DEPARTMENT OF TRANSPORTATION

Transportation Investment and Job Creation in Minnesota Counties

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January 2018

Research Project
Final Report 2018-04

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Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
MN/RC 2018-04		

4. Title and Subtitle	5. Report Date
Transportation Investment and Job Creation in Minnesota Counties	January 2018
	6.
7. Author(s) Zhirong Jerry Zhao, Weiwen Leung	8. Performing Organization Report No.
9. Performing Organization Name and Address Humphrey School of Public Affairs University of Minnesota 301 19th Ave S Minneapolis, MN 55455	10. Project/Task/Work Unit No. CTS # 2017004 11. Contract (C) or Grant (G) No. (c) 99008 (wo) 240
12. Sponsoring Organization Name and Address Minnesota Local Road Research Board Minnesota Department of Transportation Research Services & Library 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899	13. Type of Report and Period Covered Final report (July 2016 to January 2018) 14. Sponsoring Agency Code

15. Supplementary Notes

http:// mndot.gov/research/reports/2018/201804.pdf

16. Abstract (Limit: 250 words)

Numerous studies have been conducted about the impact of transportation investment on economic development. These studies typically use a conventional production function model of economic development augmented by a public capital input, such as highways, rail, or other transportation investments. The findings, in general, confirm a positive elasticity between transportation investment and economic development, but the range of the effects varies widely among studies. In a recent research project, Zhao (2015) quantifies long-term transportation capital stocks in Minnesota counties and finds that these stocks have positive returns on property values. This study extends Zhao (2015)'s methodology to study the link between transportation investment and job creation. We find that long-term transportation investments contribute significantly to employment in Minnesota counties. The results have several policy implications. First, investments on local roads within a county can increase the employment rate in the county. Second, investments on trunk highway surrounding a county can increase the employment rate in the county. Lastly, in the context of Minnesota, it could be more effective to invest in rural areas compared to urban areas, as far as employment growth in concerned.

17. Document Analysis/Descriptors		18. Availability Statement	
County roads, Highways, Employment, Employee compensation		No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312	
19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	42	

Transportation Investment and Job Creation in Minnesota Counties

FINAL REPORT

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January 2018

Published by:

Minnesota Department of Transportation
Research Services & Library
395 John Ireland Boulevard, MS 330
St. Paul, Minnesota 55155-1899

ACKNOWLEDGEMENTS

It has been delightful for us to work on this project for the Minnesota Department of Transportation (MnDOT). We are indebted to many colleagues and friends for their kind support and advice along different stages of the project. First, we want to express our gratitude to Bruce Hasbargen, the County Engineer of the Beltrami County. Bruce championed this research proposal and then served as the Technical Liaison (T.L.) of the project. Without his help, this project would not have been possible. Second, we are also indebted to Farideh Amiri and Nelson Cruz, who both work at MnDOT and served as project coordinator. Third, we want to thank Elizabeth Andrews at the Center for Transportation Studies (CTS), University of Minnesota. Elizabeth provided great help in coordinating the delivery of the project. Finally, we want to thank all members of the Technical Advisory Panel, which includes Michael Iacono, Kenneth Buckeye, Rasmussen, Mitchell, Mark Nelson, Melvin Odens, Jodi Teich, and Neal Young, for their kind support and indispensable advice throughout the project.

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EXECUTIVE SUMMARY

Numerous studies have been conducted about the impact of transportation investment on economic development. These studies typically use a conventional production function model of economic development augmented by a public capital input, such as highways, rail, or other transportation investments. The findings, in general, confirm a positive elasticity between transportation investment and economic development, but the range of the effects varies widely among studies. In a recent research project, Zhao (2015) quantifies long-term transportation capital stocks in Minnesota counties and finds that these stocks have positive returns on property values. This study extends Zhao (2015)'s methodology to study the link between transportation investment and job creation.

This study compiled a dataset about county business patterns in Minnesota during 1995-2010. The data include (1) the number of county business establishments, (2) jobs in Minnesota counties by sectors, and (3) the amount of annual payroll. Linking data of county business patterns to data of transportation expenditures in local roads and trunk highways, we find that long-term transportation investments contribute significantly to employment in Minnesota counties. In particular, the analysis demonstrates some positive and statistically significant relationships:

- A 1% increase in local road capital within a county is associated with a 0.007% increase in the employment rate in the county, holding constant various socioeconomic factors.
- A 1% increase in trunk highway capital in surrounding areas is associated with a 0.008% increase in the employment rate of a county, again holding constant various socioeconomic factors.

The impacts are significant but not substantial, which may be explained by the fact that most Minnesota counties are rural and are already having relatively high employment rates. In addition, we do not find any significant relationship between local road or trunk highway capital (or their spatial lags) and any of the following employment variables: aggregate employment, payroll, and payroll per employee.

Although we are not able to control for all possible confounding effects as we do not have a natural experiment, our results have significant policy implications assuming a causal interpretation. First, investments on local roads within a county can increase the employment rate in the county. Second, investments on a trunk highway surrounding a county can increase the employment rate in the county. Lastly, in the context of Minnesota, it could be more effective to invest in rural areas compared to urban areas, as far as employment growth in concerned.

CHAPTER 1: **INTRODUCTION**

Numerous studies have been conducted about the impact of transportation investment on economic development. These studies typically use a conventional production function model of economic development augmented by a public capital input, such as highways, rail, or other transportation investments. The findings, in general, confirm a positive elasticity between transportation investment and economic development, but the range of the effects varies widely among studies. In a recent research project, Zhao (2015) quantifies long-term transportation capital stocks in Minnesota counties and finds that these stocks have positive returns on property values. On average, one additional dollar of local road investment would increase assessed values by $1.25 for the county. For trunk highways, one additional dollar of investment within a county would generate about $3 in assessed values in a nearby region.

This project extends Zhao (2015)'s methodology to study the link between transportation investment and employment. We use several datasets to measure employment, such as the Quarterly Census of Employment and Wages (which contains overall employment) and County Business Patterns (private employment only, though this is more accurate as it is based on business register data).

We combine these with data on transportation investment, business patterns, and socioeconomic conditions in Minnesota counties during 1995-2012 and use spatial econometric models to answer four sets of questions:

- How does transportation investment affect the employment rate, aggregate employment (i.e. number of jobs), and annual payrolls?
- Which mode of transportation, trunk highways or local roads, is more effective in job creation?
- Does the link between transportation investment and job creation differ between metropolitan and rural counties?

Findings of the research will have significant policy implications. Understanding the impact of transportation investment on employment related variables – by region and by business sector – can help state and local governments make informed decisions about transportation investment.

Our key results are that for the employment rate, local road stock and the spatial lag of trunk highway stock matters, and their elasticity is around 0.008. There is evidence of heterogeneity across areas; for example, metro areas are not affected by road or highway stocks (or their respective spatial lags). There is no evidence that such variables affect aggregate employment, payroll, or payroll per employee.

Like Zhao (2015), this project contributes toward the Local Roads Research Board knowledge-building priority of "Funding, Communications, and Public Engagement." Local policy makers, the state transportation department and the public will benefit from this study. There are multiple policy implications. It helps both state legislators and bureaucrats to make better decisions regarding the volume of local road and trunk highway investment. Furthermore, our results also inform state-level decisions on *where* the investment would be most effective, since we examine differential impacts across urban and rural counties, and find that rural counties benefit most. The public will also better understand the importance of local road and trunk highway investments, as such investments are positively linked to the employment rate.

The rest of the report is organized as follows. Section 2 reviews the literature on the economic impact of transportation development. Section 3 describes the regression methods and data we use. Section 4 explains the results of exploratory spatial data analysis, while Section 5 contains the regression results. Section 6 presents our conclusions.

CHAPTER 2: **LITERATURE REVIEW**

We begin this section by examining the literature on roads and economic outcomes (a broad range of outcomes are considered). Subsequently, we narrow our focus to examine the link between road development and employment growth. The section concludes by discussing the intended contributions of this project.

2.1 TRANSPORTATION AND ECONOMIC DEVELOPMENT

Whereas economic growth focuses on whether the value of goods and services a country produces has changed, economic development considers a wider variety of measures. For example, the United Nations' Human Development Index has life expectancy and average schooling as indicators. Within the urban economics and urban growth literature, other factors such as urban form (roughly speaking, the shape of a city and how the population is distributed within that city) are also considered.

A large literature examines the impact of roads (and related infrastructure) on economic outcomes. Baum-Snow, Brandt, Henderson, Turner, Zhang (2015) investigates how configurations of urban railroads and highways influenced urban form in Chinese cities since 1990. They find that each radial highway displaces about 4 percent of central city population to surrounding regions, while each radial railroad reduces central city industrial GDP by about 20 percent. Further analysis indicates that radial highways decentralize service sector activity, radial railroads decentralize industrial activity and ring roads decentralize both.

Baum-Snow (2007) finds that the construction of new limited access highways has contributed to central city population decline in the US. His estimates indicate that one new highway passing through a central city reduces its population by about 18 percent between 1950 to 1990. In the counterfactual situation where highways had not been built, central city population would have instead increased by 8 percent had the interstate highway system not been built. The underlying mechanism is likely to be developed by Alonso (1964): highways lower the commuting cost from the suburbs to the city center, thus making suburban living more attractive. In other words, faster commuting implies lower population density (and by extension, housing prices), all else equal.

