Rural Highway Expansion and Economic Development: Impacts on Private
Earnings and Employment

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Abstract

With the interstate system substantially complete, the majority of new investment in highways is likely to take the form of selective capacity expansion projects in urban areas, along with incremental expansions and upgrades to expressway or freeway standards of existing intercity highway corridors. This paper focuses specifically on the latter type of project, rural highway expansions designed to connect smaller outstate cities and towns, and examines their effects on industry-level private earnings and local employment. We examine three case study projects in rural Minnesota and use panel data on local earnings and employment to estimate the impacts of the improvements. Our results indicate that none of the projects studied generated statistically significant increases in earnings or employment, a finding we attribute to the relatively small time savings associated with the projects and the maturity of the highway network. We suggest that for rural highway expansion projects, as with other types of transportation projects, user benefits should be a primary evaluation criterion rather than employment impacts.

Keywords: Highways; Economic Development; Employment; Panel data
Introduction

There remains a large amount of interest at state and local levels in using transportation investment as a means to promote economic development. Cities and regions that are growing slowly or not at all view improvements to infrastructure networks, especially transportation networks, as a potential way to stimulate growth by lowering the costs of local firms and making their location a more attractive place for private investment and expansion. Transportation investment programs often become more attractive when coupled with the offer of grants from higher levels of government. They also benefit from the reputation of infrastructure projects as a “safe” type of investment during periods of lower growth. This has been seen most recently with the United States government’s promotion of the American Recovery and Reinvestment Act, where infrastructure spending became emblematic of the bill’s efforts to promote employment, despite being a relatively small portion of the overall spending. Yet, as fewer resources have become available for such projects at the state and local levels in recent years, state departments of transportation and other public works organizations have begun to sharpen their focus to determine where and how such resources should be deployed in order to yield the greatest returns. This study evaluates the potential of transportation investment to generate increases in private economic activity by empirically examining a recent set of case studies of highway expansion projects in rural Minnesota.

With the interstate system substantially complete, the majority of new investment in highways is likely to take the form of selective capacity expansion projects in urban areas, along with incremental expansions and upgrades to expressway or freeway standards of existing intercity highway corridors. These types of projects are less likely to generate the kinds of larger-scale growth and relocation impacts associated with the interstates [16, 4], yet their effects may still be measurable. This paper focuses specifically on the latter type of project, rural highway expansions designed to connect smaller outstate cities and towns, and examines their effects on industry-level private earnings and local employment. For both types of measures of economic activity, we construct panel data sets and attempt to estimate the impact of the improved highway as a fixed, unobserved increment to growth that is phased in after the completion of construction. Our analysis of employment, which uses city-level data, also attempts to account for spatial differences in growth effects at a sub-county level which might be brought about by the highway improvement.

The paper is organized as follows: the next section provides a brief overview
of the types of methodological approaches to studying the relationship between highways and economic development and their results. The third section provides more detailed descriptions of the three highway expansion projects that are the focus of this study. The fourth and fifth sections document the design and results of analyses of private earnings and employment for the case study projects. The final section summarizes the results of the findings and suggests what they might imply for the evaluation of rural highway projects.

Measurement of the Economic Impacts of Highways

The measurement of the relationship between highway networks and economic development is marked by a heterogeneous set of methodological approaches, often with different aims and conducted at different scales, which have led to generally mixed results on the question of magnitude and direction. Perhaps the most well-known among these studies is the literature on public capital stocks and economic growth, motivated largely by attempts to explain the US productivity slowdown of the 1970s and 1980s. Despite early published results which claimed exceptionally large returns to infrastructure investment, including highway capital stocks [1, 17], subsequent studies which relied on more disaggregate data and corrected for certain econometric issues tended to show more modest results [12, 10, 18]. These types of studies were generally carried out at rather aggregate levels and considered only the size of the capital stock (as opposed to its composition), and thus were not able to offer much in the way of policy-relevant direction on investment at more local levels.

A second line of empirical studies into the relationship between highways and economic development can be grouped into what we might call growth regressions. This term is used to capture a range of empirical approaches that are less explicitly tied to economic theory, but which systematically study the relationship between transportation and economic development. These include structural models which consider highway networks as an exogenous input to equilibrium models of population and employment [3, 5] or population, income and employment [6]. Others model highway networks as endogenously determined within the scope of labor and housing markets [22]. Most of these studies show highway networks as having small, but positive impacts on local growth, typically measured at the county level.

