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MODEL FOR PREDICTING THE IMPACT UPON ECONOMIC DEVELOPMENT RESULTING FROM HIGHWAY IMPROVEMENT PROJECTS

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Model for Predicting the Impact upon Economic Development Resulting from Highway Improvement Projects

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16. Abstract

The Nebraska Department of Roads (NDOR) has an interest in integrating state economic development impact as another factor in prioritizing transportation investments. Such efforts require the development of a comprehensive model that can be used to estimate a consistent final measure of economic development impact that can be readily integrated into existing prioritization formulas. This report summarizes the efforts of the University of Nebraska-Lincoln Bureau of Business Research (UNL-BBR) to develop such a model, by measuring the impact of expressway, viaduct, and other major investments projects around the state. Specifically, UNL-BBR developed an economic model to predict the economic impact of transportation investments based on relevant factors such as the magnitude of the investment and the region's population or economic activity. This report summarizes the model and explains how it was developed. The model itself is contained in a separate Excel workbook which can be utilized to make estimates of the economic impact of highway investments. We estimated that the economic impact of the highway investment projects in Nebraska based on 47 major investment projects in the state from the last two decades. We found mixed evidence that highway capital investments led to faster growth in manufacturing wages and total wages in the decades that followed. Generally speaking, larger investments taking place in larger counties tended to yield a positive economic impact; that is, growth in the county receiving the investment was faster than growth in control counties. Small investments in smaller counties, however, did not clearly generate an economic impact. These empirical findings were used to generate an economic model to predict the economic impact of highway investments in Nebraska. This model can be utilized by NDOR in the coming years and can be readily updated for continued use in the future.

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Executive Summary

The Nebraska Department of Roads (NDOR) has an interest in integrating state economic development impact as another factor in prioritizing transportation investments. Such efforts require the development of a comprehensive model that can be used to estimate a consistent final measure of economic development impact that can be readily integrated into existing prioritization formulas.

This report summarizes the efforts of the University of Nebraska-Lincoln Bureau of Business Research (UNL-BBR) to develop such a model, by measuring the impact of expressway, viaduct, and other major investment projects around the state. Specifically, UNL-BBR developed an economic model to predict the economic impact of transportation investments based on relevant factors such as the magnitude of the investment and the region's population or economic activity.

This report summarizes the model and explains how it was developed. The model itself is contained in a separate Excel workbook, housed at the Nebraska Department of Roads, which can be utilized to make estimates of the economic impact of highway investments.

We estimated that the economic impact of highway investment projects in Nebraska based on 47 major investment projects in the state from the last two decades. We found mixed evidence that highway capital investments led to faster growth in manufacturing wages and total wages in the decades that followed. Generally speaking, larger investments taking place in larger counties tended to yield a positive economic impact; that is, growth in the county receiving the investment was faster than growth in control counties. Small investments in smaller counties, however, did not clearly generate an economic impact.

These empirical findings were used to generate an economic model to predict the economic impact of highway investments in Nebraska. This model can be utilized by NDOR in the coming years and can be readily updated for continued use in the future.

Chapter 1 Introduction

The Nebraska Department of Roads prioritizes potential highway investments in Nebraska on an ongoing basis and in the development of its 6-Year Transportation Plan. Investment projects are prioritized according to multiple criteria, including benefit-cost analyses, but NDOR has an interest in integrating state economic development impact into the process of prioritizing transportation investments. Such efforts have begun. For instance, modeling is now included as part of the TIGER grant program. However, NDOR has an interest in the development of a comprehensive model that can be used to estimate a consistent final measure of economic development impact that can be readily integrated into existing prioritization formulas.

This report summarizes the efforts of the University of Nebraska-Lincoln Bureau of Business Research (UNL-BBR) to develop such a model. Specifically, the objective was to develop a comprehensive model that can be used to estimate the statewide economic development impact of transportation capital improvement projects, such as road widening, new interchange construction, geometric corrections, bypasses, and highway/railroad grade separations. The benefit of a comprehensive model is that it would be flexible enough to account for the varying impact of different capital improvement projects but would also generate a single measure that could be combined with other measures (such as a benefit-cost analysis) when prioritizing projects.

Such a model was developed based on estimates of the economic impact of four dozen major investments in the expressway system, viaducts, and other larger projects in Nebraska since the late 1980s. The comprehensive model produces consistent metrics (i.e., apple to apple comparisons) across different types of highway projects and, therefore, provides a single measure of economic development impact: the increase in wages in basic sectors of the economy. In the model, wage impacts vary with relevant factors such as the magnitude of the investment and the level of population or economic activity in the region where the highway improvement takes place.

The research team proposes that the single measure for comparing economic impact among projects would be the present value of the wages created as a result of the highway investment per the number of dollars invested. Note that this measure of economic development impact would not overlap with or duplicate road user benefits measured in the benefit-cost analysis already undertaken by the Nebraska Department of Roads.

This report summarizes the model and explains how it was developed. The model is contained in a separate Excel workbook which can be utilized to make estimates of the economic impact of highway investments. The workbook contains current values for each impact model variable for each Nebraska county. The spreadsheet also contains economic multipliers for Nebraska so that total wage impacts for all Nebraska industries could be calculated based on modeled impacts in primary industries. The model can be readily implemented by Nebraska Department of Roads personnel.

Chapter 2 summarizes our review of research and survey of states about the economic impact highway development has on state and local economies. Our complete literature review is also provided in Appendix 1. Chapter 3 provides a description of the capital investment projects that were analyzed and lists the counties that “hosted” one or more of the projects. The section also lists the “control” counties without a major NDOR investment that were used for comparison. Chapter 4 provides a description of our comparison model. The model compares growth trends between treatment counties—which hosted a highway capital investment—and their control county as a function of project or county characteristics. The data sources for the model are provided in Chapter 5. Model results are provided in Chapter 6, which also provides a description of the economic impact model provided in the companion Excel workbook. A summary is provided in Chapter 7.