Duranton, Morrow, Turner (2013) also study the US, and find that highways have an effect on the composition of trade, but not on the total value of trade: cities with more highways specialize in sectors producing heavy goods. The underlying framework (Anderson & Wincoop, 2003) uses a rich model with features such as distance between cities. Because highways lower the travel costs between cities, industries that use highways intensively are more likely to be located in cities with highways. However, industries that are not reliant on highways tend to locate in cities without them, as costs are lower, ceteris paribus.

It is also known that highways increase firm productivity; in other words, with the same number of workers and machines, firms can produce more (Holl, 2016). Possible mechanisms include savings in transport costs, which in turn increases market size, and facilitating sales and exports in markets located further away. New forms of production organization and better supply chains may also result from highway construction. However, there is significant heterogeneity in impact. When built in rural areas, highways tend to have a lower impact than in urban areas. Moreover, suburban firms close to the new highways gain, but these are in part offset by losses in neighboring areas.

2.2 ROAD DEVELOPMENT AND EMPLOYMENT GROWTH

2.2.1 Measuring Employment Growth

In an economy, people of working age can be typically classified into one of three categories: employed, unemployed, and out of the labor force. There is a distinction between the latter two categories: while unemployed people are looking for a job, those out of the labor force are not. For example, they could have given up on a job search, or they could be taking care of their children.

The employment rate is the number of employed divided by the number in the labor force. Typically, an increase in the employment rate (or a decrease in the unemployment rate) is seen as good news. However, note that this is not necessarily the case, for increases in the employment rate could be driven by a labor force decrease, which in turn could be due to disheartened unemployed people giving up on their job search.

Another relevant concept is employment growth: the net inflow into the employed category. Notice that two regions with the same amount of employment growth could have different job dynamics. For example, a region with zero employment growth could have negligible job creation and destruction, or equally large job creation and destruction rates.

Ideally, one would analyze job creation and destruction in addition to employment growth (Davis & Haltiwanger, 1999), as simultaneous and equal changes in job creation and destruction can reflect important underlying trends, such as changes in sorting and re-sorting frequency (Davis & Haltiwanger, 1992). However, without detailed microdata, it is only possible to work with net employment growth. Indeed, that is what most studies use (e.g. Duranton and Turner (2012), Basker (2005)), and we will follow suit.

2.2.2 Determinants of Employment Growth

Positive causal links have been plausibly demonstrated include those due to the rate at which new houses can be constructed (Saks, 2008), availability of credit to firms (Chodorow-Reich, 2014), reductions in traffic congestion (Hymel, 2009), decreases in crime (Cullen & Levitt, 1999), and shorter unemployment insurance benefits duration as well as the benefit replacement rate (Lalive, Van Ours, & Zweimuller, 2006), decreases in import competition (Autor, Dorn, & Hanson, 2015). Positive associations (not necessarily causal links) have been demonstrated between employment growth and the following: entrepreneurial activity and diversity among geographically proximate industries (Acs & Armington, 2004), better labor market institutions (Nickell, Nunziata, & Ochel, 2005), the initial level of human capital (Simon, 1998), size of firms (Acs & Mueller, 2008), growth shocks within and outside the country (Altonji & Ham, 1990), broadband expansion (Kolko, 2011), as well as vehicle ownership (Baum, 2009).

Null results have been found for enterprise zones (Kolko & Neumark, 2010), the minimum wage (for fast food employment) (Card & Krueger, 1994), airport size (Sheard, 2014). For a full review, one can consult the Handbook of Labor Economics (Card & Ashenfelter, 2011).

2.2.3 The link between road development and employment growth

There are two especially noteworthy papers in this literature. The first is Duranton and Turner (2012), which studies the effects of interstate highways on US city growth between 1983 and 2003. They find that a 10% increase in a city's initial stock of highways causes about a 1.5% increase in its employment over this 20 year period. They obtained the necessary data to use a technique called "instrumental variables", which reliably controls for the fact that increases in highway stock could be correlated with other factors that increase employment.

The second is Chandra and Thompson (2000), which examines the relationship between spending on interstate highway construction and the level of economic activity. They exploit the fact that such highways are primarily built to connect large cities, so small towns in between benefit from spillover effects. They find that economic activity increases in the counties that highways pass directly through (by 6 to 8% 24 years after the initial opening). Studies in other countries also find generally positive effects: Gibbons, Lyytikainen, Overman, Sanchis-Guarner (2016) finds that in the United Kingdom, new road infrastructure is linked to substantial positive effects on employment and numbers of plants at the electoral wards level.

That the location of highway exits are important can also be seen in Percoco (2015), which finds that in Italy, towns closer to highway exits see a greater increase in employment and the number of plants and that this growth is concentrated in transport service-intensive sectors, compared to towns further away from highway exits.

However, many studies (including some of the aforementioned) found that highway building has heterogeneous effects. Chandra and Thompson (2000) find that highways have a differential impact across industries: certain industries (such as retail) grow as a result of reduced transportation costs, whereas others shrink as economic activity relocates. However, activity in adjacent counties decreases (by 1 to 3% over the same period). Michaels (2008) finds that the advent of the U.S. Interstate Highway System caused rural counties along those highways to experience an increase in trade-related activities, such as trucking and retail sales. Consequently, relative demand for skilled manufacturing workers in skill-abundant counties increased, but relative demand in less skill-abundant counties decrease. Gibbons, Lyytikainen, Overman, Sanchis-Guarner (2016) find that the effect depends on whether a firm is an existing firm or an entrant: while the entry of new firms creates a net employment increase, for firms already in the area they find negative effects on employment coupled with increases in output per worker and wages. They conclude that it is likely that new transport infrastructure attracts transport intensive firms to an area, but with some cost to employment in existing businesses. Faber (2014) finds that China's National Trunk Highway System led to a reduction in GDP growth among peripheral counties that were not targeted by the highway system. This effect appears to be driven by a significant reduction in industrial output growth, perhaps due to a trade-based channel in the light of falling trade costs between peripheral and metropolitan regions.

2.3 INTENDED CONTRIBUTIONS OF THIS PROJECT

There are several key contributions of this project. First, we study the impact of road development on employment growth in Minnesota. While many of the previously cited studies were done in the US, they only recover the average effect across the US. We only know of one study within Minnesota (Iacono & Levinson, 2016), which focused on whether road building could predict future employment growth, as opposed to a strictly causal study, which would control for other factors. Moreover, it is clear from the previously cited studies that the impact of highway building is heterogenous. As such, there could well be heterogeneous impacts across different states. For example, Minnesota could benefit more than average, since its median household income is 9th in the nation.

The second contribution of this project is that within Minnesota, we differentiate between the building of local roads and trunk highways. Most of the literature has only focused on trunk highways. By differentiating between both, we can compare the relative effectiveness of the two. Since both highways and local roads benefit from state funding, the analysis could well inform future policy decisions.

Third, we apply instrumental variables to address endogeneity issues. Although we have focused more on studies that address endogeneity issues well, it should be noted that a large number of studies do not. While their results are of value, they should be treated with some caution.

CHAPTER 3: **METHOD AND DATA**

3.1 RESEARCH METHODS

3.1.1 Exploratory Spatial Analysis

We first analyze whether the primary, secondary, and tertiary sectors have been expanding or shrinking over time (considering Minnesota as a whole). As measures of size, we use the number of establishments, employment, as well as payroll.

We then analyze the same patterns at the county level, producing GIS maps which allow us to examine spatial patterns. We also overlay highways in our maps to allow us to examine whether growth is correlated with proximity to highways. Finally, we examine the growth of small establishments over time, where a small establishment is defined as one that employs less than 500 employees. Note that results here should be treated with caution: for example, growth in small establishments could be due to large establishments becoming small establishments, or new small establishments appearing.

3.1.2 Panel Data Regressions

We build on the approach of Zhao (2015). Let i index counties and t index years. Let y is the variable of interest (in this case, employment rate, though aggregate employment and payroll are also secondary variables of interest). Let the variables $Trunk$ and $Local$ denote the (logged) stock of Trunk Highway and Local Road capital. The suffix $.W$ indicates spatial lag. X denotes a vector of control variables, while δ_i and α_t are county and time fixed effects respectively. $\kappa_i t$ controls for area-specific time trends, with t referring to the time period and κ_i being the area-specific coefficient. ϵ_{it} is the error term, which is clustered by area and time. β and γ are parameters to be estimated by Ordinary Least Squares.

$$y_{it} = \beta_0 + \beta_1 Trunk_{it} + \beta_2 Trunk.W_{it} + \beta_3 Local_{it} + \beta_4 Local.W_{it} + \gamma X + \delta_i + \alpha_t + \kappa_i t + \epsilon_{it} \quad (1)$$

Because the trunk highway stocks, local road stocks, and their spatial lags are highly correlated, statistical insignificance may be due to high multicollinearity. With this in mind, in some specifications we drop some of the key dependent variables to examine whether the remaining variables become significant.

Another potential concern is endogeneity: the error term may be correlated with omitted variables. We cannot solve this problem fully. However, we use an instrumental variables approach as elaborated upon in Section 5 as a tentative approach. Our approach uses the spatial lag of local road stock and trunk road stock as instruments for local road stock in the area itself, under the premise that both are correlated because there is a lot of movement between neighboring counties.

3.2 DATA

3.2.1 Employment Data

There are three major sources of data for employment and employment related measures in Minnesota: the Quarterly Census of Employment and Wages (QCEW), the County Business Patterns (CBP), and data from the Minnesota Department of Employment and Economic Development (DEED). The below table summarizes key aspects of the data.

