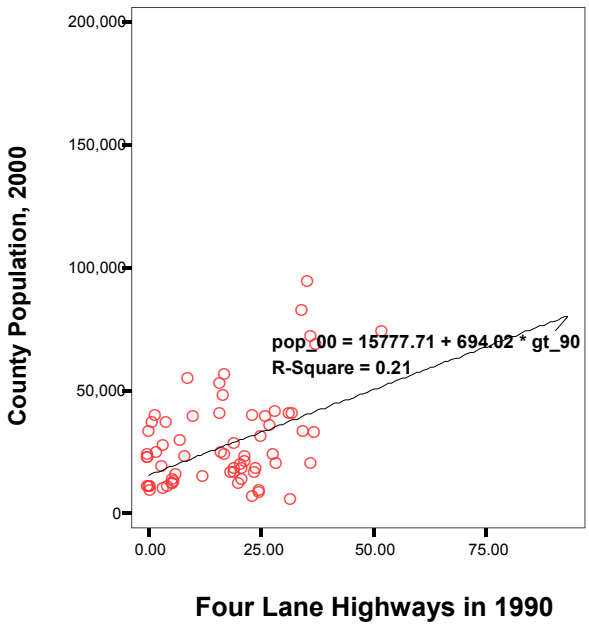


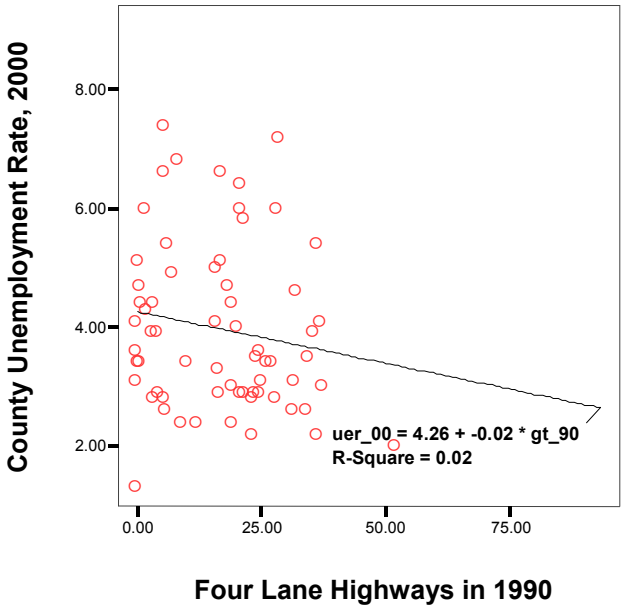
Figure 6. **Population Increases With Investment In Road Improvement.**



As Figure 6 indicates, the county population in 2000 was somewhat related to the number of miles of four lane road in the county in 1990. The R-square value indicates that 21% of the variation in population levels across the sixty-five rural counties under study is accounted for by the number of miles of four lane highway. Other factors obviously also affect population growth, including population composition (e.g., number of families in the child-bearing years, death rates and quality of health care). The addition of each mile of four lane road (in 1990) meant an increase of nearly 700 persons in the county population in 2000.

Each additional mile of four lane road in a county decreases the unemployment rate by 0.02%, so the addition of 50 miles of four lane roads would be required to reduce unemployment by 1% as seen in the relationship in Figure 7 above. Further, very little of the change is explained by highway mileage improved (2%). So, despite the fact that there is some slight relationship to average wages earned and population, the number of four lane highway miles in a county has almost no effect on reducing unemployment rates in rural counties. The magnitude of this relationship, while statistically significant, is not impressive.

Figure 7. **Unemployment Rates Decrease With Increased Four Lane Road Mileage.**



Recommendations and Implementation

Why Does Highway Improvement Show Little Effect On Economic Development?

Economic development is a complex activity and transportation's role is also complex, depending on many factors. Not only is it difficult to determine whether the right "logic" is that economic development occurs and creates a demand for improved transportation infrastructure, it is also a difficult matter to determine just how the economic factors and transportation quality factors are related. There is little doubt that transportation infrastructure quality is one of the many factors considered when a business owner decides upon a location for business operations. However, for small, rural retailers, transportation infrastructure makes little difference: they will locate in their "home community." By contrast, a major branch manufacturing facility may want access to extremely good transportation infrastructure—including more than four lane highways—when they decide where they will do business. With the growth of "just-in-time" inventory and production management," the amount of transport time from the supplier to the end user is critical. There are, of course, other infrastructure considerations business owners think about when making location decisions and these are well documented in the literature. It is often the case that transportation is, at least for manufacturing firms, one of the ten most important factors although the specific priority assigned to it changes with the nature of the business operation and other factors. In sum, we should expect the relationship between factors like transportation quality other factors influencing economic development and economic development results to be a complicated one. Further, the full extent of these relationships is not investigated in this brief preliminary study.

It is also not clear what facets of transportation infrastructure are actually considered important. For some users, it may be four lane, limited access highways, while for others a wider two or three lane highway may be adequate, depending on other factors such as proximity to an international airport. Another "measurement problem" is reflected in the indicators chosen to represent economic development. In this preliminary study we used straightforward, direct indirect of economic activity and related effects. Other indicators, such as total employment might also be employed. As noted, in many cases several of these indicators will be so closely related that one may often be substituted for another in an analysis. There are other measures such as "pull factors" that relate directly to transportation patterns but which must be derived from other data and computed as more indirect factors. These kinds of measurement questions deserve further investigation.

Further, economic development occurs in many ways. Research has demonstrated that this process is quite variable among the different regions of the country, comparing for example Silicon Valley with the Great Plains or the "Rust Belt" with the Mississippi Delta. Different economic sectors play a lead role in the process in different regions. The most successful economic development strategies cannot afford to ignore regional differences.

In rural Missouri, factors other than transportation may be more important to business. Frankly, there have been few recent studies of rural economic development in Missouri to use as a guide for this analysis. What we know about Missouri's economy is somewhat superficial although we can certainly see the results of factors like globalization and the recession recently experienced. Some observers feel that Missouri's economy—especially in rural areas—is more like the "old" industrial economy than it is the new "information" economy. If so, we should expect that transportation quality would play some role, but other factors such as proximity to markets, labor force qualities, amenities, and so forth, may also play a substantial role. Further, it is likely that these factors "work together" and reinforce one another in the process of decision making used by commercial firms. It is unlikely that one factor alone determines the location of business activity and economic development outcomes. It is also likely that the combinations are very numerous and the interrelationships difficult to sort out, especially given some of the limitations of the secondary data most readily available for analysis.

Finally, if community effects are more important than county effects, the data used in this preliminary analysis may obscure relationships. Communities are usually more aggressive and have more capacity for economic development activity than counties in Missouri, but data on economic development-related outcomes is available mostly at the county level so analysis is complicated by the lack of correspondence between types of units. While there are a few economic development efforts organized on a countywide basis in Missouri, it is most often at the community level where this leadership is most effective and active. Therefore, conducting studies of the relationship between transportation infrastructure and economic development may reveal stronger linkages at the community level of analysis than it has shown at the county level.