The class of growth regression studies can also include studies which have investigated the issue of causality between highways and economic development
by means of temporal precedence, such as vector autoregression analyses [15][13]. Most such studies employ highway data aggregated to the state level, as these tend to be more readily available, though there are examples of county-level studies as well [21]. These studies tend to find evidence of mutual causation between economic development and the growth of highway networks, but the largest effects of highways on development seem to be concentrated in urban regions.

A third class of studies which merit attention are those which use quasi-experimental techniques to more directly isolate and estimate the causal effect of highway improvements on economic development. One study by Rephann and Isserman [19] used a quasi-experimental matching framework to try to identify “treatment” and “control” counties that could be used in an evaluation of the development effects the Appalachian Development Highway System. Another study by Chandra and Thompson [4] used the development of interstate highways through rural areas as a natural experiment (interstates were originally planned to primarily connect urban areas) to examine their effects on the growth of rural areas. Both of these studies found that the primary effects of the highways under study were to redistribute growth, either from neighboring counties to counties adjacent to the highways, or from rural counties to those closer to existing urban areas.

Due to the difficulty of finding such experimental cases, researchers must often settle for other, less direct methods of evaluating the effects of highway improvements. Longitudinal methods in general, and especially those which can account for unobserved heterogeneity such as various panel data techniques, offer an acceptable substitute. These methods can be more useful when they are coupled with spatially disaggregate data. These are the methods employed in the present study, which is targeted specifically toward rural highway expansion projects.

Case Study Projects

Our empirical analysis proceeds in two phases, focusing alternately on private earnings and employment, and takes as case studies three rural highway expansion projects:

- The incremental expansion of Minnesota Trunk Highway (TH) 371 along a roughly 30-mile segment between Little Falls and Brainerd, Minnesota. The project involved expansion of a two-lane highway to a four-lane divided highway and included the construction of a new bypass around the city of Brainerd.
The completion of a four-lane bypass along US Highway 71 around the city of Willmar, Minnesota. This project was initiated in the mid-1980s, with much of the grading work being done then, but the construction of the full, freeway-grade four-lane bypass with interchanges was not completed until the early 2000s.

The expansion of US Highway 53 north of Virginia, Minnesota. This project involved expansion of an 11-mile segment of rural highway from a two-lane to a four-lane divided highway on a new alignment.

Each project is described in more detail below.

TH 371 Expansion
The first case study, described briefly above, is the expansion of Minnesota TH 371. This project was completed in various phases between August 1998 and October 2005. The first phase involved completion of a bypass around the city of Brainerd, Minnesota on TH 371 and a new interchange at the junction of the new TH 371 alignment and the old alignment, now a business route for 371 which serves the city directly. The remainder of the project expanded the roughly 30-mile segment of 371 between Little Falls (in Morrison County) and Brainerd (in Crow Wing County) in two phases, the first upgrading the highway to four lanes between the junction with US Highway 10 near Little Falls and CSAH 48 near Camp Ripley, and the second phase completing the new four-lane segment between Camp Ripley and the new Brainerd bypass. These latter two phases included the construction of two new interchanges and were completed between May 2003 and October 2005. Taken together, the improvements to TH 371, including the right-of-way and construction costs, had a combined cost of around $60 million.

US 71/TH 23 Expansion
The primary objective of this project was to construct a four-lane, freeway-grade bypass of the city of Willmar, Minnesota which had a reported population of just under 20,000 as of the 2010 census. Grading work for the new highway was begun during the 1980s, along with with expansion of a 5-mile segment of US 71 and Minnesota TH 23 just north of Willmar from two to four lanes. Due to funding constraints, the bypass of Willmar was not completed as a four-lane highway until
the fall of 2001. Shortly after the bypass was completed, an additional segment of TH 23 northeast of Willmar (from the junction of US 71 and TH 23 north of Willmar to New London, MN) was expanded to four lanes, completing a continuous four-lane section of TH 23 from New London, MN to the south end of Willmar. This latter project was completed in the spring of 2003. The two projects together were largely completed over the period from 1999 to 2003 at a combined cost of around $60 million.