Table 3.1 Sources for employment data

	QCEW	CBP	DEED
Frequency	Quarterly	Annually	Monthly
Time Lag	6 months	18 months	< 2 months
Source	The data are produced from quarterly tax reports submitted to State workforce agencies by employers	The data are produced from the Business Register (BR), which is a database of all known single and multi-establishment employer companies maintained and updated by the U.S. Census Bureau. The BR contains the most complete, current, and consistent data for business establishments.	The data are derived using regression techniques using QCEW and CES data

The QCEW is produced by the Bureau of Labor Statistics on a quarterly basis and has the following variables at the county level, and further subdivided into fifteen categories (twelve industries and federal, state, and local government). The dataset consists of the following variables: Annual Average Establishment Count (which is the annual average of quarterly establishment counts for a given year), Annual Average Employment (annual average of monthly employment levels for a given year), Annual Total Wages (sum of the four quarterly total wage levels for a given year), Annual Average Weekly Wage (average weekly wage based on the 12-monthly employment levels and total annual wage levels), Annual Average Pay (average annual pay based on employment and wage levels for a given year), Employment Location Quotient Relative to US (concentration of employment relative to a larger geographical area), and Total Wage Location Quotient Relative to US (size of total wages relative to a larger geographical area).

County Business Patterns is produced by the Census annually and has the following variables at the county level, and further subdivided into the industry level (according to NAICS codes from 1998 onwards, and SIC codes from 1997 and earlier), though there is significant data suppression at finer levels. Variables we are interested in (at the county-year level) include the total number of employees (in mid-March of a given year), total number of establishments, the number of establishments of each employee size class, and total first quarter payroll.

Local area employment statistics are provided by the Bureau of Labor Statistics (state agencies such as Minnesota's Department of Employment and Economic Development distribute the BLS data). These are derived using regression techniques from other datasets, namely QCEW and Current Employment Statistics Datasets. These techniques are needed because of the high frequency (monthly basis). Variables include the number of people that are employed, the number of people that are unemployed, and the size of the labor force.

Studies focusing on aggregate private employment generally use CBP data, since is based on a database of all known companies in the US. Moreover, the longer lag allows for statistics to be more carefully produced. Third, the CBP data provides a good breakdown of employment into different industry sectors. With these advantages in mind, we use CBP data for our exploratory spatial data analysis in Section 4. However, since the main focus of our regression analysis is the employment *rate* (which includes public employees), we use the QCEW data. However, our regression results are robust to using CBP data.

3.2.2 Road development: capital stocks

Our road measures are essentially the same as those in a previous project (Zhao, 2015). In particular, transportation investment data come from two sources. One is the annual "Minnesota County Finances Report" compiled by Minnesota's Office of the State Auditor, for which we have data from 1985. On the revenue side, this data include federal and state grants that are allocated for streets and highways.

On the expenditure side, this data include construction, maintenance, and administration outlays for streets and highways. This data source provides the information about local road investments that are managed by counties.

Another source is the "Trunk Highway Construction and Maintenance Costs" provided by Minnesota Department of Transportation (MnDOT). Available during the period 1995-2012, this data include annual trunk highway costs (construction and maintenance) that are allocated to each Minnesota counties based on highway segments. This data source provides the information about system-wide state trunk highway investments that are managed by MnDOT. From the MnDOT website, we also collected Minnesota Highway Construction Cost Index (MHCCI) during 1995-2011. Annual fiscal variables about transportation investments were first adjusted with MHCCI (with 2000 as the base year) before they were used to calculate the accumulated transportation capital stocks.

In our study, highways constitute public capital. In contrast, private capital consists of non-labor factors of production owned by companies (such as machines). To calculate public capital for any year, we use the equation $PK_{i,t} = (1-\delta)PK_{i,t-1} + I_{i,t}$, where $I_{i,t}$ refers to new infrastructure investment in county i in year t, and $PK_{i,t}$ refers to public capital. δ refers to the depreciation rate, which we set at 2%. $K_{i,t}$ refers to private capital (which we do not need to calculate as we have direct measures).

With labor measures in mind, we model output $O_{i,t} = f(L_{i,t}, K_{i,t}, PK_{i,t}, wPK_{j,t})$, where $L_{i,t}$ is a measure of employed people, and w refers to a spatial weight matrix. Notice that $wPK_{j,t}$ captures the effect of highways of neighboring counties on a given county, which can be positive or negative.

3.2.3 Control variables

We have a large set of control variables. Unless otherwise specified, they are from the Census Bureau. We first and foremost control for population. We also control for other key socioeconomic factors: we have the percentage of people in an urbanized area, the percentage of population who do not have a high school diploma, the percentage of population that are under 18, as well as the percentage of population that are over 65. The age controls ensure that changes in employment are due to highways and not due to people entering or exiting the workforce. It is also important to control for the degree of urbanization, because urban areas may be more prone to employment shocks compared to rural areas.

CHAPTER 4: EXPLORATORY SPATIAL DATA ANALYSIS

The methodology explained in Section 3.1.1. gives the following mapping from NAICS codes to sectors:

Table 4.1 Classification of sectors

NAICS code	Meaning of NAICS code	Sector
11	Agriculture, forestry, fishing and hunting	Primary
21	Mining, quarrying, and oil and gas extraction	Primary
22	Utilities	Secondary
23	Construction	Secondary
31-33	Manufacturing	Secondary
42	Wholesale trade	Secondary
44-45	Retail trade	Tertiary
48-49	Transportation and warehousing	Secondary
51	Information	Tertiary
52	Finance and insurance	Tertiary
53	Real estate and rental and leasing	Tertiary
54	Professional, scientific, and technical services	Tertiary
55	Management of companies and enterprises	Tertiary
56	Administrative and support and waste management and remediation services	Tertiary

61	Educational services	Tertiary
62	Health care and social assistance	Tertiary
71	Arts, entertainment, and recreation	Tertiary
72	Accommodation and food services	Tertiary
81	Other services (except public administration)	Tertiary
99	Industries not classified	Not applicable

4.1 SECTOR SIZE

Using CBP data, we find that the tertiary sector has been expanding relative to the secondary sector over time, whether sector size is measured in terms of employment, payroll, or establishments (see Figure 4.1). For example, the secondary industry accounted for around 30% of employment in 1998, but this share dropped to less than 25% in 2014. Almost all of this change can be explained by the rise of the tertiary sector, which has increased from 70% to 75% over the same period.

Table 4.2 Size of each sector across time

		Primary	Secondary	Tertiary
Establishments	1998	641	35,859	97,525
	2006	602	39,788	110,261
	2014	669	36,485	110,068
Employment	1998	8,909	697,473	1,564,502
	2006	7,213	689,749	1,778,865
	2014	8,703	614,091	1,929,017
Payroll	1998	392,327	26,750,332	42,935,726
	2006	102,536	34,777,461	65,422,166
	2014	156,793	8,937,997	22,213,804

4.2 EMPLOYMENT STRUCTURE

Analyzing spatial changes in the number of workers employed in each sector using Figure 4.2, we find that these changes are not driven by any particular region in Minnesota. Rather, the decline in secondary industry and the rise of the tertiary industry appears to be a statewide trend. Note that we only analyze the secondary and tertiary sectors. As mentioned, there is heavy suppression in the primary sector (due to its small size); perhaps the only conclusion that can be drawn is that there are no obvious trends in this sector.

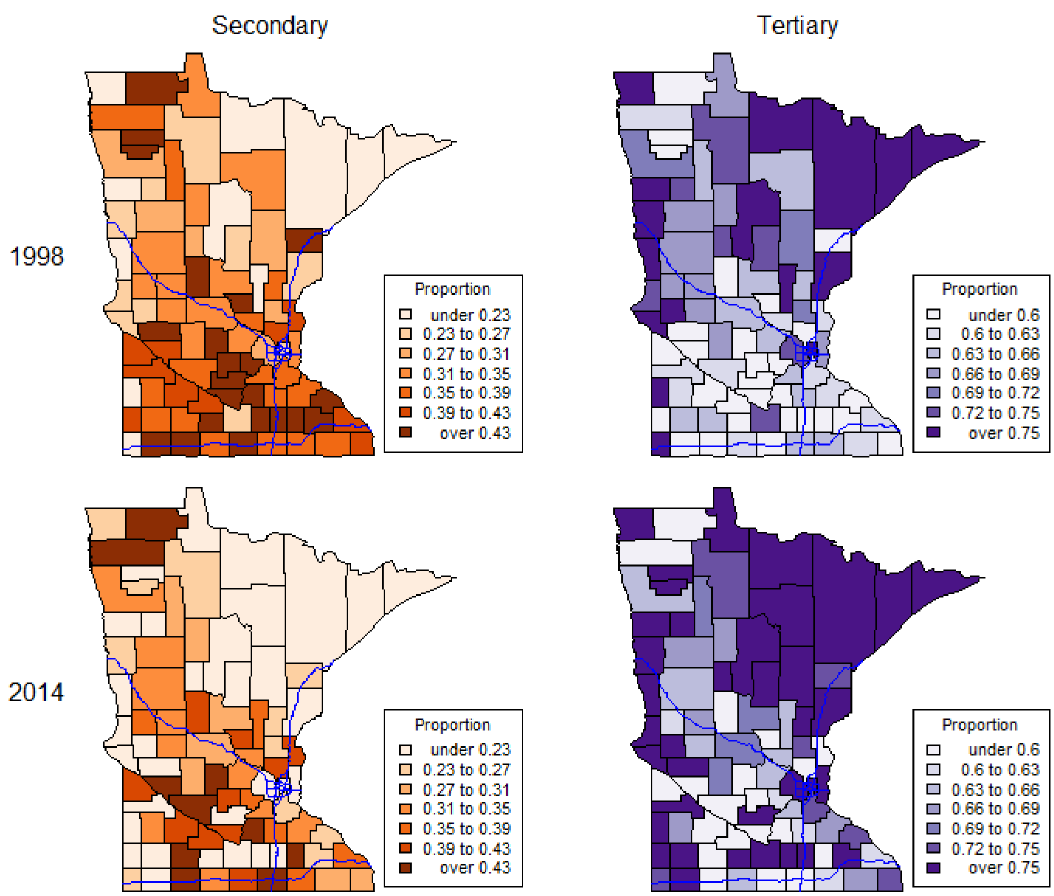

Figure 4.1 Spatial changes in employment

4.3 JOB COUNT AND JOB COUNT DENSITY

We now study the spatial allocation of jobs within Minnesota. Figure 4.3 summarizes the information in Figure 4.2 for the year 2014. Notice that even though the tertiary sector is on average much larger than the secondary sector, there are still counties where the secondary sector is larger, such as Kittson

County in the northwest of the state[1]. It is also evident that the primary sector's share is negligible in any county (even if figures are not suppressed).