Chapter 2 Literature Review and Survey of States

The UNL-BBR conducted a review of economics and transportation literature evaluating the economic impact of highway capital investments on states and localities. UNL-BBR further conducted a survey of state transportation agencies to learn: 1) how other states include economic impact considerations into decisions about highway investments and 2) how these states measure economic impact. The research team worked with TAC members and other NDOR staff to develop the set of questions for the survey. A detailed summary of the literature review, survey of states, and findings is provided in Appendix 1 to this report. A copy of the survey questionnaire is provided in Appendix 2.

The literature review and survey of state agencies reinforced our proposed comparison-of-growth methodology. We found that a variety of researchers have utilized a treatment-control group methodology when assessing the economic impact of projects. Further, the states that were active in conducting economic impact studies for their transportation investments tended to utilize models that evaluated projects using a consistent methodology. Their methodologies were sensitive to the specific characteristics of the highway investment (i.e., amount of traffic, the number of miles) as well as the specific characteristics of the communities where the investment took place. Representatives of state transportation agencies also emphasized economic development measures that functioned on a per dollar basis. For example, one state examined regional valued added (Gross Regional Product) per investment dollar, while another respondent from a different state proposed a measure for jobs created per dollar of investment.

The proposed methodology for this study uses such a measure, and we also propose to develop a model where estimated economic development impacts will vary according to the characteristics of the highway investment and the community where the investment takes place. In other words, our literature review supports the empirical methodology we have proposed for this research study. As noted, our treatment-control modeling pairs are discussed in the next chapter, while our specific growth model as a function of highway investment and county characteristics is described in Chapter 4.

Chapter 3 Projects Analyzed and Treatment and Control Counties

With the help of NDOR staff, UNL-BBR researched the timing of larger highway capital investment projects in Nebraska since the late 1980s. This timeframe included the period when development proceeded on the state expressway system, and is also the time period for which electronic records are available. As noted, UNL-BBR gathered information on the timing and amount of investment in three basic types of projects:

- Expressway Projects
- Viaducts
- Other Projects (individual capital improvement projects over $6 million in cost)

The expressway category covered most bypass projects and also most widening projects, in which roads were expanded from two lanes to four lanes. Viaduct projects were collected in their own category. Other projects, such as interchange construction, other bridge work, major geometric correction, and major grade improvement or paving projects were captured in the Other Projects (over $6 million) category. Most projects in the Viaducts and Other Projects (over $6 million) categories primarily impacted only a single county. However, highway infrastructure investments in the Expressway category often impacted multiple counties. Table 3.1 provides a list of each county which “hosted” a major investment in an expressway, viaduct, or other major investment. The table also shows the period of investment activity and whether the project fell under the Expressway, Viaduct, or Other Projects category. Note that projects that were completed after 2006 were not listed. At the time of research, not enough data was available for the post-project period for such projects to be useful in our economic impact analysis. Further, note that some counties received more than one major investment since the late 1980s. If investments took place many years apart, then the county would be considered to have received two separate investments and would be entered twice in the table. Otherwise, the multiple investments were treated as one major investment.

Finally, if an expressway project impacted a county during the same period as another type of major investment, the combined project was considered an expressway project.

As seen in table 3.1, there were a total of 47 treatment episodes. The table also shows the control counties that were selected for each treatment county. Control counties were those counties which did not have an expressway, viaduct, or other major highway investment and were most similar to a treatment county. This type of control region comparison has been proposed or used successfully in other research regarding highway impacts (Thompson, Rosenbaum, and Hall 2008; Thompson, Miller, and Roenker 2001; Rephann and Isserman 1994). Similarity was determined based on the shares of aggregate county income due to manufacturing earnings, agricultural earnings, services earnings, transfer payments, dividend and interest income, and commuting. Counties were also evaluated based on similarity of total population and proximity to Interstate 80.

Table 3.1 Treatment and Control Counties

Treatment County	Time Frame of Investment	Type of Investment	Control County
Adams	1996-1999	Expressway	Phelps
Banner	1994-1997	Expressway	Webster
Box Butte	2000	Viaduct	Clay
Boyd	2005	Other Major Investment	Garfield
Buffalo	1996-2003	Viaduct	Thurston
Butler	2000	Other Major Investment	Pawnee
Cedar	2001	Other Major Investment	Burt
Chase	2001	Other Major Investment	Clay
Colfax	2001-2004	Expressway	Phelps
Custer	1994	Other Major Investment	Nuckolls
Custer	2003	Other Major Investment	Nuckolls
Dawes	2003	Other Major Investment	Sheridan
Dawson	1989	Viaduct	Thurston
Dawson	2005	Viaduct	Thurston
Dixon	2001	Other Major Investment	Merrick
Dodge	1992-1997	Expressway	Burt
Fillmore	1999-2002	Expressway	Antelope
Gage	1990-1993	Expressway	Keith
Hall	1996	Viaduct	Phelps
Hall	2003	Other Major Investment	Phelps
Hamilton	1998	Viaduct	Burt
Harlan	2003	Other Major Investment	Knox
Holt	2005	Other Major Investment	Brown
Howard	1996	Other Major Investment	Pierce
Jefferson	2000	Viaduct	Keith
Johnson	1999	Other Major Investment	Brown
Kimball	1997	Expressway	Brown
Lincoln	2000-2003	Viaduct	Keith
Madison	1991-1998	Expressway	Phelps
Morrill	1995	Viaduct	Kearney
Nemaha	2005	Other Major Investment	Garfield
Nuckolls	2004	Other Major Investment	Keith
Otoe	2003	Other Major Investment	Burt
Otoe	1993-1999	Expressway	Burt
Platte	1995-1999	Expressway	Saline
Polk	1991	Expressway	Webster
Red Willow	1996	Other Major Investment	Garfield
Richardson	1996	Other Major Investment	Sheridan
Sarpy	2003-2005	Viaduct	Saline
Scotts Bluff	1999-2006	Expressway	Keith
Seward	1996	Viaduct	Dixon