US 53 Expansion

This project was undertaken to expand a segment of US Highway 53 from two to four lanes on a new alignment between the towns of Virginia and Cook in St. Louis County, Minnesota. The expanded segment of highway was 11 miles long, with construction being completed in phases between February 2007 and October 2009. Total project cost was approximately $30 million.

County and Industry-Level Earnings

Data

Our analysis of aggregate, county-level impacts of specific projects uses industry earnings as a key measure of economic impact. The data on earnings are made available by the Bureau of Economic Analysis (BEA) as part of its Regional Economic Accounts. The term “earnings” specifically refers to three components of personal income: wage and salary disbursements, supplements to wages and salaries, and proprietors’ income.

An important consideration in using the BEA data on earnings is that, over the time period that will be evaluated in the county-level analysis (1991 to 2009), the industrial classification system that is used to aggregate data to various industry levels was converted from the former Standard Industrial Classification (SIC) system to the currently-used North American Industrial Classification System (NAICS). One impact of this reclassification was that the number of “one-digit” industries (the highest level of industry aggregation in the data) included in the data set increased from nine to 20. Another related impact was that many of the former SIC one-digit industries were split up, or in some cases combined, to form new industries. For example, the one-digit industry classified as “Transportation and Public Utilities” (SIC code 500) under the SIC system was
reclassified into two new one-digit industries under the NAICS system, “Utilities” (NAICS code 300) and “Transportation and Warehousing” (NAICS code 800).

While there is some overlap between the two classification systems, including a few years for which data were reported in both systems, data are generally available for download from BEA using the SIC system for the years 1969 through 2000, while the NAICS system is used for more recent years leading up to 2009.

Another issue that arises with the use of the industry-level data is data suppression. BEA may suppress data at any level of industry aggregation if 1) the total annual earnings for a given year are less than $50,000 or 2) publication of the figure would disclose confidential information (for example, an industry in which a single firm greatly influences aggregate trends at a county level). In either case, the figures are included in any higher-level totals aggregated by industry or geography. Fortunately, there are few instances of missing or suppressed data among the counties at the one-digit industry level. The few observations that contained missing or suppressed data were removed from consideration.

**Specification**

We now turn to the empirical analysis of a pair of case studies of road network improvements in Minnesota using aggregate (county-level) data as units of observation. Our analysis focuses on earnings in specific industries which have been identified by previous research [8] as using transportation as an input more intensively. These industries include construction, manufacturing, wholesale, retail, and trucking.

Our analysis of these projects takes as the period of study the 19-year period between 1991 and 2009. This represents a long enough time period to examine the changes in economic activity which occurred both before and after the completion of the case study projects. Our focus is on the changes in private earnings in the four industries described above. Data sets for each of the study locations are constructed from the county (or counties) in which the project is located, along with all neighboring counties. We model the earnings in each industry at the county level as a function of national and state-level economic trends, along with changes in population. The effect of a highway project is represented as a series of indicator variables identifying the county in which the project is located, along with a specific time period, either before, during, or after completion of construction, when the improved highway is opened to traffic. In each case, this series of indicator variables breaks the study period into three distinct phases and attempts to measure changes in industry-level earnings in the county receiving the highway.
improvement over time relative to neighboring counties. Formally, we can write
the model predicting county-level earnings in a given industry as:

\[
\ln y_{it} = \alpha + \beta_1 \ln GDP_t + \beta_2 \ln StateEarn_t + \beta_3 \ln Pop_{it} + \sum_{j=1}^{3} \gamma_j County_j + \epsilon_{it} \quad (1)
\]

where:

- \(\ln y_{it}\) = natural log of earnings in a given industry in county \(i\) at time \(t\)
- \(\ln GDP_t\) = natural log of real GDP (in 2009 dollars) at time \(t\)
- \(\ln StateEarn_t\) = natural log of state-level earnings in a given industry at time \(t\)
- \(\ln Pop_{it}\) = natural log of population in county \(i\) at time \(t\)
- \(County_j\) = indicator variable identifying the county (or counties) in which the
  highway improvement was located during a specific period, \(j\)
- \(\epsilon_{it}\) is an error term, and
- \(\alpha, \beta_1, \beta_2, \beta_3, \text{and } \gamma_j\) are parameters to be estimated

The model represented by Equation 1 includes controls for three exogenous
factors. The first is national output, which may be seen as influencing the demand
across all sectors. The second is state-level earnings in a given industry. This
variable is taken to represent industry-level demand shifts which are unrelated to
broader economic growth [11, 4]. The third factor is population, which we assume
to be exogenous for the purpose of this analysis, and which is assumed to influence
the local demand for goods in each industry.

