The Influence of Highways on Rural Economic Development: Evidence from North Carolina

By:

Conaway B. Haskins III

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Approved By:

_____ READER (optional)

_____ ADVISOR

Introduction

State and local highway investment projects are often justified on grounds that such efforts will produce positive economic impacts. In particular, road network enhancements are trumpeted as a primary means of bringing development to distressed areas, including rural localities. In some manner, transportation routes have been promoted as vehicles for commerce in the U.S. For rural areas experiencing economic distress, such policies are often welcomed with open arms. Empirical evidence suggests that there is a relationship between the presence of major highways and economic development in general, however, evidence is less certain as to whether road investments play a role in the economic growth of rural areas specifically.

Spurred by the initiation of the "Good Roads State" policy in the 1920's, the state of North Carolina began an ambitious effort to connect every county seat and major locality in the state with a state highway (Harrington 1989). Where possible, these roads were four-lanes highways. Often, they ran though low-density rural areas. Even though the construction of these state highways is virtually complete, there is still a move within policy circles for increasing the state's highway capacity in order to spur rural development (Rural Task Force 2000). Despite the prevalence of research on the subject of rural economic development and transportation, the current effects of North Carolina's highway system on rural economies is less certain. Much of the state's current road network was built out by the 1960's, but roadway lane expansions and interstate highway extensions have been made since and are planned for the future. Despite the massive road system, rural development advocates continue to cite highway expansion as a major

mechanism for economic development. This paper seeks to determine if highway investments are an enabler of economic development in rural North Carolina.

Building off of the recent convergence of rural transportation and economic development policy in North Carolina, the paper examines if, given the widespread coverage of the state road network, highway investment – in terms of mileage - is a differentiating development factor among rural counties. This research is motivated by several factors. As previously asserted, transportation projects, including highways, are often justified based upon expected and potential economic development impacts. North Carolina has historically shown a preference for highway infrastructure development and improvements over alternative forms of transportation. The justification for such a system, The Good Roads State Policy, was partially based upon perceived economic benefits, including job growth. The paper will test if transportation infrastructure influences economic development in North Carolina, a state that has a dispersed and dense road system and a significant non-agricultural economy. It will also establish whether marginal accessibility benefits, in terms of jobs, accrue to a state with a mature road system.

The Policy Context: Good Roads and Economic Development

Transportation issues have been at the forefront of North Carolina's state government's efforts to bring prosperity to its people and communities since North Carolina's inception. In particular, over the last eighty years, the development of highways has been a key component to the economic development and growth policies instituted by the state and its counties. More recently, issues of the rural economic

development and rural transportation have converged, thus giving rise to discussions that mirror those of the days prior to the Good Roads Policy (Rural Task Force 2001).

In 1915, the state legislature authorized the formation of an active Highway Commission to oversee the state's roadway investments. The Commission consisted of several high-profile individuals who were very interested in growing the state's economy through transportation. Based upon their efforts, the state government in partnership with the counties began an ambitious road construction project. From this effort, North Carolina earned the nickname of "The Good Roads State." With the devastating effects of the Great Depression at hand, the state assumed responsibility of providing roads for the counties. Since that time, county roads were, have been state roads. The system was divided among a combination of multilane freeways, primary arterial highways, and secondary, local-serving routes (Harrington 1989).

After weathering the Depression and World War II, the state developed a stable highway finance fund for constructing highways, and continues to do so to this day. During the 1950's the federal Interstate Highway Act provided additional roadways to states, and North Carolina developed its portion of the interstate system, guiding the creation of several routes throughout it. The federal system further increased the highway network, and the bulk of the state and interstate highway system was completed by 1990 with the completion of I-40 from Raleigh to Wilmington (Harrington 1989). Currently, the state contains of over 78,000 miles of highways, and all but 7 counties contain part of the state highway and interstate system (NC DOT 2000).

A prime example of the convergence of rural transportation and development planning and policy is the creation and administration of Rural Planning Organizations

(RPOs). In 1999, the General Assembly passed legislation authorizing the creation of (RPOs), and charged the state Department of Transportation (NC DOT) with implementing the program. RPOs are voluntary organizations that work cooperatively with the Department to plan rural transportation systems and to advise the state government on rural transportation policy (NC DOT 2001). RPOs have several required functions that can be accentuated by other activities as regions see fit. Other planning-related activities may stem from formation of an RPO, as they relate to integrating multi-modal transportation planning with regionalism. The legislation allows for the combination of transportation, land use and economic development activities, and RPO advocates have advanced the notion that integrating transportation and economic development will enhance the economies of rural counties.