Stanton	2002-2003	Expressway	Kearney
Thayer	1994-1998	Expressway	Antelope
Washington	1999	Viaduct	Saline
Washington	2005	Other Major Investment	Saline
Wayne	2001-2005	Other Major Investment	Merrick
York	1999-2000	Expressway	Burt

Due to these multiple criteria, some control counties were selected multiple times. The research team felt that it was better to pick the same county as a control for multiple treatment counties than to settle for other control counties which were more poorly matched.

Chapter 4 Economic Impact Model

The analysis of economic impact focuses on the relative growth of the primary economic sector of manufacturing. This is because the manufacturing industry contains the types of businesses that serve multistate, national, or even international markets and can achieve a net advantage over competitors in other states due to transportation improvements, spurring state economic growth.[1] For example, such positive impacts were identified for primary sectors (i.e., manufacturing) due to interstate highway investments by Chandra and Thompson (2000). As a result, by focusing on the impact on primary sector activity, we can be confident that localized impacts in sectors such as manufacturing will also be statewide impacts.

For each treatment county in table 3.1, UNL-BBR gathered data for other control variables associated with growth in primary sector activity including region population, proximity to metropolitan areas (or location within a metropolitan area), existing primary sector activity in the region (a measure of agglomeration, such as the number of primary sector establishments)[2], and an indicator of preparedness for economic development. This last indicator would show whether the county was prepared for economic development via other measures, such as having well-developed industrial parks and economic development organizations. The research team also gathered information about the highway investment project, such as the amount of money spent or volume of traffic on the highway before the investment, measured via AADT.

A regression equation was estimated to evaluate whether regions receiving highway investments had faster growth in manufacturing wages and to determine how that impact varied with

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[1] Locally oriented industries such as retail and most services, by contrast, would primarily see a redistribution of existing business activity due to highway improvements, as low cost providers would capture a larger share of the market as the cost of transportation falls. Retail and services could expand in response to a growth in primary employment, and this proposal describes how this secondary impact can be measured.

[2] Wage data for county and multicounty regions would be derived from the Regional Economic Information System of the U.S. Department of Commerce. This database also contains information on county population. Data on the number of primary sector establishments in each region will be derived from firm counts in the County Business Patterns publication of the U.S. Department of Commerce. Data on effective tax rates will be derived from each state’s Department of Revenue, while information on energy prices will be derived from the Energy Information Administration of the U.S. Department of Energy.

county and project characteristics. The dependent variable was the percentage growth in manufacturing wages in the treatment county minus the percentage growth in manufacturing wages in the relevant control county.

Specifically, a regression model of primary sector wage growth would be estimated for treatment regions (regions that receive the capital improvement) and the identified sample of control regions. In the regression equation, relative growth in manufacturing wages was a function of the treatment counties' characteristics, such as population, metropolitan proximity, and existing primary sector activity (a measure of agglomeration, such as number of establishments). This can be seen in the equation below.

Relative Growth of Manufacturing Wages =

b0 + b1*population + b2*metroproximity + b3*primary sectoractivity +
b4*highwayinvest + b5*highwayinvest*AADT +
b6*highwayinvest*developmentreadiness + b7*highwayinvest*population

In the equation, the size of the investment is interacted with a set of key county characteristics (population and development readiness) and project characteristics (AADT). The coefficient estimates b0 through b7 indicate the degree to which the economic development impacts vary with these characteristics.

As noted earlier, an advantage of this modeling approach is that simulations using the model will show how the impacts of highway investments vary based on the specific characteristics of the investment project and the affected regional economy. Estimates of the impact on growth on manufacturing wages were made 2, 4, 6, and 8 years after the highway investment is completed. Results for 10 to 20 years after project completion were not available due to the limited sample size. In particular, many projects were completed in the late 1990s or during the 2000s, and 10 years of post-project data was not yet available. Impact estimates for years 2 through 8 were used to extrapolate for years 9 through 20.

After calculating the impact on manufacturing wages, the UNL-BBR research team estimated the total economic impact on wages in all industries but, specifically, wages in secondary industries such as retail trade and services. The economic impact model IMPLAN was used to make the calculations. The research team developed an economic multiplier for Nebraska that shows the ratio of total Nebraska wages (including both primary and secondary industry wages) for each dollar of manufacturing industry wages. A similar set of multipliers were previously developed by Thompson (2007).[3] These multipliers were applied to the total manufacturing wage impacts for years 0 through 20 that were described above. The result was an estimate of the total wage impact across all industries for each year. The present value of these 20 years of wage impacts was then calculated utilizing a 7% real discount rate.

This present value was the basis for our basic measure of the economic impact of highway investment projects. In particular, for each project, the present value of the wage impact would be divided by the total cost of the project. This single economic development impact measure could be utilized by the Nebraska Department of Roads in its formulas for prioritizing highway investment projects, along with other measures like benefit-cost analyses.