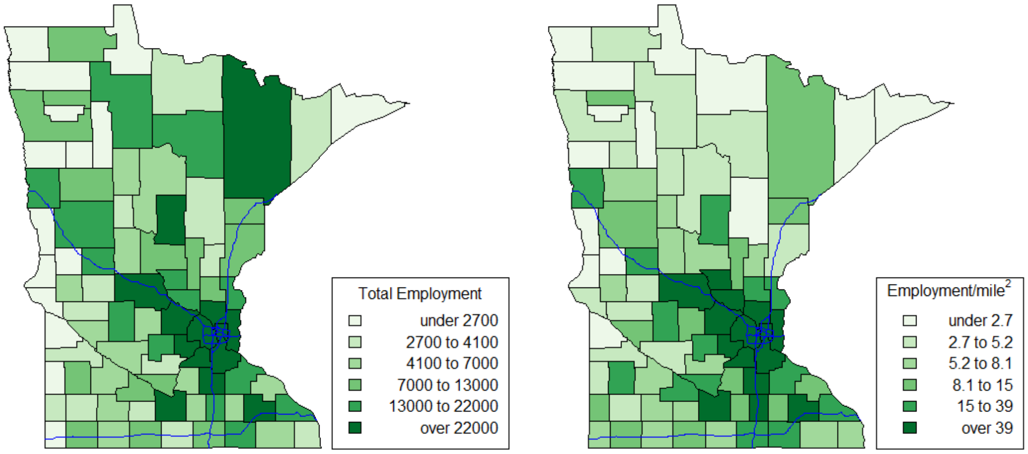

Figure 4.2 Employment: aggregate (left) and normalized by area (right) in 2014

Figure 4.3 illustrates total employment (aggregated across all sectors), as well as employment normalized by county area. Since counties in Minnesota generally do not differ vastly in size, both measures are highly correlated ($\rho = 0.83$, $p < 0.01$). Notable exceptions include St. Louis County, the largest county in the state.

4.4 PAYROLL

Figure 4.4 indicates that payroll proportions have also undergone similar changes: the proportion of pay that workers in the secondary sector receive is in relative decline, but it is on the rise for the tertiary sector.

[1] One potential explanation is that these secondary industries are needed to service certain agricultural industries. Despite having one of the smallest populations, Kittson is ranked near the top in terms of spring wheat, barley, oil sunflowers, and sugar beets: see http://www.mda.state.mn.us/food/business/agmktg-research/~/media/Files/food/business/countyprofiles/econrpt-kittson.ashx

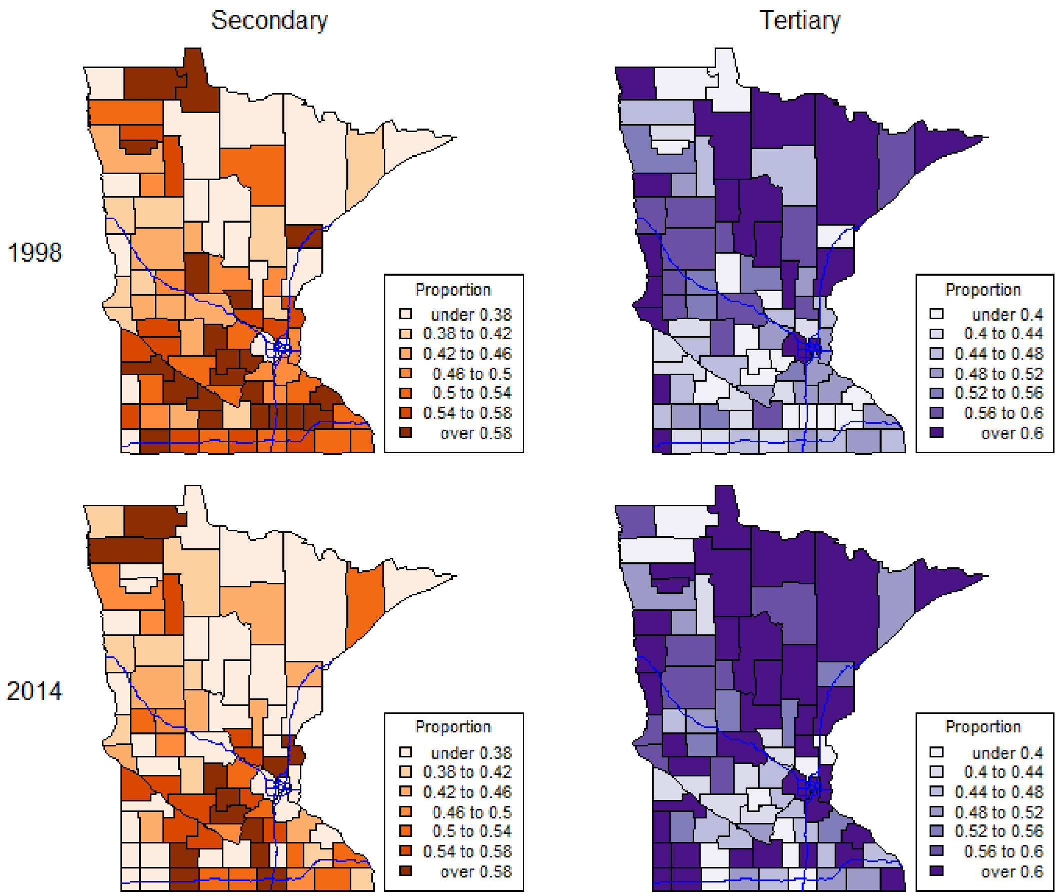

Figure 4.3 Payroll by sector over time

4.5 BUSINESS: ESTABLISHMENTS

The proportion of establishments in each sector is considerably more stable: Figure 4.5 indicates that there do not appear to be large changes in the proportion of establishments in each county that are from the secondary sector or the tertiary sector.

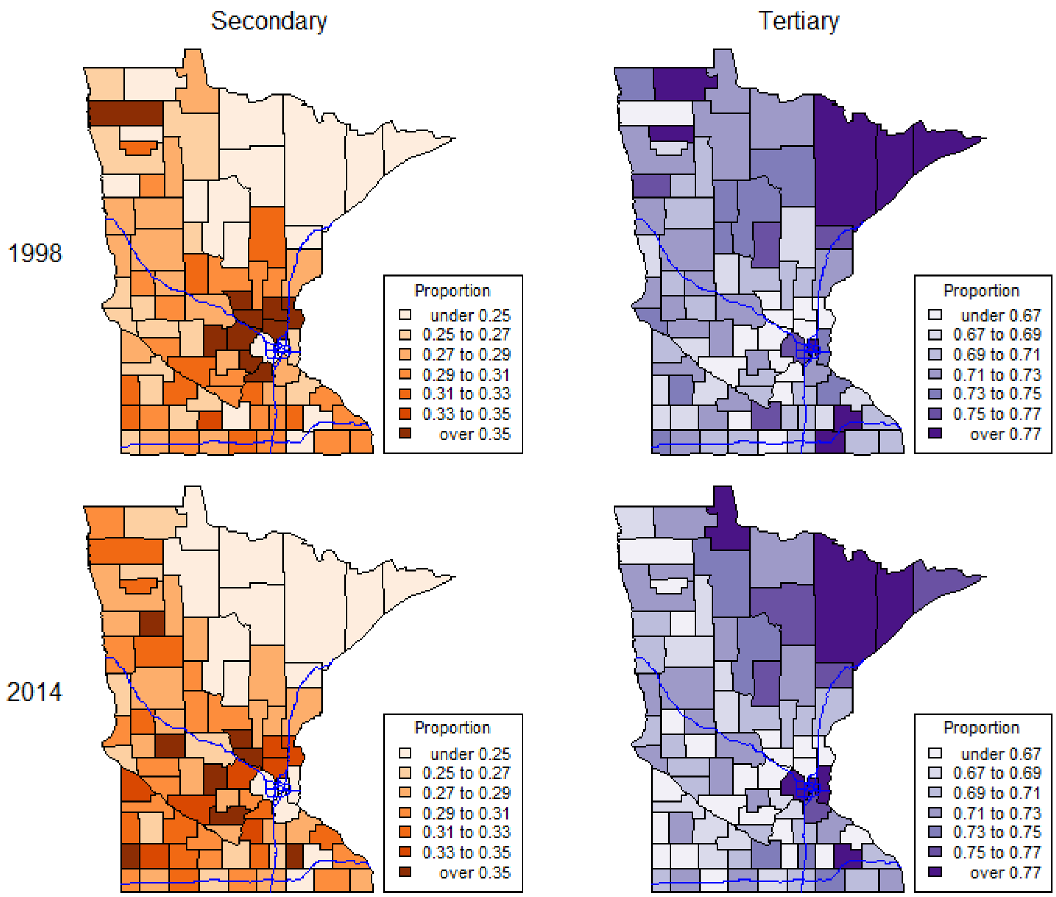

Figure 4.4 Establishments by sector over time

The number of small establishments in each county has also been relatively stable. (The Census Bureau defines a company to be large if it hires 500 employees or more; therefore, we consider small companies as those that hire less than 500 employees). The exception to this the Twin Cities area, where the counties surrounding Hennepin and Ramsey counties (roughly speaking, the city centers of Minneapolis and St. Paul), have seen much faster growth relative to Hennepin and Ramsey counties themselves. This can be seen more clearly in Figure 4.6 than Figure 4.5.