The series of county-time period indicator variables, \(County_j\), provide the
interpretation of the economic impact of the project on earnings in a given in-
dustry. If the difference in the estimated coefficients of these variables in the
pre-construction period (period 1) and the post-construction period (period 2) is
statistically significant, this would provide possible evidence of an increase in
earnings attributable to the project under study.

**Estimation and Results**

**TH 371 Expansion**

It will be useful for the purposes of this analysis to consider the projects related to
the expansion of TH 371 together as a complete set of improvements. There are
practical reasons for doing so, since the projects were considered part of an inte-
grated strategy for improving TH 371 as an inter-regional highway corridor. More
importantly, considering them together allows us to define a single construction
period for the improvements which fits the modeling framework described above.
We define the construction period as covering the years from 1998 through 2005.
The years prior to 1998 are considered part of the “pre-construction” period, while
the years after 2005 are considered “post-construction”.

We fit the model described in Equation 1 to four data sets representing earnings
data for the construction, manufacturing, retail and wholesale industries. Descrip-
tive statistics for these data are reproduced in Table 1.

The county/time indicator variables were defined for both Crow Wing and
Morrison counties, since each of these counties contained a substantial share of
the improved section of TH 371. The other neighboring counties included in
the data were Aitkin, Cass, and Mille Lacs counties. Each of the industry-level
regressions had 95 observations, with the exception of the “wholesale” data set,
which was missing one observation due to data suppression.

We estimate the models using ordinary least squares with panel-corrected stan-
dard errors. This technique allows us to fully exploit the panel structure of the
data, accounting for correlation across panels within the data set, while also cor-
recting for serial correlation among the residuals in the model, and has been shown
via simulation to generate efficient parameter estimates [2]. Our estimates are gen-
erated using the “xtpcse” procedure in Stata (version 10), with the Prais-Winsten
method for correcting for serial correlation and an AR(1) structure assumed for
correlation among the residuals. The estimation results for the four industry-level
earnings regressions are provided below in Table 2.

The use of the panel correction procedure results in very high $R^2$ values for
each of the models due to the correction for autocorrelation among the residuals
and cross-panel correlation among observations. The Wald $\chi^2$ statistic provides
a test of the null hypothesis that the parameters of all nine independent variables
are jointly equal to zero. The large test statistic for each of the models allows this
hypothesis to be rejected at any reasonable level of significance. Table 4.1 also
provides the estimated $\rho$ autocorrelation parameter for each of the models.

The models appear to provide a good fit to the data. The population and state-
level industry earnings variables are positive and highly statistically significant.
for nearly every industry, with one exception being the population variable in the
manufacturing regression. Of interest, a negative coefficient is observed for the
GDP variable in three of the four regressions (the exception being manufacturing),
indicating that growth in national output adds little to earnings growth in these
industries once state-level industry output is controlled for.

Examining the county-time indicator variables for the two counties where the
improvement occurred, we see little evidence of a statistically significant effect of
the completion of the highway on earnings in each of the four industries. Again,
these variables capture any unobserved differences in earnings between the coun-
ties where the highway improvements occurred and neighboring counties, ob-
served at three points in time (before, during, and after completion of construc-
tion). For example, looking at the manufacturing regression we see a small in-
crease in earnings in Crow Wing County between time periods 1 and 3 (before
and after construction) relative to neighboring counties. However, the difference
in parameter values between these two periods is less than one standard error for
either of the parameter estimates, indicating that this differences is not statisti-
cally significant, or rather that the change in parameter values from the pre- to
post-construction period is simply the result of chance variation. Comparing the
estimates for the county-time indicators in the other models reveals largely the
same result. Where there is any evidence of an increase in earnings, it fails to be
large enough to rise to the level of statistical significance.