[3] Thompson, Eric, *Technical Documentation for the Lincoln Economic Development Impact Model* (Bureau of Business Research Report for the Lincoln Partnership for Economic Development, 2007).

Chapter 5 Data Sources

Data for running the above regression equation came from a variety of sources. The first source was the manufacturing wage data for treatment and control counties. This data was available through the year 2008[4] for all Nebraska counties from the *Regional Economic Information System* from the Bureau of Economic Analysis of the U.S. Department of Commerce. Relative manufacturing wage growth was measured beginning the year after the highway investment was completed. This was also the source for the population of each treatment county. Population was taken for the year in which the highway investment was completed. Data for metropolitan proximity was from the Economic Research Services of the U.S. Department of Agriculture. We utilized the Urban Influence Codes to determine which counties were adjacent to a metropolitan area or which were a micropolitan area.

Primary sector activity was estimated based on the total number of manufacturing establishments in a treatment county in the year in which the highway investment was completed. Counts of manufacturing establishments were taken from the *County Business Patterns* database of the Bureau of Census, U.S. Department of Commerce. Data on preparedness for economic development were taken from the Nebraska Department of Economic Development. All Nebraska counties that contained at least one community certified for economic development by the Nebraska Department of Economic Development received a value of 1 for the economic preparedness variable. All other counties received a value of 0.Finally, data on AADT and the dollar amount of highway investment were gathered directly from the Nebraska Department of Roads, and UNL-BBR calculated the AADT in the year in which each investment project was finished .

Table 5.1 shows the summary statistics for the model variables. Mean values and standard deviations are provided. Variable names are largely self-explanatory. Population stands for the initial population in the county receiving the highway investment; investment refers to the level of

[4] Data was also available for 2009 but was not used due to the severe recession that occurred during that year.

investment. Micropolitan indicates whether the county receiving the investment was a micropolitan county. Results indicate that with rounding, 26% of projects were viaduct projects, while 32% of projects were expressway investments and 43% were other types of investments. The variable establishment refers to the count of manufacturing establishments in a county, a measure of potential growth benefits from industry concentration. Ready refers to whether a county was ready for development because it included one or more communities certified for development by the Nebraska Department of Economic Development.

For most variables, the standard deviation exceeds the mean value. This emphasizes that there was great variance among the characteristics of the projects, including the amount of the investment, the population of the "host" county, the initial number of manufacturing establishments in each county, and the level of AADT on the road receiving improvements. Our data set includes projects with a great variety of scope. Finally, note that summary statistics for relative manufacturing wage growth in treatment counties (relative to control counties) are provided in the next chapter.

Table 5.1 Summary Statistics

Variable	Mean	Standard Deviation
Population	18,300	21,470
Investment	$21,092,414	$21,993,664
Micropolitan	0.28	0.45
Establishments	23	25
Ready	0.43	0.50
AADT	4,728	3,665
Expressway	0.32	0.47
Viaduct	0.26	0.44
Other Project	0.43	0.50
N	47	47

Chapter 6 Regression Results and Description of Simulation Model

Data on manufacturing wages were utilized to calculate the difference in the growth rate of manufacturing wages in control counties and treatment counties. Differences in growth rates were measured for 2, 4, 6, and 8 years after each highway investment project was completed. Results are cumulative, so results for 8 years show the cumulative difference in growth rates over 8 years. Separate results are provided for expressway, viaduct and other types of projects in Table 6.1. Aggregate results for all types of projects are also presented.

Initially, after 2 years, manufacturing grew more slowly in treatment counties than in control counties. Average growth rates were higher for treatment counties 4 years after highway projects were completed, but were lower again after 6 and 8 years. The exception was expressways, where treatment counties had faster average growth than control counties 4, 6, and 8 years after completion of the highway investment.

However, it is fair to say that these growth averages do not show clear evidence that manufacturing growth accelerated in counties that received highway investments. Results were mixed. Further, the estimates presented in table 6.1 are merely averages, and none of these averages is statistically different than 0. As is seen in table 6.2, sample sizes were quite low, particularly 8 years after completion.

We therefore examined how the characteristics of highway investments and the counties influenced manufacturing growth.

Table 6.1 Average Difference in Manufacturing Wage Growth between Treatment and Control Counties

	Cumulative Manufacturing Wage Growth After			
Type of Investment	2 Years	4 Years	6 Years	8 Years
Expressway	-8.5%	8.8%	4.6%	5.0%
Viaduct	-6.4%	-6.6%	-4.5%	-23.2%
Other	6.8%	6.1%	-9.5%	-36.9%
All Projects	-1.4%	3.7%	-2.8%	-13.0%

Table 6.2 shows the regression results from estimating the full regression model described above (model 1) as well as a simpler model containing only key variables (model 2). Estimates are provided for 2, 4, 6, and 8 years after project completion.

Generally speaking, model 2 had a more consistent and statistically significant set of results. This model included the key variables of size of the investment and the population in the county receiving it (this population is typically also correlated with AADT). We did not find that adding more variables to the simple model increased its explanatory power. In fact, these additional variables detracted from the consistency of model results, as sometimes occurs when the sample size is limited.

Focusing on the results for model 2, the estimated values for natural log of population and investment were always positive. In years 2, 4, and 8, coefficient estimates were statistically significant for one of these variables. The model, however, performed poorly for year 6. Overall, the results from model 2 are the basis of our economic impact analysis. In particular, these models appear to produce different impacts for various projects; larger investments in more populous counties tended to have positive economic impacts whereas smaller projects in sparsely populated counties had no impact.