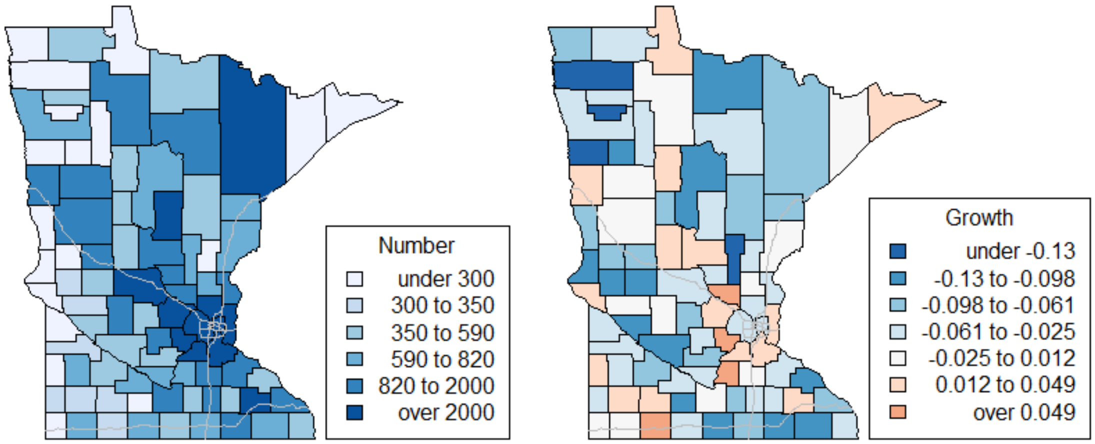

Figure 4.5 Growth in the number of small establishments from 2006 to 2014

Most counties with a large number of small establishments are located in or around the Twin Cities area, with a notable exception being St. Louis County (which contains Duluth).

4.6 METROPOLITAN AND MICROPOLITAN STATISTICAL AREAS

Metropolitan Statistical Areas (MSAs) and Micropolitan Statistical Areas (µSAs) are defined by the US Office of Management and Budget as groups of counties that have a relatively high population density and are anchored in an urban center.

The below maps summarize results given earlier in this section, but counties are aggregated into MSAs of µSAs if they belong to them. Of Minnesota's 87 counties, 45 belong to either an MSA or a µSA. Note that some of the MSAs and µSAs spill over into neighboring states. For example, the Duluth MSA includes Douglas County in Wisconsin. The MSA encompassing the Twin Cities also includes two Wisconsin counties.

Figure 4.7 indicates that growth in the MSAs was moderate for the eight year period spanning 2006 to 2014: it was rural counties that tended to have extreme values of growth. Furthermore, employment growth and payroll growth are moderately correlated, while establishment growth is less correlated with the other two measures. There does not appear to be any obvious correlation between interstate highways and any of the growth measures.

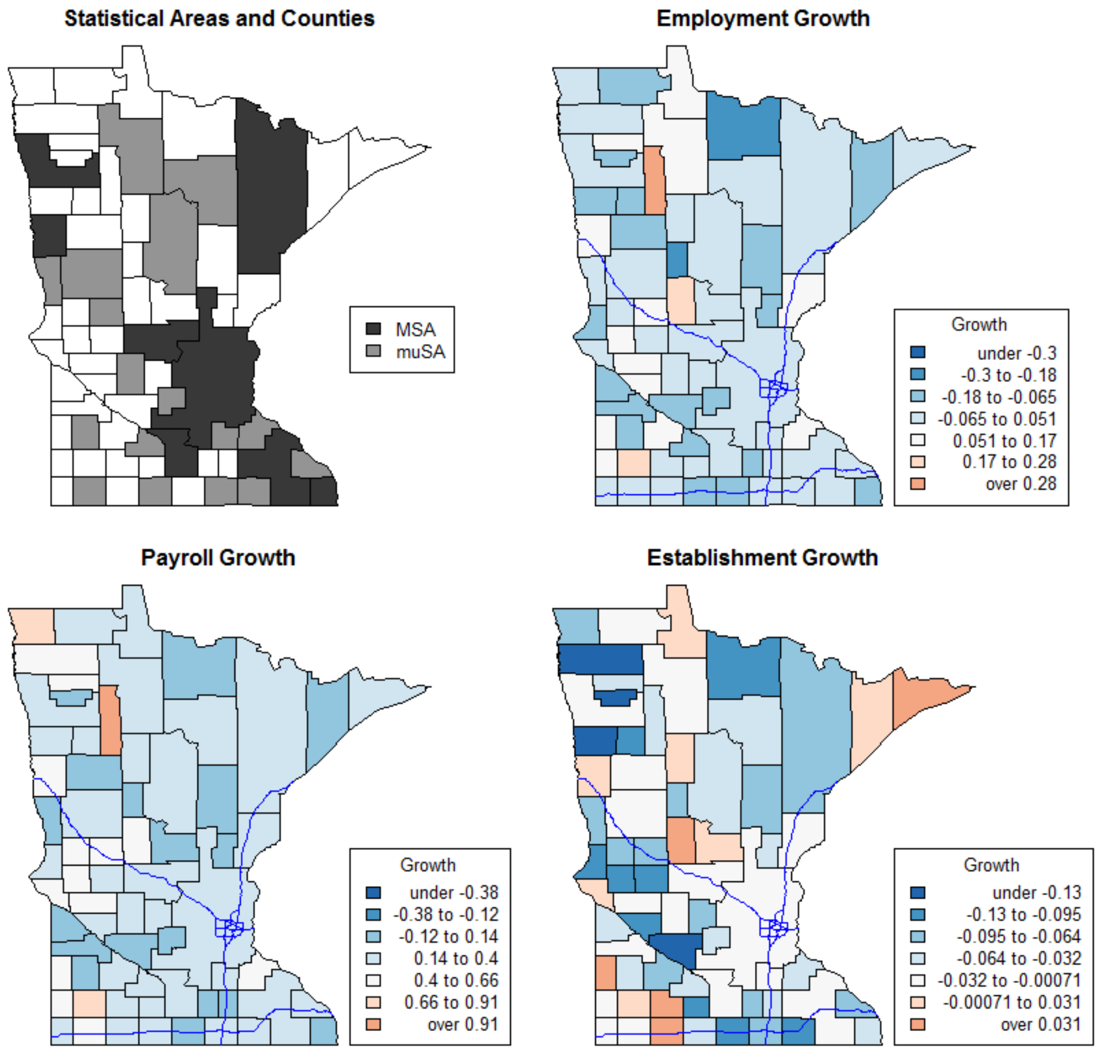

Figure 4.6 Growth at the MSA level from 2006 to 2014

Several of these counties see large changes. Caution must be taken when interpreting these changes, for these counties often see significant year-to-year variation in employment (for smaller counties, these may actually be noise added by the Census Bureau to protect the confidentiality of employers). For example, Clearwater County saw an increase in employment from 1667 to 2332, an increase of 40%. However, the standard deviation of year-to-year changes was around 300 jobs.

CHAPTER 5: **STATISTICAL ANALYSIS**

5.1 DESCRIPTIVE STATISTICS

Table 5.1 illustrates how trunk highway levels and local road levels (and their corresponding spatial lags) vary over time; the calculation method is described in Zhao (2015). The value in each cell is the unweighted average across counties. The first thing to note is that trunk highway levels are increasing over time. In contrast, there is much less variation in local road levels (which in fact decrease slightly from the start of the sample to the end of the sample).

Table 5.1 Local road and trunk highway stock levels over time

Year	TRUNK	TRUNK.W	LOCAL	LOCAL.W
1995	$138,256	$135,964	$548,029	$539,606
1996	$143,440	$141,259	$548,993	$540,787
1997	$147,855	$146,274	$549,363	$541,056
1998	$152,974	$151,468	$547,544	$539,377
1999	$157,860	$156,723	$547,060	$538,992
2000	$162,609	$161,790	$547,606	$539,669
2001	$167,632	$166,922	$548,115	$540,270
2002	$174,466	$173,774	$549,108	$541,137
2003	$182,541	$182,725	$550,069	$541,760
2004	$189,729	$190,552	$550,144	$541,996
2005	$196,909	$197,780	$549,532	$541,427
2006	$203,340	$203,640	$549,374	$541,380
2007	$209,158	$208,885	$549,230	$541,328
2008	$214,144	$214,007	$546,908	$539,272
2009	$219,315	$219,176	$545,251	$537,723
2010	$223,952	$223,515	$543,811	$536,382
2011	$227,317	$226,527	$542,014	$534,909
2012	$233,834	$231,888	$540,723	$533,877
TRUNK	Trunk highway level (TH_stock/AREA)			
TRUNK.W	Trunk highway level (TH_stock/AREA) with spatial lag			
LOCAL	Local road level (LC_stock/AREA)			
LOCAL.W	Local road level (LC_stock/AREA) with spatial lag			

Table 5.2 illustrates the corresponding averages for population and several economic variables. Again, an unweighted average across counties is used. There is a general upward trend for all variables except employment rate (which remains roughly constant). However, there was a slight dip in employment and payroll during the financial crisis (2009 and 2010).