**US 71/TH 23 Expansion**

Similar to the case study of the TH 371 expansion, we identify periods before,
during, and after completion of construction to examine changes in earnings. The
analysis is simplified slightly in this case, since all of the highway improvements
are contained within Kandiyohi County. Accordingly, the number of explanatory
variables in our model is reduced from nine to six. The data set is comprised of
six counties, Kandiyohi plus five neighboring counties (Chippewa, Meeker, Pope,
Renville and Swift). The data sets for the manufacturing and retail industries con-
tain a full set of 114 observations, while the construction and wholesale industries
are missing four and three observations, respectively, due to data suppression. The
models are fitted using the same techniques as were applied to the TH 371 case
study. Descriptive statistics for this case study are included in Table 2, while a
summary of the model results is presented below in Table 3.

The results of the earnings regressions for the US 71/TH 23 study area are
similar to those observed in the previous case study. The population and statewide industry earnings variables are uniformly positive and statistically significant at the $p < 0.05$ level. The national GDP variable still has a negative coefficient in two of the four industry regressions, though one of the two is not statistically significant. National output is positive and significant for the manufacturing and wholesale industry regressions.

Looking at the county-time period indicators, there is again little evidence of statistically significant changes in earnings for each of the four industries examined. Comparing the coefficients for the pre- and post-construction periods, there is only a small change for the construction and manufacturing industries, neither rising to any level of significance. There is a slightly larger change for the county-time indicators in the retail and wholesale industry regressions. However, the magnitude of the difference in each case is only equal to roughly one standard error, indicating that the difference is not statistically significant. Moreover, in the case of the wholesale industry the coefficients decline in value over time indicating that, all else equal, earnings in Kandiyohi County were declining relative to those in neighboring counties.

### Analysis of Local Employment

In the previous section, we examined the impacts of highway improvements in two of the case study locations by estimating their effects on private earnings in several sectors of the economy. While no evidence of statistically significant were found, we noted the possibility that some impacts might exist at a smaller geographic scale due to relocation or changes in the location of new economic activity induced by the highway improvements. In this section, we examine this possibility by using more disaggregate data on employment levels from the Quarterly Census of Employment and Wages (QCEW), aggregated to the minor civil division for analysis by staff at the Minnesota Department of Employment and Economic Development.

### Data

As was done with the county-level earnings analysis, we assemble a panel data set to analyze the changes in a cross-section of locations through time in response to the case study projects. The use of disaggregate employment data from the QCEW allows us to construct models that are more spatially explicit, accounting
for the likelihood that locations that are directly served by the improved highway will benefit more than those not served.

Our unit of analysis for each the case studies is the municipal level, including all incorporated cities for which at least total annual employment figures are reported. Many cities also have industry-level annual totals, but the lack of consistency in reporting due to suppression (particularly among smaller towns) leads us to focus our attention on total employment in order to avoid a potential source of bias. In analyzing the US71/TH23 and US 53 case studies, we restrict the sample of cities included in the analysis to those within the county where the project is located. In the case of the improvements to TH 371 we include cities in both Crow Wing and Morrison Counties, since the expanded section of highway spans parts of both counties and connects the largest cities in each county (Brainerd and Little Falls).

The QCEW employment data are available annually dating back to 2000, with the most recent year of complete data being 2010 as of the time of this writing (though some quarterly data are available for 2011). While the QCEW data contain relatively detailed information about employment at the minor civil division (MCD) level, it is somewhat difficult to find other variables that are measured at the same geographic scale and that are available on an annual basis. Similar to our analysis of county-level earnings, we focus on predicting employment levels as a function of a few, relatively straightforward demographic and economic factors.

**Specification**

City population and per capita incomes are the primary statistical controls employed in our model of local employment. The former variable helps to control for the cross-sectional heterogeneity in the sample of employment data and represents an indicator of market size, since larger cities are likely to be served by a larger base of service industries. A variable representing income levels is included, both to account for differences in consumption levels (holding population constant) and as a way to account for some of the macroeconomic trends present during the study period, primarily the onset of the recession toward the end of the decade. Since no measure of municipality-level incomes is available on an annual basis, we use as a proxy measure per capita wages. Wages represent one of the major components of personal income and correlate reasonably well with other measures of total income. There are, however, a couple of notable limitations to their use as a proxy for incomes. The first is that they ignore other potentially important sources of income, such as proprietors’ income, transfers, and
other sources of non-wage income. The second is that, as economists have noted, wages tend to be “sticky” in the downward direction during recessions. That is, they do not fall as fast as output during a recession, due to previous contractual commitments and imperfect information with regard to price changes.