Another example of this convergence rests with the establishment of the Rural Prosperity Task Force. The state created the Rural Prosperity Task Force to address the destructive effects of natural disasters (such as Hurricane Floyd), the decline of the textiles industry, and the recent developments in the tobacco industry. The Task Force works under the premise that rural North Carolina counties face certain challenges and pressures that converged to cause a sense of distress. Statewide, the overall economy was growing yet thousands of rural manufacturing workers were being laid off and the traditional tobacco-focused agricultural economy was facing a crisis status. The task force determined that much of rural North Carolina lacked the appropriate infrastructure to connect to the emerging, growing global economy (Rural Task Force 2000). Among its recommendations are proposals for increased funding for transportation projects in rural counties. The central tenet of the task force recommendation is the establishment of

policies and funds for joint rural transportation and economic development program to implement road improvements that increase economic development opportunities (Rural Task Force 2000).

The final prime example of the integration of rural transportation and economic development concerns is a major report developed by the Brookings Institution. Along with the state policy efforts, the Brookings Institution (2000) compiled a large amount of data to study growth patterns across the state of North Carolina and performed trend analysis. They found that North Carolina has enjoyed significant population and economic growth throughout the 1990s, and it is one of the fastest growing states in the nation. Over the past decade, North Carolina has become attractive for migrants due to its relative high quality of life. However, the factors that make it a desirable and growing location threaten the long-term health of the state due to rapid growth. North Carolina is growing at a rapid pace in terms of population, jobs and land consumption. Most of this growth occurs in the state's seven major metro areas, and urban and suburban sprawl threatens the quality of life of many parts of NC. Mainly occurring in major metro area, rapid growth is not uniform over the entire state. Brookings holds that rural North Carolina, as a whole, has not recently undergone the same rapid growth patterns as metropolitan North Carolina, and those rural areas are not currently seeing the benefits related to job growth that the states metropolitan areas are. One caveat is that this study view rural counties in total, and did not differentiate between counties with growth and those that have historically had distressed economies.

Brookings concludes that North Carolina needs to enact policies and practices to purse a different growth pattern toward more compact and balanced areas. Among the

eight steps that they recommend is rethinking state and local transportation policy to counteract the historic over-investment in highways. They propose alternative transportation strategies and a continuing support of rural economic development efforts.

Given the current and historical policy environment, the issue of transportation as a mechanism to further rural economic development is of great importance. This convergence of two streams of policy has significant implications for the future of rural North Carolina and the state in general. Additionally, the decentralized road network of North Carolina is a unique case for testing whether accessibility improvements of highways in a state with ubiquitous road access has any economic development impacts.

The Literature

The empirical literature linking transportation to economic variables is rich in scope and scale. Analysts and researches have sought to link transportation improvements with economic grown and development. A prime argument is that transportation, rather than crowd out private investment (such as other public expenditures are held to do), actually stimulates investment, and thus economic activity, by increasing the rates of return to private capital (Banister and Berechman 2000). This empirical work has sought to advance the notion that there are significant and positive correlations between highway transportation infrastructure and economic activity (Apogee 1994). Many empirical studies assert that transportation infrastructure is important in generating local economic development (e.g., Brown, 1999, Cambridge Systematics et al., 2001, and Forkenbrock and Foster, 1996).

Others view transportation as a necessary, but not sufficient, condition for economic growth (Eberts 1990). Others find that highway systems interact with other variables to drive rural economic growth (Aldrich and Kusmin 1997). Some assert that other factors are sometimes found to be more important than highways for generating benefits (Brown 1999). These other factors include an area's attractiveness to retirees, the presence of right-to-work laws, excellent high school completion rates, and good public education expenditures. Poor earnings growth was due to higher wage levels, high concentrations of transfer-payment recipients, and concentrations of small, independent businesses in goods-producing sectors.

Empirical research also suggests that geographical proximity to metropolitan areas plays an important role in growth outcomes along with other factors. Thus, urbanization, development, and public infrastructure may be important triggering forces in the US. Economic growth of counties with interstate highways is greatest for those close to large cities or those with some degree of prior urbanization. Interstate counties that are isolated or rural have few benefits over different periods of time (Rephann and Isserman 1994).