Table 5.2 Socioeconomic indicators over time

Year	Population	Labor Force	Employment	Payroll	EmpRate
1995	53,178	29,934	28,816	$715,139	94.8%
1996	53,825	30,489	29,284	$779,156	94.4%
1997	54,435	30,796	29,793	$828,985	95.3%
1998	54,969	31,170	30,330	$902,278	96.0%
1999	55,614	31,680	30,805	$963,248	95.9%
2000	56,546	32,333	31,312	$1,040,891	96.0%
2001	57,194	32,704	31,471	$1,076,307	95.6%
2002	57,842	32,869	31,392	$1,091,465	95.2%
2003	58,491	33,042	31,429	$1,121,693	94.7%
2004	59,139	33,108	31,559	$1,184,483	94.9%
2005	59,633	33,101	31,756	$1,212,940	95.4%
2006	60,128	33,194	31,863	$1,267,233	95.4%
2007	60,501	33,407	31,882	$1,339,258	94.8%
2008	60,781	33,622	31,797	$1,376,314	94.0%
2009	60,930	33,816	31,189	$1,303,539	92.0%
2010	60,965	33,779	31,278	$1,338,636	92.3%
2011	61,290	33,865	31,670	$1,392,758	93.1%
2012	61,616	34,003	32,105	$1,455,763	94.1%

Population	Annual population (Minnesota State data)
Labor Force	Number of people in the labor force (BLS LAUS data)
Employment	Number of people employed (BLS LAUS data)
Payroll	Annual payroll (thousands, BLS QCEW data)
EmpRate	Employment to labor force ratio

Figure 5.1 illustrates how key economic variables have evolved in Minnesota relative to the base year of 1995. There has been a steady increase in population (around 15% in 16 years). There also has been an increase in employment and payroll. However, the increases were less steady; there were dips after the dot-com bubble burst, as well as during the Great Recession.

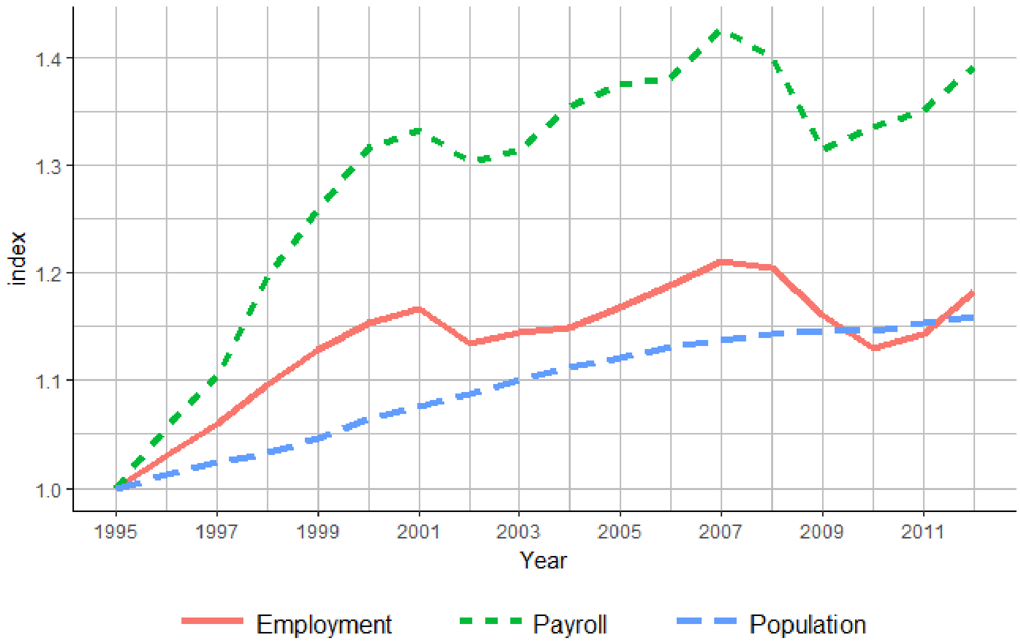

Figure 5.1 Index of three key economic variables from 1995 to 2010

Table 5.3 contains the descriptive statistics of the key variables in our dataset. As mentioned, our dataset contains a variety of variables. The key variables are those relating to employment (e.g. EmpSqMile, EmpRate), highway (THLevel, THLevel_w), and road levels (LRLevel, LRLevel_w). The other variables are control variables; these are mainly socioeconomic and demographic. There is often significant variation across socioeconomic and demographic variables across counties. For example, in some counties less than 10% have a college degree, but one county has almost half of people having a college degree. Hence, it is important to control for such factors.

Table 5.3 Descriptive statistics for key variables

	Mean	SD	Median	Min	Max
Employment	31,096	77,103	10,957	1,656	648,571
EmpRate	95.0%	2.0%	95.0%	85.0%	98.0%
Payroll	$1,132,783	$4,648,873	$208,491	$19,290	$52,049,600
Population	58,171	139,399	21,648	3,502	1,173,695
Labor force	32,606	80,422	11,543	1,754	666,946
Poverty	5,219	14,030	2,066	321	156,330
Urban	13.0%	28.0%	0.0%	0.0%	100.0%
Under18	25.0%	3.0%	25.0%	16.0%	34.0%
Over65	15.0%	5.0%	16.0%	4.0%	28.0%
BelowHS	15.0%	5.0%	14.0%	4.0%	30.0%
HighSch	35.0%	5.0%	36.0%	19.0%	43.0%
SomeCLG	32.0%	3.0%	32.0%	22.0%	42.0%
College	19.0%	7.0%	17.0%	9.0%	46.0%
TRUNK	$185,852	$389,121	$67,270	$420	$3,779,751
LOCAL	$547,382	$914,529	$327,784	$59,684	$7,329,204
TRUNK.W	$185,159	$254,912	$104,135	$5,564	$1,640,121
LOCAL.W	$539,497	$578,587	$326,826	$97,747	$2,926,385
Area	971.50	876.99	716.28	164.49	6750.49

Employment	Number of people employed (BLS data)
EmpRate	Employed/Labor force
Payroll	Annual payroll, thousands (QCEW data)
Population	Annual population (Minnesota state data)
Labor force	Number in the labor force (BLS LAUS estimates)
Poverty	Population under the poverty line
Urban	Percentage of population in urbanized area
Under18	Percentage of population under 18
Over65	Percentage of population above 65
BelowHS	Population with less than high school education (in percentage)
HighSch	Population with high school education (in percentage)
SomeCLG	Population with some college (in percentage)
College	Population with a college degree (in percentage)
TRUNK	Trunk highway level (TH_stock/AREA)
LOCAL	Local road level (LC_stock/AREA)
TRUNK.W	Trunk highway level (TH_stock/AREA) with spatial lag
LOCAL.W	Local road level (LC_stock/AREA) with spatial lag
Area	Area in square miles

5.2 REGRESSION RESULTS: FIXED EFFECT MODELS

We consider three possible regression techniques: OLS, Fixed Effects, and Random Effects. Our main results rely on Fixed Effects models. First, the Fixed Effect Model is preferred to the Random Effects model, as the latter imposes an assumption that the county-level fixed effect is uncorrelated with any factor that influences employment. We also prefer Fixed Effects to OLS because the latter controls for unobserved differences that are time-invariant across all counties.

For the rest of the Fixed Effects tables in this section, column M1 uses trunk highway level (THLevel, written as TRUNK in our regression tables) and its spatial lag (THLevel_w, written as TRUNK.W in our regression tables) only, without local roads and its spatial lag. Column M2 uses local road level (LRLevel, written as LOCAL in our regression tables) and its spatial lag only. Column M3 uses THLevel and LRLevel, but without their spatial lags. Column M4 contains both trunk highways and local roads, with their spatial lags. We use two-way fixed effects (i.e. area and time) in all cases, unless otherwise specified.

A second factor we consider is the degree to which our independent variables should be temporally lagged. We try using different amounts of lag for our measures of road and highway stock (1 year, 2 year, and 3 year) and find that the best fit is with a one year lag. In our regression, we therefore lag our measures of road and highway stock by one year. However, our control variables (such as percentage of population with below high school education) are not lagged. This is because shocks to employment often affect certain sectors of the economy (e.g. blue-collar workers), and the proportion of people who have not completed high school is a good proxy for the percentage of blue collar workers (for example). However, whether the control variables are lagged has little impact on our results, as our results are robust to lagging the control variables. Finally, we control for county-specific time trends. Having such time trends prevents us from picking up correlations that may be spurious.

The main dependent variable of interest is the employment rate. Table 5.4 shows evidence of a positive association between the spatial lag of trunk highway stock (TRUNK.W) and the employment rate. There is also some evidence of a positive association between employment rate as well as local road stock (LOCAL) and its spatial lag (LOCAL.W), though the correlations are not robust to changes in model specification. Note that for employment rate, we only have time fixed effects, because the Hausman test suggests that area fixed effects are not necessary and we do not wish to waste degrees of freedom on them. We interpret the findings, taking M4 as our preferred model. TRUNK.W has a coefficient of 0.008. Since the regression model is log-log, this indicates that a one percent increase in the spatial lag of trunk highway stock increases the employment rate by 0.008 percent (note: not percentage points), ceteris paribus. This effect is statistically significant at the five percent level. Additionally, the coefficient on LOCAL is 0.007, indicating that a one percent increase in local road stock increases the employment rate by 0.007 percent, and this effect is significant at the 10% level. The coefficients on TRUNK and LOCAL.W are small and statistically insignificant.