In order to account for the possible differential effects on city-level employment due to the highway improvements in each case study, we introduce into each model a set of time- and location-specific indicator variables. These variables combine the time element, which identifies whether the observation took place before or after the highway improvement was completed, with a spatial indicator to identify the location of the city or town relative to the improved highway. Spatially, the observations are split into three groups:

- Cities that are located directly on the improved segment of highway
- Cities that are located upstream or downstream from the improved segment of highway
- Cities that are located neither on nor upstream or downstream from the improved segment of highway

We hypothesize that, all else equal, the cities located along the improved segment of highway will experience more employment growth than those not near the highway (“non-highway” cities). Cities located upstream or downstream from the improved segment of highway may also see some growth effects, since they may also be beneficiaries of the improved highway, though not as much as those cities directly effected. These cities are expected to experience employment growth greater than the non-highway cities, but not as great as the cities directly affected. The general spatial relationships between the location of the observed cities and the improved highway are depicted in Figure 1.

These space and time-specific characteristics are combined into a set of indicator variables which capture unobserved differences in employment levels (those not attributable to the population and income variables previously mentioned) across locations and before and after the highway improvements of interest. Since there are three location classifications and two time periods, there are a total of six combinations of these variables. We omit one of these time-location combinations, namely the one corresponding to non-highway cities observed before the highway improvement, in order to use it as a reference case against which
to evaluate the impacts in other locations and time periods. The use of variables representing “before” and “after” periods allows their comparison to check for statistically significant changes over time.

The formal specification of the empirical model is described in Equation 2:

\[
\ln(e_{it}) = \alpha + \beta_1 \ln(P_{it}) + \beta_2 \ln(I_{it}) + \sum_{j=1}^{5} \gamma_i(Highway_i) + \epsilon_{it}
\]  

(2)

where:

- \(\ln(e_{it})\) = natural log of total private sector employment in city \(i\) at time \(t\)
- \(\ln(P_{it})\) = natural log of population in county \(i\) at time \(t\)
- \(\ln(I_{it})\) = natural log of real per capita income (in 2009 dollars) in city \(i\) at time \(t\)
- \(Highway_i\) = indicator variables representing location and time-varying characteristics of city \(i\)
- \(\epsilon_{it}\) is an error term, and

\(\alpha, \beta_1, \beta_2, \text{ and } \gamma_i\) are parameters to be estimated

As noted, the continuous variables in the model are transformed into their natural logarithms to allow for direct elasticity estimates. The set of time and location-specific indicator variables are collectively referred to as \(Highway_i\). These variables will be described in more detail in the next section. The descriptive statistics for the three case study projects are listed in Table 4.

Estimation and Results

Table 5 displays the results of the basic employment regressions, predicting total private sector employment for each of the cities in the three case study areas. The models are fit using ordinary least squares estimation. The time and location-specific indicator variables are given names which correspond to their location. For example, the “H” variable represents cities located along the improved segment of highway. The “before” and “after” subscripts denote the time aspect of these variables, and correspond to the periods before and after completion of the highway improvement. For the variables in each of the estimated equations, the table contains the parameter estimates, standard errors, and associated t-statistics. We discuss the results of each of the case studies individually.
We first examine the case of the set of improvements to US Highway 71 and Minnesota Trunk Highway 23, including the Willmar Bypass, in Kandiyohi County. The summary results of the model in the first few columns of Table 5 indicate that the model provides a good overall fit to the panel data on total employment. As should be expected, employment appears to scale with population, with a one percent increase in population being associated with greater than a 0.9 percent increase in employment. Local per capita incomes are also strongly associated with employment levels, though the effect is somewhat smaller.

Looking at the variables representing the time and location, there appears to be no evidence of the completion of the highway improvement on employment in non-highway cities. The $O_{after}$ variable, which measures the residual effect of being located in a non-highway (or “off-highway”) city after the completion of the highway improvement (relative to being in the same location before the improvement), has a very small coefficient which is not statistically different from zero at any reasonable level of significance.