Table 6.2 Regression Results

	2 Years		4 Years		6 Years		8 Years	
Variables	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	-2.56	-3.07***	-26.56[c]	-2.95**	-25.91	-2.13	-88.24**	-5.37*
	(11.75)	(1.10)	(16.66)	(1.21)	(26.37)	(1.80)	(30.76)	(2.58)
LN(Population)	0.091	0.17***	2.67	0.061	2.64	0.068	8.85**	0.10
	(1.27)	(0.06)	(1.82)	(0.071)	(2.86)	(0.12)	(3.32)	(0.16)
LN(Invest)	-0.017	0.08	1.57[c]	0.14**	1.59	0.09	5.38**	0.26*
	(0.73)	(0.06)	(1.02)	(0.07)	(1.60)	(0.10)	-1.86	(0.15)
Micropolitan	-0.19		-0.20		-0.63**		-0.74**	
	-0.15		(0.16)		(0.29)		(0.33)	
Establishments	-0.005		-0.002		0.008		0.01	
	(0.005)		(0.005)		(0.11)		(0.01)	
LN(Invest)*LN(POP)	0.013		-0.16		-0.16		-0.54**	
	(0.08)		(0.11)		(0.17)		(0.20)	
LN(Invest)*Ready	0.003		0.14		0.004		0.01	
	(0.009)		(0.01)		(0.17)		(0.02)	
LN(Invest)*AADT	$-8.3*10^{-7}$		$5.3*10^{-7}$		$1.1*10^{-7}$		$2.6*10^{-7}$	
	$(1.3*10^{-6})$		$(1.5*10^{-6})$		$(2.7*10^{-6})$		$(3.2*10^{-6})$	
Viaduct	0.023		-0.05		-0.011		0.19	
	(0.21)		(0.22)		(0.33)		(0.49)	
Other Project	0.23	0.29**	0.10	0.14	-0.041	-0.02	0.09	-0.10
	(0.17)	(0.12)	(0.18)	(0.13)	(0.29)	(0.21)	(0.42)	(0.35)
N	47	47	38	38	29	29	21	21

NOTE: c= statistically significant at 15% criteria, * at 10% criteria, ** at 5% criteria, *** at 1% criteria

Results from model 2 in table 6.2 are utilized to develop an Excel workbook-based simulation model to calculate the economic impact of highway capital investment projects in Nebraska. The simulation model provides an estimate of the annual impact on total wages in the state, the present value of that impact, and a ratio between the present value of the wage impacts and the amount of the project investment. This latter measure may be of use to NDOR to assess the economic impact component of highway investments.

The Excel workbook-based simulation model is provided separately, but is easy to utilize. The model operator simply types project characteristics such as the amount invested and whether the project was an expressway, a viaduct, or other type of project. The operator then types in the population and the total manufacturing wages of the county receiving the highway investment. For the three largest counties in Nebraska—Douglas, Lancaster, and Sarpy—the model operator would provide total manufacturing wages for the zip codes where the transportation investment would occur.

The model also relies on underlying economic assumptions, such as the annual growth in real manufacturing wages and the discount rate (used to place future manufacturing wages in terms of present value). These economic variables are provided but the model operator can change these.

The model automatically calculates the annual wage impact for each of the next 20 years. The model calculates the manufacturing wage impact based on the results in table 6.2 for 2, 4, 6, and 8 years. This calculation occurs internally to the model but is based on the percentage differences in manufacturing wage growth between a control county and the treatment county with its given characteristics. The growth impact is then multiplied by the level of real manufacturing wages to estimate the level of economic impact in each year. The cumulative growth rate impacts are utilized for years 2, 4, 6, and 8, and growth rates are interpolated to provide estimates for years 1, 3, 5, and 7.

The simple average of the 2-, 4-, 6-, and 8-year growth impact is utilized to provide an estimate for years 9 through 20.

The method above is utilized to estimate the economic impact in terms of manufacturing wages. This is not the total wage impact, however. An impact on manufacturing wages will yield an impact on other industries in both the county and the state. To calculate this additional impact, we estimated an economic multiplier for manufacturing wages, which showed that each dollar of new manufacturing wages yields more than an additional dollar in other wages statewide. This ratio, which is approximately 2.4 (or $1.4 additional dollar of wages for each $1 of direct manufacturing wages) is used to turn annual estimates of the manufacturing wage impact into annual estimates of the total wage impact.

The total annual wage impact is a useful measure of economic impact. However, for some purposes, it may be useful to calculate the present value of annual wage impacts. A discount rate is used to calculate the present value of wage impacts in future years and these present values are added over the next 20 years to calculate the overall present value of the investment. This investment also can be divided by the amount of the investment to calculate the economic impact ratio for all investment projects. As noted earlier, these calculations are automatically calculated by the impact model.

Chapter 7 Summary

We developed a model to simulate the economic impact of highway investment projects in Nebraska based on 47 major investment projects in the state of Nebraska over the last two decades. We found mixed evidence that highway capital investments led to faster manufacturing and overall economic growth in the decades that followed. Generally speaking, larger investments taking place in larger counties tended to yield a positive impact on wages, where growth in the county receiving the investment was faster than growth in control counties. Small investments in small counties, however, did not clearly generate an economic impact on wages.

These empirical findings were used to generate a model to predict the economic impact of highway investments. This model can be utilized by the Nebraska Department of Economic Development. We also recommend that the model be updated in future years.

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Appendix 1 Detail on Literature Review and Survey of States

I. Introduction

Drawing on its previous work and understanding of the literature, the UNL-BBR research team has developed a model to evaluate the impact of highway investments on economic development in Nebraska. That model incorporates a number of the preferred approaches to evaluating impacts on the real economy. However, it is always worthwhile to take a renewed, in-depth look at the best practices and approaches to any economics question. In the current case, such a review of the literature included an evaluation of pertinent published and unpublished research on modeling the economic impact of transportation investments and an evaluation of the best practices in states around the nation.