Other research has shown unique links between transportation and economic development, often at an industrial level. New manufacturing location is systematically influenced by the provision of highway infrastructure. The development of new motorways affects the spatial allocation of new manufacturing establishments at the municipal level, and some evidence indicates that negative spillover effects may occur in terms of displacement of current industrial centers. There is evidence that that manufacturing firms prefer locations closer to new highways to the detriment of more

distant municipalities that are not connected (Holl 2001). Certain empiricists conclude that finds that negative spillover effects are shown to exist in the case of street-and-highway capital. They assert that changes in county output are positively associated with changes in street-and-highway capital within the same county, but output changes are negatively associated with changes in street-and-highway capital in other counties (Boarnet 1998). Thus, in some instances increasing highway capacity can actually displace employment and economic activity versus generating new activity. Still, the literature is not conclusive.

Increases in four-lane highways, interstate access, and two-lane highway density have also been found to stimulate new manufacturing firm employment. Those regions that consistently have higher-than average employment density (a proxy for agglomeration economies) influence employment gains in other areas as well. A major implication for state and local policymakers is that the location, timing, and type of highway investment matter concerning whether highway investment serves as an economic development aid not just the shear production of those highways. (Singletary 1995)

Some authors find that find that highways have differential impact across industries. Thus, certain industries will grow as a result of reduced transportation costs, while others contract as economic activity relocates. As with manufacturing, highways affect the spatial allocation of general economic activity. However, while highways raise the level of economic activity in the counties that they pass directly through, those roads draw activity away from adjacent counties without interstates (Chandra and Thompson 2000). As for labor, transportation accessibility is still considered important to the

economic fortunes of workers. A relationship exists between accessibility and economic opportunity. Studies indicate that limitations on access experienced by certain workers do affect labor market outcomes. Though other factors come into play, transportation accessibility plays a significant role in advancing economically (O'Regan and Quigley 1999).

In some instances, variations in affects are due to differences in areas. Some non-metro interstate interchanges often vary according to different functions that they perform, with others some acting as interchange villages, performing the role of central places in their regions (Moon 1988).The differentials are due to the remoteness and isolation of the areas themselves more so than the actual highway. And, there is some indication that highways are losing their influence on the economic development of an area. This line of inquiry concludes that access to highways generally has become a less important factor in location decisions than it was earlier. State-level highway investment policies that emphasize proper maintenance and relatively minor improvements are likely to be more cost-effective strategies for economic development than expensive highway construction projects (Forkenbrock and Foster 1996).

The literature on transportation role in rural economic development leads to interesting findings. Though differences do exist between the implicit and explicit and positive and negative impacts and effects of highways on rural areas, evidence suggests that road infrastructure has an influence on rural economic development. Highways are either a primary or secondary economic mover. In consort with other productivity and cost factors or alone, roads tend to serve as producers or inhibitors rural economic development.

However, there are several major shortcomings of the literature. Empirical research fails to sufficiently account for the degree of highway accessibility that is necessary to generate rural economic development. The research also does not account for wide-scale development differential between areas of the same state or region. Rather, the studies either consider data from large grouping of rural areas or with specific segments of a roadway. Also, the research does not account for whether enhancements to mature road systems generate any benefits whatsoever.

Given the findings of the above literature and the state of highway infrastructure in North Carolina, this paper hypothesizes that highway infrastructure does not significantly influence rural economic development, on a county level, in areas with a dispersed and dense highway system. Given that highways are rather ubiquitous in the state, transportation is not a scarce good. The high volume of roadways virtually eliminates resource price differentials because the cost of access to firms is zero. As such, good highway access is not particularly valuable to business and does not influence location decisions. If these assumptions hold, further increasing that infrastructure will not longer be a significant economic growth generator. Thus, North Carolina's highway system will not influence rural economic development.

Methods and Data

Economic development is a function of a variety of costs and production factors, including transportation. The literature highlighted several of these factors. The most notable one were market size, localization and urbanization economies, local costs factors, labor cost qualifications, the business cycles, and transportation accessibility among others. This paper holds that the following model represents the rural economic development process

$$RE_{it} = f\,(M_{it-1}, U_{it-1}, C_{it-1}, L_{it-1}, A_{it-1}, B_{it-1})$$

Where

RE_{it} = Total or new Jobs in rural county *i* during decade *t*
M_{it-1} = Market Size of county *i* in the decade before *t*
U_{it-1} = Urbanization and Localization Economies of county *i* in the decade before *t*
C_{it-1} = Local Cost Factors of county *i* in the decade before *t*
L_{it-1} = Labor force Qualification of county *i* in the decade before *t*
A_{it-1} = Accessibility of county *i* in the decade before *t*
B_{it-1} = External Business Cycle in the decade before *t*