Likewise, there seems to be no statistically significant difference in the variables representing cities located on the improved highway segment before and after the improvement. The $H_{before}$ variable, representing the residual difference in employment levels between cities located on the improved highway segment prior to completion of the improvement and non-highway cities during the same period, is fairly large, indicating that the cities located along the improved highway already had high employment levels relative to their populations prior to the highway improvement. The cities in the “highway” class include the three largest cities in the county (Willmar, New London and Spicer), which likely serve as higher-order trade centers, accounting for much of this difference. However, it is important to note that the difference between the coefficients of the $H_{before}$ and $H_{after}$ variables, which measure the change in the residual difference between highway cities (both before and after the improvement) and the baseline case (non-highway cities observed before the improvement), is very small and not statistically significant, indicating that the effect of location did not improve as a result of the highway expansion. Stated differently, the advantage of being located on the improved highway segment (relative to location in a non-highway city) did not change as a result of the completion of the highway improvement.

Lastly, we also consider the variables representing cities located upstream or downstream from the improved segment of highway. We include in this class all cities located on either US 71 or TH 23 that are not within the improved segment.
of highway (the Willmar Bypass or the expanded stretch of TH 23). The difference between the \( U_{\text{before}} \) and \( U_{\text{after}} \) coefficients is about 9 percentage points and in the positive direction, indicating that there may be some change in employment for cities in this class relative to those in the non-highway class due to the highway improvement. We can formally test for equality of the two coefficients using Welch’s t-test to determine whether or not the observed difference in coefficients is likely due to chance variation. The test statistic generated for the null hypothesis of equality of the two coefficients was -1.56, which corresponds roughly to a \( p < .12 \) level of significance. This is not particularly strong evidence against the null hypothesis that the two coefficients are equal, hence we cannot confidently state that the observed difference resulted from the effect of the highway improvement, as opposed to simply chance variation in the data.

**TH 371 Expansion**

The second case study we consider is the expansion of TH 371 between Little Falls in Morrison County and the Brainerd/Baxter area of Crow Wing County, including the Brainerd Bypass. As described previously, this project expanded TH 371 between the two locations to four lanes in each direction, adding several new interchanges and the bypass around the central business district of Brainerd. This case study contains the largest sample of the three case studies fully analyzed in this section. This is due to the fact that we include both Crow Wing and Morrison Counties in the sample, as the improved highway traverses significant parts of both counties. We estimate the impacts of this project in the same manner that we did the US71/TH23 case study.

The results in Table 5 again indicate a good overall fit for the model, with the population and income variables both having the expected sign and level of significance. The coefficient of the population variable is very similar in magnitude to the one estimated in the US71/TH23 case, though the coefficient of the income variable is somewhat larger. The variable representing non-highway cities shows no indication of a change in employment as a result of the completion of the highway improvement. The coefficient for the variable representing the cities located on the improved highway (Baxter, Brainerd, Camp Ripley and Little Falls) after completion of the improvements is slightly larger in magnitude than the variable for the same set of cities observed before completion of the highway improvement. However, the magnitude of this difference is small relative to the estimated standard errors of the coefficients, indicating that this difference is well within the error bands of the two coefficients and unlikely to represent a statistically sig-
significant effect. The same is true of the variables representing the cities located upstream and downstream from the improved segment of TH 371. The difference in the estimated coefficients is small, both in absolute terms and, more importantly, relative to their respective standard errors. Therefore we have no evidence from this case study that the highway improvement had a statistically significant effect on employment levels.

**US 53 Expansion**

The context for our third case study, the expansion of US Highway 53 north of Virginia, Minnesota in St. Louis County, is slightly different than the previous two and thus requires a modification to our empirical approach. The improvements to US Highway 53 that are the focus of this case study are an expansion to four lanes of an 11-mile segment of the highway between the towns of Virginia and Cook. Unlike the previous two case studies, the improved segment of US 53 in this case does not pass through any cities. Thus, we cannot define the location characteristics of the cities in the sample in the same way that we treated the previous cases. As an alternative, we retain the variables representing cities upstream and downstream from the improved highway (in this case including all cities in St. Louis County along US 53) and add a classification for cities not located immediately along the highway, but within 10 miles of it. These are the variables labeled $A$ in Tables 4 and 5 to indicate their adjacency to the improved highway. The definition of non-highway cities is adjusted accordingly to include all cities not within 10 miles of US 53. The definition of cities in the “adjacent” class allows us to account for the unique geographic clustering of several mining towns near US 53 in the Iron Range region of the county.