This literature review provides such an analysis. We begin by conducting a review of recent literature evaluating the economic impact of highway investments. The research team had a particular interest in the evaluating statistical methodologies that were used, and the findings on key issues such as 1) whether different types of investments must be evaluated separately, 2) how to value the importance of access to metropolitan areas and amenities in determining the impact of investments, and 3) whether there would be linear or non-linear relationship between the scope of investment projects and their economic impact. Findings are presented in the next subsection of this appendix.

This review also considered the current best practices in other states. The BBR research team developed worked with personnel at the FHWA to identify 10 states with innovative approaches to assessing the economic development impacts of highway investments. The research team also developed a questionnaire to inquire about the approaches that are used, the frequency at which economic develop impacts are considered, and the importance that economic develop impacts are given in assessing potential investments. Project principal investigator Eric Thompson contacted key personnel in these 10 states as well as in five states adjacent to Nebraska in order to ask them the discussion questions listed in Appendix 2. The findings from this analysis are provided in the third section of this appendix. The conclusions from research are summarized in the fourth section.

II. Review of Recent Research

The research team investigated pertinent articles from economics literature examining the relationship between highway investments and economic development. The team focused on economics models because the project was designed with an approach consistent with economics practices, such as the selection of control geographies to isolate economic development impacts and models of growth. The term economic development is used to refer to growth in the economy as measured by key economic variables, such as employment, wages, or output.

The following summary provides a brief description of the most compelling articles we reviewed. The most recent articles were considered first. The remaining articles reviewed are summarized in the next subsection, which is followed by a discussion of what the papers as a group indicate about key issues like testing methodology, pooling of projects, the role of population and accessibility, the magnitude of the project, and the size of the impact region.

A. Summary of Articles

Gkitza et al. (2008): This innovative article had several key findings relating to our methodology. First, the authors utilized Chow tests to consider whether the economic development impacts varied by type of project. The finding was that test results rejected the pooling of projects that added lanes with other types of major investment projects, such as building new roads, adding a median, or adding an interchange. This result provides support for our decision to run separate regression analysis for different types of highway investments. Gkitza et al. (2008) also found that improvements to interstate highways had a stronger potential economic impact than improvements on other components of the highway system. This suggests that findings in regard to economic development impacts in the current study may not be as large as those found in studies of rural interstates such as Chandra and Thompson (2000) or Rephann and Issserman (1994). The authors had other noteworthy approaches to methodology or key findings in regard to core issues like accessibility or magnitude of project.

Berechman et al. (2006): The paper looked at the relationship between highway investments and economic activity at the municipal, county, and state levels over time. The authors utilize a production function approach and examine the impact of highway capital on economic output using data from the 1990 to 2010 period. The authors found that highway impacts have a nearly immediate impact on the local economy and that the impact, once established, grows over time. These results differ from those of Rephann and Isserman (1994) and Chandra and Thompson (2000), who found that impacts grew over time in metropolitan areas. The impacts of highway investments are larger for larger geographies (states versus counties versus municipalities), suggesting that there are substantial spillover impacts from highway investments into adjacent areas.

Chandra and Thompson (2000): This article examined the impact of a new interstate highway on the growth by industry of non-metropolitan counties throughout the United States. The model tested for the endogeneity of highway investments and failed to find differences between counties that received interstate highway investments and those that did not. The findings showed that highway growth encouraged manufacturing growth in non-metropolitan regions and that the impact grows over time. However, the research found that retail activity declined in non-metropolitan regions with new highway investments, and many other industries showed no aggregate growth. The study also found that new highway investments grew economic activity in counties that received a highway but led to a decrease in economic activity in adjacent counties. Thus, the primary impact of non-metropolitan highway investments was to re-allocate economic activity within rural regions (toward the highway) and across industries (away from retail trade and towards manufacturing).

Rephann and Isserman (1994): This article was the first to utilize the quasi-experimental matching method to examine the economic development consequences of highway investments. The method was utilized to isolate pairs of "twin" treatment and control non-metropolitan counties. Control and treatment counties were similar with the exception that treatment counties had a new interstate highway located within the counties from 1963 to 1975. Tests were used to ensure that treatment counties (i.e., counties that received a highway investment) were not growing faster than control counties in the period before the highway investment (i.e., no evidence of endogeneity). Results found that cities located near a metropolitan area or which otherwise had a degree or urbanization (25,000+ population) were the most likely to see an economic benefit from highway location. The results show the usefulness of the quasi-experimental method and also show the importance of proximity to population given that positive development impacts occurred in metropolitan, exurban, and micropolitan counties.

B. Summary of Additional Articles

Forkenbrock and Foster (1990): This article examined the role of economic development issues within the framework of highway investments. In an interesting methodological twist, the authors utilized the IMPLAN model to estimate how highway investments have a direct impact on the economy by lowering transportation costs for trucking firms. This is akin to the approach currently used in models such as REMI and TREDIS. Overall, Forrkenback and Foster (1990) concluded that many of the positive localized impacts of highway investments result from the re-allocation of businesses rather than a net increase in business activity.

Levninson and Karamalputi (2003): This article develops a non-linear cost model for new construction or highway expansion that predicts the likelihood that a new segment will be built. The model utilizes data from the Minneapolis area over a two-decade period. The research shows that new segments that provide greater potential access are more likely to be built. The paper may have implications for our current work, considering such an approach can be used to address the endogeneity of highway investment decisions. The approach could be used to test for the possibility that segments were more likely to be built in our control counties than in their comparison twin counties.