To ensure adequate causality, the model utilizes a ten-year lag whereby the economic development, measured in jobs, at the end of one decade is a function of the growth or decline in the other factors in the preceding decade. Economic development is defined according to job growth because within the policy context, job growth is the most common goal of increasing highway investments for development (Harrington 1989). Income was not included because those statistics include government transfer payments and not purely employment income. The model assumes that profitable and productive firms have increased output, which in turn, allows them to increase their labor force. Employment change is the primary measure of employment growth, and thus economic

development, for this research. Several different employment measures are included to account for shifts in sector employment in the areas. Total and new employment is used to measure the overall effects of economic development. Manufacturing employment is used to capture the specialization that may be increasing or declining within an economy. Finally, Private, Non-Farm employment is used to measure the effects within the commercial labor economy.

Market size provides firms with labor resources, thus greater population leads to a greater market size for labor. Population statistics are the measures of market size. Localization and urbanization economies are the result of relative specializations of an area's business sector and population density. Location quotients indicate potential competitive advantages of the firms and sectors in an area due to specialization. Population density highlights the level of urbanization of the residents of a county. Local cost factors vis-à-vis jobs are measured in terms of wage rates. Given the focus on employment as a measure of development, including wage rates is sensible.

Labor force qualification is measured in terms of the percentage of an area's adult population that has attained either a high school diploma or a college diploma. Although other determinants of qualification exist, the limitations of data in terms of consistency influence the decision to use these two variables as factors. Accessibility measures the ease through which labor can access employment opportunities. Geographic access to high-employment areas and transportation access are assumed to play important roles in employment levels, and thus are used to measure this. Finally, firm decisions are made with respect to the national economy, and this affects their ability to provide labor opportunities. Thus, Gross Domestic Product is the indicator for national business cycle.

Data were collected at the county level in ten-year increments for decades between 1970 and 2000 (with population data collected for 1960) for each of the factors except GDP, which is a national statistic. For this paper, the unit of analysis is the county. Designation as rural is determined by inclusion in a Metropolitan Statistical Area (MSA) during the 1970 Census. Those counties not in MSAs in 1970 are rural, and the other counties are considered urban. The result is that, over time, some counties that were rural in 1970 are currently urban due to inclusion in previously designated MSA or from becoming new MSAs.

The US Office of Management and Budget designates MSAs for Federal statistical purposes. The general concept of a metropolitan area is that of a geographic area consisting of a large population nucleus together with adjacent communities having a high degree of economic and social integration with the nucleus. MSA designation was chosen in order to standardize measurement over time and across geographies. Since economic activity does not explicitly recognize county borders, MSA designation provided the best way to ensure the capture of most regional economic effects. Though growth occurs in some instances without respect to political jurisdiction, policy decisions are made within the framework of municipalities. Therefore, the factors influencing development are functions of county borders. Finally, the MSA standard is applied throughout the United States, thus it allows for application of this model and research in other states.

Table 1. Variables for Statistical Model

Variable	Definition	Measure	Scale	Unit	Data Source
Population	Absolute Size of population	Market Size	County	Individuals	US Census
Population Density	Person per square mile of land area	Urbanization/Localization Economies	County	persons per square mile	Derived
Employment Indices (location quotients)	Location Quotient for each employment sector in a municipality	Urbanization/Localization Economies	County	Ratio	Derived
% Labor force with College Degree	Percentage of persons age 25 & older with at least a bachelors degree	Labor Force Qualification	County	Individuals	US Census
% Labor force with HS Degree	Percentage of persons age 25 & older with at least a high school diploma or equivalent	Labor Force Qualification	County	Individuals	US Census
Average Wage per Job	Average annual wages paid to workers adjusted for inflation	Local Cost Factor	County	Annual FTE Dollars	US BEA REIS
National GDP	Dollar value of all good and services provided within a nation	Business Cycle	Nation	in billions	US BEA NIPA
State Economy	Change in state's total employment, manufacturing employment and private, non-farm employment	Business Cycle	State	Individuals	USE BEA REIS
Distance to closest Major City	The distance from county i to the nearest city with population of 100,000 or more	Accessibility	County	miles	NC Dept. of Commerce
Distance to closest Interstate	Distance to closest municipality with an interstate highway	Accessibility	County	miles	NC Dept. of Commerce
Total Lane Miles	Length of State Highway System in center-lane miles	Accessibility	County	miles	NC Dept. of Transportation
Interstate Lane Miles	Length of Interstate Highway System in center-lane miles	Accessibility	County	miles	NC Dept. of Transportation
State Highway density	Number of State Highway System Miles per square mile of land area	Accessibility	County	miles per square mile	Derived
Total jobs by place of work	Number of jobs provided by employers within an area	Economic Development	County	Individuals	US BEA REIS
Manufacturing jobs by place of work	Number of jobs provided by Manufacturing employers	Economic Development	County	Individuals	US BEA REIS
Private non-farm jobs by place of work	Number of jobs in private non-farm sectors	Economic Development	County	Individuals	US BEA REIS