To get a sense of the magnitude of impacts, we will take the year of 2010 as an example. One percent increase in the trunk highway capital stock measures about $1.3 million for an “average” county, and the corresponding change in employment rate would raise employment rate from about 92.30% to about 92.31%. One percent increase in the local roads stock measures about $3.0 million, which will lead to a similar level of impact. The impacts are not substantial, which may be explained by the fact that most Minnesota counties are rural and are already having relatively high employment rates.

Table 5.4 Dependent variable: Employment rate

	M1	M2	M3	M4
TRUNK(log)	0.000		-0.001	-0.001
TRUNK.W(log)	0.010 ***			0.008 **
LOCAL(log)		0.006	0.013 ***	0.007 *
LOCAL.W(log)		0.010 **		0.001
Population(log)	0.000	-0.002	-0.001	-0.002
BelowHS	-0.255 ***	-0.244 ***	-0.263 ***	-0.249 ***
Over65	0.084	0.094	0.096	0.083
Under18	-0.066	-0.067	-0.018	-0.076
Urban	-0.011	-0.015 **	-0.017 **	-0.015 *
Observations	n = 87; T = 18	n = 87; T = 18	n = 87; T = 18	n = 87; T = 18
R^2	0.760	0.750	0.743	0.766
Adj R^2	0.741	0.730	0.722	0.747

* p < 0.1; ** p < 0.05; *** p < 0.01

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, TRUNK) = 0.71; Corr(LOCAL, LOCAL.W) = 0.74

Also of interest is whether employment varies with local road and highway stock. However, we do not find any correlation between aggregate employment and any measure of road or highway stock in any of our four models in Table 5.5. Neither do we find any correlation when we change the dependent variable to payroll, an alternative measure of aggregate economic activity (Table 5.6). Finally, for good measure, we examine what happens if the dependent variable is payroll per employee, and we do not find any significant effect.

Table 5.5 Dependent variable: Employment

	M1	M2	M3	M4
TRUNK(log)	-0.002		-0.002	0.000
TRUNK.W(log)	-0.002			0.001
LOCAL(log)		-0.072	-0.104	-0.072
LOCAL.W(log)		-0.695		-0.692
Population(log)	0.184	0.217	0.192	0.218
BelowHS	-0.207	-0.296	-0.162	-0.293
Over65	0.361	0.581 *	0.408	0.581 *
Under18	-2.450 **	-2.278 **	-2.429 **	-2.271 **
Urban	0.151	0.150	0.153	0.150
Observations	n = 87; T = 18	n = 87; T = 18	n = 87; T = 18	n = 87; t = 18
R^2	0.662	0.664	0.662	0.664
Adj R^2	0.611	0.613	0.611	0.613

* p < 0.1; ** p < 0.05; *** p < 0.01

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, TRUNK) = 0.71; Corr(LOCAL, LOCAL.W) = 0.74

Table 5.6 Dependent variable: Payroll

	M1	M2	M3	M4
TRUNK(log)	-0.003		-0.003	-0.002
TRUNK.W(log)	-0.013			-0.010
LOCAL(log)		-0.127	-0.154	-0.126
LOCAL.W(log)		-0.589		-0.576
Population(log)	-0.151	-0.119	-0.137	-0.117
BelowHS	0.018	-0.029	0.090	-0.025
Over65	-1.883 ***	-1.676 ***	-1.820 ***	-1.669 ***
Under18	-2.120 .	-1.960 .	-2.077 .	-1.958 .
Urban	-0.156	-0.154	-0.152	-0.156
Observations	n = 87; T = 18	n = 87; T = 18	n = 87; T = 18	n = 87; T = 18
R^2	0.674	0.675	0.675	0.675
Adj R^2	0.624	0.626	0.625	0.626

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, TRUNK) = 0.71; Corr(LOCAL, LOCAL.W) = 0.74

5.3 URBAN-RURAL DIVIDE: FIXED EFFECT MODELS

This subsection examines whether different areas of Minnesota are impacted differentially by local road and trunk highway stocks. We classify counties as "Metro" if they belong to a Metropolitan Statistical Area, "Micro" if they belong to a Micropolitan Statistical Area, and "Rural" if they do not belong to either. (See Figure 4.7 for such a map)

In order to get a good idea of trends in each kind of county, we examine Figure 5.2, which plots trends for Metro counties (MSA), Micro counties (muSA), as well as Rural counties. We notice first and foremost that there has been a general increase in employment, payroll, and population across all areas over time. However, the increases have been much more pronounced in Metro counties compared to other areas. For example, population increased by around 20% in Metro areas, but by 15% in Micro areas, and around 12% in rural areas. This analysis lends support to our previous decision to control for county-specific time trends.

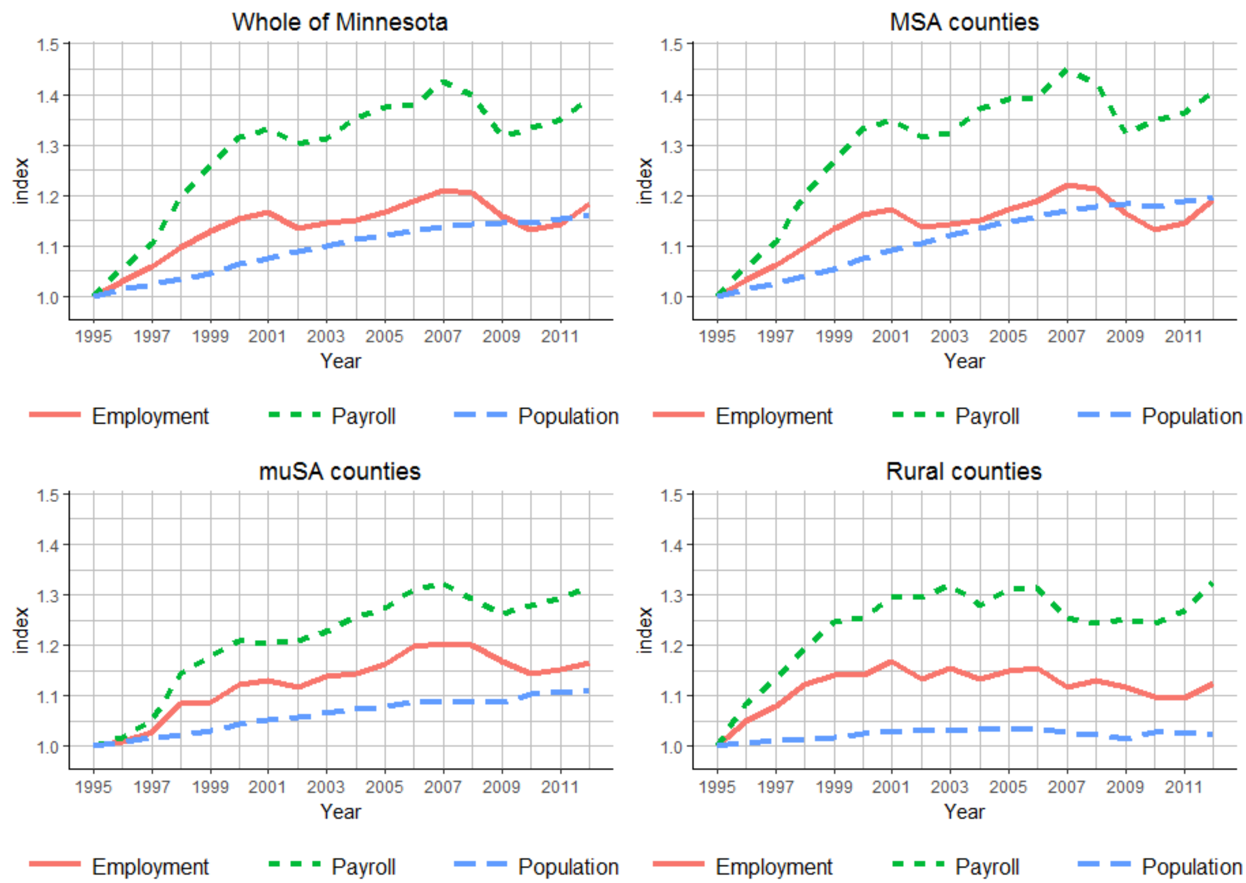

Figure 5.2 Index of economic variables in different Minnesota areas

There is some evidence that different areas are affected differently. For example, the overall relationship (across all counties) is that the employment rate is positively affected by TRUNK.W and LOCAL. However, not all areas are positively affected by these stocks. There is no evidence that counties belonging to Metro areas are affected by either. Moreover, counties belonging to Micro areas are actually negatively affected by TRUNK.W (though they are positively affected by LOCAL). Only rural counties are positively affected by both.

Recall that we did not find any relationship between aggregate employment and trunk highway stocks or local highway stocks, as well as their spatial lags. Table 5.8 shows that this effect is relatively homogenous across all areas in Minnesota, as there is only one coefficient statistically significant at the 10% level (which could be a Type I error). However, we note that the coefficients for rural counties are suggestively negative and large in magnitude. It could either be that there is indeed no effect, or there is an imprecisely estimated effect.