Snyder and Associates (1999): This article examined the impact of bypass roads on retail sales, population growth, and property values in Iowa. It used control counties as comparisons when examining population growth and found only mixed evidence of positive economic impacts.

Burress (1996): This article examined the economic impact of bypass roads on employment and retail sales in Kansas, utilized control cities and counties, and found only mixed evidence of a positive economic impact on bypass investments.

C. Implications for Research

These articles provide a number of lessons for designing economic impact analyses of highway investments. These implications occur in key areas such as testing methodology, pooling of projects, the role of population and accessibility, the magnitude of the project, and the size of the impact region. Implications are discussed below, but several key lessons can be drawn. The first is that it is critical to use a methodological framework that avoids problems with endogeneity (whether road investments cause economic growth and vice versa). The second is that research should provide separate tests for the economic impact of different types of projects. The third is that the size of the impacted economy and nearby areas has critical impact on growth. The fourth and fifth are that the economic impact grows with both the magnitude of the project and the impact region, and the modeling framework should account for both. Generally speaking, the model proposed by the Bureau of Business Research team in its initial proposal addresses these issues.

Testing Methodology: Articles such as Forkenbrock and Foster (1990) suggested that it was critical for the research team to consider whether highway investments grow economic activity or tend to rearrange economic activity within the state. Rephann and Isserman (1994) pioneered the use of control and twin treatment counties (the quasi-experimental matching method) for use in assessing highway investments. Other researchers also employed control counties, sometimes in a simple framework (Burress, 1996) or sometimes using a form of the treatment control method suggested by Rephann and Isserman (1994) (Thompson et al. 2001). Among its other advantages, the quasi-experimental matching method can be used in order to test for and mitigate endogeneity issues. Levninson and Karamalputi (2003) provide a framework for addressing the potential endogeneity of highway investments.

Pooling of Projects: Gkritza et al. (2008) ran statistical tests to determine whether it was appropriate to pool data from different types of projects (adding lanes, new roads, adding a median, adding an interchange) in impact analysis. The authors rejected pooling projects that added lanes to roads with other types of projects. This suggests our research team should be careful in pooling different categories of project together.

Role of Population and Accessibility: Gkritza et al. (2008) found that accessibility to airports or universities significantly influenced the economic development impact of highway investments. Rephann and Isserman (1994) found the most evidence of economic development impacts in communities that were located adjacent to metropolitan areas or in counties that already had a significant level of urbanization (i.e., a population of at least 25,000).

Magnitude of Project: Gkritza et al. (2008) found that the number of lane miles in a project had a significant impact on the magnitude of the project's economic impact.

Size of Impact Region: Berechman et al. (2006) found that there are substantial spillover impacts from highway investments into adjacent areas. This suggests that it is important to consider multicounty as well as single-county impact regions when assessing the economic impacts of highway projects in Nebraska.

III. Discussions with State Agencies

The research team sought to supplement its review of the economic and transportation literature by identifying methodologies and practices in other states. The goal was to determine the most common and best practices in other states for measuring economic impact. We also sought to gather information about whether and how states gather and utilize information about economic impact in making their transportation investment decisions. Specifically, the research team developed discussion questions to inquire about the approaches that are used, the frequency at which economic develop impacts are considered, and the importance that economic develop impacts are given in assessing potential investments. A draft of the discussion questions is included in Appendix 2.

The research team contacted the director of planning (or analogous title) in 15 states, and the director or their designate discussed each of the questions in Appendix 2. The 15 states were chosen both to develop the regional practice of adjacent states and to discover best practices from other states around the nation. The five adjacent states included Colorado, Iowa, Kansas, South Dakota, and Wyoming. The research team at the Bureau of Business Research also worked with personnel at

FHWA (specifically, David Luskin) to identify states throughout the nation with innovative approaches of allocating highway investment dollars among projects. The research team settled on contacting the states of California, Kentucky, Minnesota, Missouri, New York, Ohio, Oregon, Texas, Utah, and Wyoming.

A. Discussion Questions

The discussion questions were designed to address whether and when states were conducting studies of the economic development impact of highway investments. A series of questions inquired whether states frequently or at least occasionally conducted such studies. We also asked states if there were particular types of projects that merited economic development analyses, such as widening, bypasses, and grade separation projects. Questions then turned to how states utilized the results of economic development analyses in making decisions about highway investments. We had a particular interest in learning if state's assigned a specific weight (such as 5%, 10%, or 25%) to economic development considerations as part of overall highway investment decisions. The last set of questions turned from practice to opinion. We asked planning leadership for their opinions about the ideal system for measuring and incorporating the economic development impacts of highway investments. Respondents were asked to indicate their preferred methodology for measuring economic impact, and their preferred approach of including economic impact in highway investment decisions.

B. Findings

Among responding states, only one state had a comprehensive program for reviewing the economic development consequences of all investments (other than repaving). The state utilized an economic model (TREDIS) to analyze the economic impact of more than 100 projects under consideration. The state even had formal weighting of economic development within highway investment decision-making.

It was more common for states to evaluate economic development impacts for only specific types of projects. States included economic development impacts as part of Tiger grant applications, naturally. However, our analysis focused on long-term practices outside of the requirements within the temporary ARRA program. In terms of long-term practices, most responding states studied the economic development consequences of only a subset of highway investment projects. There were three types of projects: 1) the largest investment, 2) projects with funds earmarked for economic development, and 3) particular types of investments deemed likely to have economic development consequences.