As shown earlier, North Carolina has experienced a period of high growth and development over the last twenty years (Brookings 2001). However, the indicators are mixed with respect to the state's rural counties in general. The eighty-one rural counties exhibit a wide range of values for each variable, and have gone through a variety of growth patterns over the last thirty years (1970-2000).

Table 2: Summary Statistics for Study Variables

	1970				2000			
Variable Label	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Market Size								
POP	34,549	23,977	3,806	103,126	50,286	36,910	4,149	150,355
Urbanization/Localization Economies								
MANULQ	0.96	0.49	0.06	2.05	1.04	0.49	0.1	2.21
PNFLQ	0.77	0.39	0	1.34	0.93	0.2	0.22	1.21
POPDENS	72	45	9	227	106	71	10	360
Labor force Qualification								
COLLEGE	0.03	0.02	0.00	0.10	na	na	na	na
HISCHOOL	0.24	0.06	0.13	0.40	na	na	na	na
Labor Cost								
AVGWAGE	1,032	150	708	1,428	23,737	2,561	19,305	29,361
External Business Cycle								
STATEMPL	2,468,519	na	na	na	4,855,147	na	na	na
STATMAN	733,401	na	na	na	821,916	na	na	na
STATPNF	54,619	na	na	na	4,241,464	na	na	na
Accessibility								
MAJCITY	68	32	21	145	68	32	21	145
INSTDIST	32	32	0	150	31	32	0	150
TOTMILE	683	333	189	1703	715	352	193	1768
INSTMILE	4.61	10.76	0	63	7.47	13.42	0	61
HWYDENS	1.44	0.48	0.43	2.48	1.51	0.5	0.46	2.61
Economic Development								
EMPL	15,704	13,146	1,185	63,782	26,031	22,019	1,527	115,770
MANU	5,011	5,692	23	31,781	5,595	6,256	0	43,685
PNF	9,161	9,478	0	54,619	21,957	18,892	1,119	109,395

na – data not available or not applicable to county level

With respect to population growth, rural counties grew at an average of 46% percent. However the range of population growth increased 53%. In terms of employment, rural areas saw their share of the state's manufacturing employment increase by 8.3% while private, non-farm employment specialization grew nearly 21%. In real terms, average wages in rural counties grew significantly, and the differences among the counties grew at a slower rate than the wage increase. State employment changes are dispersed, and thus may or may not equally affect rural areas as other parts of the state.

Proximity to major cities can influence the employment opportunities that rural residents have, and the location behavior of firms. On balance, the average distance of a rural county to a major city remained constant, and there was a slight decrease in the

distance of rural counties to an interstate highway. Distance to interstates is considered because the literature showed that interstates have varying effects on localities. Nearby interstates can enhance a counties' economy, while being further from interstates may contribute to decline. On average, rural counties have less than 5% more state highway miles and highway density over the 30-year period, but those counties saw their interstate mileage increase by over 62%.

Finally, the economic development variables saw increases in general. On average, rural employment grew at an average rate of 66% for the time frame. Of this, manufacturing employment grew much slower than private employment as a whole. The average county saw its manufacturing sector grow nearly 12% while total private employment grew nearly 140%.