Table 5.9 studies the relationship between payroll and road as well as highway stocks. We find a negative and significant correlation between TRUNK as well as payroll in rural areas. It could be that trunk highways enable people living in rural counties to seek better paying jobs in other counties.

Table 5.7 Dependent variable: Employment Rate

	Metro	Micro	Rural	All
TRUNK(log)	-0.001	0.000	-0.001	-0.001
TRUNK.W(log)	0.001	-0.003 **	0.008 *	0.008 **
LOCAL(log)	0.003	0.017 ***	0.008 *	0.007 *
LOCAL.W(log)	0.004	0.001	0.011	0.001
Population(log)	-0.004 **	-0.006 ***	-0.006	-0.002
BelowHS	-0.158 ***	0.009	-0.325 ***	-0.249 ***
Over65	-0.022	-0.116	0.007	0.083
Under18	-0.030	-0.092 *	-0.070	-0.076
Urban	0.005	0.017		-0.015 *
Observations	n = 21; T = 18	n = 20; T = 18	n = 46; T = 18	n = 87; T = 18
R^2	0.826	0.852	0.748	0.766
Adj R^2	0.801	0.831	0.724	0.747

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, LOCAL) = 0.77; Corr(TRUNK, LOCAL.W) = 0.73

Table 5.8 Dependent variable: Employment

	Metro	Micro	Rural	All
TRUNK(log)	-0.008	0.001	-0.008	0.000
TRUNK.W(log)	0.008	0.005	-0.052	0.001
LOCAL(log)	0.017	0.210	-0.106	-0.072
LOCAL.W(log)	0.528	1.493 *	-0.995	-0.692
Population(log)	0.434	0.113	-0.101	0.218
BelowHS	-3.432 **	-1.380	0.191	-0.293
Over65	-1.153 **	0.347	-1.013	0.581 *
Under18	-2.096 *	-3.629	-0.776	-2.271 **
Urban	-0.138	0.086		0.150
Observations	n = 21; T = 18	n = 20; T = 18	n = 46; T = 18	n = 87; T = 18
R^2	0.937	0.668	0.536	0.664
Adj R^2	0.922	0.593	0.457	0.613

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, LOCAL) = 0.77; Corr(TRUNK, LOCAL.W) = 0.73

Table 5.9 Dependent variable: Payroll

	Metro	Micro	Rural	All
TRUNK(log)	0.003	0.000	-0.022 **	-0.002
TRUNK.W(log)	0.026	0.024	-0.062	-0.010
LOCAL(log)	0.245	0.029	-0.041	-0.126
LOCAL.W(log)	-0.157	1.587	-0.198	-0.576
Population(log)	0.368	-0.259	-0.271	-0.117
BelowHS	-2.184	-1.459	0.453	-0.025
Over65	-1.728 **	-0.670	-2.837 ***	-1.669 ***
Under18	-1.043	-4.041	-0.150	-1.958
Urban	-0.591 **	-0.171		-0.156
Observations	n = 21; T = 18	n = 20; T = 18	n = 46; T = 18	n = 87; T = 18
R^2	0.792	0.708	0.619	0.676
Adj R^2	0.745	0.642	0.554	0.626

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Corr(TRUNK, LOCAL) = 0.81; Corr(TRUNK.W, LOCAL.W) = 0.93

Corr(TRUNK.W, LOCAL) = 0.77; Corr(TRUNK, LOCAL.W) = 0.73

5.4 ADDITIONAL TESTS WITH INSTRUMENTAL VARIABLES

Although we found a positive correlation between the employment rate and local road stocks, one concern is that this correlation may be spurious (besides the fact that it was not completely robust to changes in specification). For example, unobservable factors correlated with such stocks could be driving changes in the unemployment rate. To examine whether this concern could be legitimate, we adopt an instrumental variable approach. We instrument local road stock with LOCAL.W and TRUNK.W (spatial lags of local road stock and trunk highway stock). We chose these instruments because counties are generally quite similar to their neighbors; hence, the amount of trunk highways and local roads in neighboring counties is generally highly correlated with the amount of local roads inside a county. Furthermore, there is a lot of travel across counties; people frequently live in one county and work in another. We therefore hypothesize that the impact of LOCAL.W and TRUNK.W is through LOCAL.

We note that the strong positive correlation we found earlier in this section persists with our instrumental variables approach. This is the case whether we are looking at all areas, Metro areas only, Micro areas only, or rural areas only. We view this as tentative evidence that the correlation we have found could be causal. Interestingly, there is an increasing pattern. The coefficients for Micro areas are bigger than that of Metro areas, and the coefficients for rural areas are the highest of all. Indeed, the coefficient in rural areas is 0.037, more than double that of Micro, and more than four times that of Metro. The IV estimates are also higher than the OLS estimates, which suggests that to the extent that we have controlled for the endogeneity problem, the residual endogeneity we encounter when using OLS biases coefficient estimates downwards.

Table 5.10 Dependent variable: Employment Rate (IV approach)

	Metro	Micro	Rural	All
LOCAL(log)	0.009 ***	0.015 ***	0.037 ***	0.021 ***
Population(log)	-0.006 ***	-0.005 ***	-0.009	-0.004
BelowHS	-0.183 ***	-0.015	-0.308 ***	-0.240 ***
Over65	-0.024	-0.112	0.037	0.091
Under18	-0.024	-0.096	-0.133	-0.040
Urban	0.001	0.019		-0.022 **
Observations	n = 21; T = 17	n = 20; T = 17	n = 46; T = 17	n = 87; T = 17
Instruments	LOCAL.W (lag1), TRUNK.W (lag1)	LOCAL.W (lag1), TRUNK.W (lag1)	LOCAL.W (lag1), TRUNK.W (lag1)	LOCAL.W (lag1), TRUNK.W (lag1)

* p < 0.1; ** p < 0.05; *** p < 0.01

5.5 SUMMARY OF FINDINGS

Our main conclusions from this section are as follows:

- During the research period, we see substantial growth of highway capital stock over time, but the local-road capital stock fluctuated at about the same level and even decreased slightly in most recent years.
- At the same time, we see in Minnesota counties the growth of population, employment, and payroll, but in different trends. The growth of population has been steady. The growth of employment and payroll increased substantively between 1995 and 2001 but then fluctuated since then, significantly affected by recent economic cycles. Over the whole study period, total payroll grew faster than total employment numbers.
- When using fixed effects models, we note that Employment rate is positively affected with TRUNK.W (spatial lag of the trunk highway stock) as well as LOCAL (local road stock), but unaffected with TRUNK and LOCAL.W. Aggregate employment, Payroll, and Population, however, are unaffected by any of these variables.
- There is some evidence of heterogeneity in impact across areas, especially with regards to employment rate. Overall, the employment rate is positively affected by TRUNK.W and LOCAL. However, counties belonging to Metro areas are not affected by either.
- Instrumenting local road stock with LOCAL.W and TRUNK.W provides additional suggestive evidence that the relationship could be causal.

CHAPTER 6: **CONCLUSION AND DISCUSSIONS**

This study compiled a dataset about county business patterns in Minnesota during 1995-2010. The data include (1) the number of county business establishments, (2) jobs in Minnesota counties by sectors, and (3) the amount of annual payroll. Linking data of county business patterns to data of transportation expenditures in local roads and trunk highways, we find that long-term transportation investments contribute significantly to employment in Minnesota counties. In particular, the analysis demonstrates some positive and statistically significant relationships:

- A 1% increase in local road capital within a county is associated with a 0.007% increase in the employment rate in the county, holding constant various socioeconomic factors.
- A 1% increase in trunk highway capital in surrounding areas is associated with a 0.008% increase in the employment rate of a county, again holding constant various socioeconomic factors.

The impacts are significant but not substantial, which may be explained by the fact that most Minnesota counties are rural and are already having relatively high employment rates. Besides, we do not find any significant relationship between local road or trunk highway capital (or their spatial lags) and any of the following employment variables: aggregate employment, payroll, and payroll per employee.

Our results have significant policy implications assuming a causal interpretation. First, investments on local roads within a county can increase the employment rate in the county. Second, investments on a trunk highway surrounding a county can increase the employment rate in the county. Lastly, in the context of Minnesota, it could be more effective to invest in rural areas compared to urban areas, as far as employment growth in concerned.

There are several limitations of this study. First, although we took care to control for socioeconomic and related conditions, it is still possible that some unobservable variables could drive our results. Second, the allocation of funds to local roads and trunk highways is a complicated process within Minnesota. While there does not appear to be systematic effort to direct funds to any particular area in Minnesota, it could be that funds are inadvertently being allocated to areas that are experiencing more employment growth, thus confounding the interpretation of the results. Lastly, we cannot claim generalizability of the results to outside of Minnesota or beyond the study period.

The study can be extended in many ways to further understand the linkage between transportation investment and economic growth in Minnesota counties. One is to focus on small business development, which is the backbone of rural communities. It is unclear which types of investment – on trunk highway or on local roads – would be more beneficial for small-scale entrepreneurship. And the answer may depend on types of counties, or other interacting factors. Another idea is to categorize the workforce by creative class, service class, and working class, following Richard Florida's theory, and to examine how transportation investments – roadway transportation and public transits – change their spatial distribution. Some types of works may be increasingly centralized in central cities, while other types of works are scattered throughout rural areas. Transportation likely plays an important role in shaping the spatial pattern, with significant economic and social implications. Yet another idea is to study how transportation may interact with education in affecting employment growth. Roads and K-12 education are the two major expenditure items for local governments. A study to understand how these two areas may substitute or complement each other for local economic development will have significant implications for informed policymaking.

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