For projects that were large investments, states may have purchased a comprehensive economic feasibility study considering benefit-cost and financial feasibility but also economic impact. In other words, these states looked at economic development impacts as part of a comprehensive economic study. In these cases, a comprehensive economic assessment was required by the federal government. Other states limited economic development analysis to particular types of investments that were targeted towards economic development. One state limited economic development analysis to interchange projects because the state legislature specifically provided funds earmarked for interchanges, with an emphasis on promoting economic growth. Interestingly, this state relied on its state Department of Economic Development to conduct this analysis. In the third case, state transportation agencies limited economic development analysis to the types of projects that were believed to be most likely to spur economic growth. In particular, one state limited economic analysis to projects that involved new interchanges, road widening, or new roads.

The methodology for assessing economic development impacts varied with the motivation for conducting studies. States that only conducted economic development assessments for the largest investments typically hired a national consulting firm to conduct a comprehensive economic analysis, including economic development. These studies utilized whatever model the consultant used. States that regularly conducted economic development assessments of most potential investments or specific classes of investments (such as widening, interchanges, and new roads) tended to utilize economic models such as REMI and TREDIS. These states required models with the flexibility to predict the economic development impact of different investment projects based on the characteristics of the project (AADT, expense, number of miles affected) or the characteristics of the highway investment region (industry mix, population, or presence of other types of infrastructure). As noted earlier, some state transportation agencies also utilized their state economic development agency for conducting economic development assessments.

The role of economic development within highway investment decisions also varied with the motivation for conducting studies, though the correlation was far from perfect. The state transportation agency that conducted an economic development assessment of most investment projects assigned project economic development (regional value-added per dollar of cost) a 25% weight in the initial screening of projects, though it had a less formal role in the final assessment of projects. As could be expected, the state transportation agency that had earmarked funds for interchanges that promoted economic development placed a substantial weigh on economic development impacts. On the other hand, a state transportation agency that regularly conducted economic development assessments of road widening, interchange, and new road projects did not include the studies formally in decision-making, focusing instead on featuring the economic development information in community meetings. States that only occasionally commissioned economic development assessments utilized an ad-hoc approach. Results were not part of the project evaluation process, though economic development was thought to be a factor informally in one state, and important for projects in lagging regions of another state.

Respondents typically did not have a strong opinion about how to change measurement of economic development impacts. One respondent did express concerns that measurement of localized economic impact might fail to distinguish between overall growth and the reallocation of economic activity. One state agency that relied on TREDIS was concerned that it failed to accurately define "contingent development." One respondent simply wanted more evidence that economic development impacts predicted by modeling would actually occur. Respondents had stronger opinions about how the results of economic development analysis should be used in making decisions about highway investments. Several respondents said they wanted their state transportation agency to have a formal role for economic development in the project selection process. One respondent placed a special emphasis on this for projects in rural areas. However, an equal number of respondents were just as adamant that economic development not play a formal role in project selection. Other respondents had considered the type of economic development measures that should be used. One proposed focusing on projects that create "high wage" jobs. Another suggested ranking projects according to the number of jobs created per dollar and to focus on investments that had high ratios (before diminishing returns set in).

IV. Summary

The literature and discussion with state agencies tended to reinforce our proposed methodology. A variety of researchers have utilized the treatment control group methodology when assessing the economic impact of projects. Further, the states that were active in conducting economic impact studies for their transportation investments tended to utilize models that evaluated projects using a consistent methodology and a methodology that reflected the specific characteristics of the highway investment (AADT, the number of miles) as well as the communities where the investment took place. Representatives of state transportation agencies also emphasized economic development measures that functioned on a per dollar basis. For example, one state examined regional valued added (Gross Regional Product) per investment dollar, while the respondent from another state proposed a measure for the number of jobs created per dollar of investment. We note that the proposed methodology for this study uses such a measure and that we also propose to develop a model where estimated economic development impacts will vary according to the characteristics of the highway investment and the community where the investment takes place. In other words, our review of the literature supports the empirical methodology we have used for this research study.

Appendix 2 Discussion Questions for Highway Investments and Economic Development

The following questions are on the topic of how your state addresses the contribution of highway investments to economic development. These questions are asked as part of a research study that the University of Nebraska-Lincoln Bureau of Business Research is conducting for the Nebraska Department of Roads.

Question 1: Does your agency regularly conduct studies of the economic development contribution of highway investments in your state?

Follow-up Question 1A: If no, does your agency occasionally conduct studies of the economic development contribution of highway investments, or have consultants conducted such studies?

(If the answers to Question 1 and Question 1A are both no, proceed to Question 4).

Question 2: What is your current approach for assessing the economic development contribution of highway investments?

Follow-up Question 2A: How often are such assessments used?

Follow-up Question 2B: Is this same approach used for assessing all highway capital investments (e.g. road widening [from two to four lanes], bypasses, highway/railroad grade separations) or is a different assessment approach used for some types of highway investments?

Follow-up Question 2C: If so, for which types of highway investments?

Question 3: How do the results of economic development assessments influence decisions about highway investments in your state?

Follow-up Question 3A: How often do economic development assessments influence decisions?

Follow-up Question 3B (If the answer to Question 3A is less than 100%): For which types of highway investments does economic development influence decisions?

Question 4: If you had the resources and support to make changes, what would you change about your state's approach to assessing the contribution of highway investments to economic development?

Question 5: If you had the resources and support to make changes, would you change how economic development findings are used to make decisions about highway investments in your state?

Question 6: Can you provide me with an electronic copy of any economic development studies that your state agency has conducted or commissioned over the past three years?

Question 7: If we have additional questions in the future, may we call you back?

Question 8: Is there anyone else from your state that you recommend we contact to discuss some or all of these issues?