The results of the model for the US 53 improvements in Table 5 show similar findings to those in the previous two case studies. Population and income variables have similar signs and magnitudes to those included in the other models. Again, employment in non-highway cities do not appear to have been affected by the completion of the improvements. The coefficient for the $U_{after}$ variable, indicating the effect on employment in cities located on Highway 53 after the completion of the expansion project, is smaller than the corresponding variable for the pre-improvement period, though again this difference is too small to register as statistically significant. The same is true for cities located within 10 miles of the highway, as indicated by the adjacency variables. Overall, the model results appear to reject the notion of statistically significant employment impacts due to the expansion of the highway.
Conclusions

The findings of no statistically significant impacts on earnings and employment from the two sets of empirical analyses at the core of this study, while consistent, do require some caveats. First, we note that in both of the empirical applications there were relatively few years in the time period following the construction of the highway improvements in each of the case studies. This was especially true for the analysis of the employment data, where only 11 years were available, and thus the period of analysis was somewhat compressed. Likewise, in both cases the latter years in the sample corresponded to a fairly deep depression, from which most US states are continuing to recover. Thus, it may be useful to continue to track the economic growth paths of the case study locations for several years following the completion of this study and, if necessary, to update the analysis.

We note that our findings are in general agreement with a number of other recent studies of highway improvements, including those focusing on rural regions, which have found modest to insignificant economic impacts of network expansions [4, 20, 14]. These findings are broadly attributed to the maturity of the highway network [9, 8] and the relatively modest improvements in travel time brought about by the projects in question. In a similar vein, others have noted the importance of distinguishing between average and marginal net rates of return [7] in studies where transportation infrastructure is treated in a more aggregate fashion and longer time series are used.

We do not interpret the results of our analysis as necessarily providing prima facie evidence that the projects in question were not cost-effective or economically viable. Rather, we suggest that projects like these should continue to be evaluated based on their ability to deliver benefits to users. Travel time savings, safety benefits, and other types of measurable social benefits, such as reductions in pollutant emissions, are the core justification for undertaking improvements to highways and other transportation networks. Moreover, focusing only on jobs created or local income effects may cause analysts to lose sight of the fact that for highway improvement projects like those covered in this study, many of the benefits may be diffuse and accrue to non-local users of the highway. The focus on user benefits seems particularly appropriate in light of the fact that there are few projects that could not pass a standard cost-benefit test, yet also be expected to provide sizable economic development benefits. We believe this observation applies not only to the rural highway expansion projects examined here, but more broadly to the majority of transportation projects under consideration at state DOTs and local planning organizations.
References


Table 1: Descriptive statistics for TH371 and US71/TH23 project case studies

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Table 2: Industry-level earnings regressions for TH 371 improvements

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Table 3: Industry-level earnings regressions for US 71 improvements

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<td>Coeff.</td>
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<td>S.E.</td>
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<tr>
<td>ln $P_{it}$</td>
<td>0.926</td>
<td>0.011</td>
<td>84.88</td>
<td>0.921</td>
<td>0.012</td>
<td>78.44</td>
<td>0.912</td>
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<td>ln $I_{it}$</td>
<td>0.660</td>
<td>0.013</td>
<td>49.24</td>
<td>0.822</td>
<td>0.019</td>
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<td>$O_{after}$</td>
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<td>0.028</td>
<td>0.07</td>
<td>-0.014</td>
<td>0.036</td>
<td>-0.38</td>
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<td>11.60</td>
<td>0.126</td>
<td>0.067</td>
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<tr>
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<td>0.041</td>
<td>12.90</td>
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<td>-5.91</td>
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<td>0.060</td>
<td>0.59</td>
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<td>0.038</td>
<td>-4.69</td>
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<td>0.140</td>
<td>-48.48</td>
<td>-7.959</td>
<td>0.181</td>
<td>-43.98</td>
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Figure 1: Location of cities relative to improved highway segment