Table 3: Summary Statistics over time

Variable Label	Mean	Std. Dev.	Variable Label	Mean	Std. Dev.
Market Size			**Accessibility**		
POP	45.55%	53.94%	MAJCITY	0.00%	0
Urbanization/Localization Economies			INSTDIST	-3.13%	0
MANULQ	8.33%	0.00%	TOTMILE	4.69%	0.057
PNFLQ	20.78%	-48.72%	INSTMILE	62.04%	0.247
POPDENS	47.22%	57.78%	HWYDENS	4.86%	0.0417
Labor Cost			**Economic Development**		
AVGWAGE	2200.10%	1607.33%	EMPL	65.76%	0.675
			MANU	11.65%	0.099
			PNF	139.68%	0.993

Overall, the data indicates that rural areas have witnessed significant changes in general over the last thirty years. This is tempered by the fact that the differences between the counties have also increased. This indicates that there is a disparity among certain rural counties, but that the contributing factors to this disparity needs to be examined to assess potential influences. Thus, this leads to the specification of the model.

The Model and Empirical Results

Recall that a model has been hypothesized using several factors that empirical research has shown as affecting economic development, such as market size, agglomeration economies, local cost factors, labor force qualifications, accessibility, and the external business cycle. Using OLS regression, two sets of models are developed, in which highway access is factored with the other variables and tested with respect to employment changes. Each set of models contains three specifications. The first set uses total employment, manufacturing employment, and private, non-farm employment as dependent variables. It seeks to account for differences between the total stocks of independent variables among the counties. The second set uses changes in total employment, manufacturing employment and private, non-farm employment (lagged). This approach accounts for differences in the changes among the counties over time. Both models incorporate time dummies for 1990 and 2000 in order to account for time-series effects.

Models with Employment Totals

The first specification, using manufacturing employment as a dependent variable, accounts for at least 79.4% of the variation in the outputs. Of the independent variables, eight demonstrate at least 90% significance. This iteration indicates that differences in manufacturing employment are positively linked to total highway mileage, population density, distance to interstate highways, and specialization in manufacturing. Highway density, population, and the average wage per job appear to account for negative changes in manufacturing employment. These results indicate that areas further away from

interstates and with higher road inventories tend to add employment. Additionally, it indicates that rural counties with higher degrees of urbanization and manufacturing specialization can expect higher manufacturing employment. At the same time, higher labor costs and dense road networks tend to negatively influence manufacturing employment.

Table 4. Manufacturing Employment

Dependent Variable: MANU

R Square	Adjusted R Square
0.794	0.781

Model	B	Std. Error	Beta	t	Sig.	
(Constant)	-4791.835	1616.733		-2.964	0.003	***
TOTMILE	8.835	1.822	0.481	4.850	0.000	***
HWYDEN	-3593.936	1007.975	-0.282	-3.566	0.000	***
TOMICHG	8.821	10.138	0.028	0.870	0.385	
POP	-0.060	0.036	-0.267	-1.669	0.096	*
PNFLQ	919.507	1008.757	0.038	0.912	0.363	
MANULQ	3934.983	511.940	0.360	7.686	0.000	***
POPDEN	114.522	16.076	0.970	7.124	0.000	***
HISCHOOL	-7198.181	5009.235	-0.195	-1.437	0.152	
COLLEGE	5893.414	9156.342	0.043	0.644	0.520	
AVGWAGE	-0.598	0.266	-0.459	-2.249	0.025	**
INSTDIST	15.697	8.262	0.080	1.900	0.059	*
MAJCITY	8.122	8.087	0.042	1.004	0.316	
POPCHG	0.034	0.072	0.027	0.473	0.637	
Y1990	1729.893	1209.879	0.131	1.430	0.154	
Y2000	6338.092	3025.993	0.475	2.095	0.037	***

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

The findings of this model seem consistent with the literature and empirical expectations that manufacturing is sensitive to accessibility and costs factors. However, these results also indicate that the density of the road network can actually cause a decline in manufacturing employment among counties. Accordingly, it appears that rural counties with small cities and dispersed but long highway networks will attract manufacturing jobs.

The second variable tested in this model is private, non-farm employment. The independent variables in this specification account for 87.9% of the variation among the counties. Seven of the variables demonstrate significance at the 90% level or greater. Total highway miles, population density, higher number of college-educated adults, increased distances to interstates, population growth, and manufacturing specialization are all positively correlated with increased rural, private, non-farm employment.

Table 5: Private, Non-farm Employment

Dependent Variable: PNF

R Square	Adjusted R Square
0.879	0.879

Model	B	Std. Error	Beta	t	Sig.	
(Constant)	-11769.291	3096.927		-3.800	0.000	***
TOTMILE	15.798	3.489	0.344	4.527	0.000	***
HWYDEN	-5839.535	1930.823	-0.183	-3.024	0.003	**
TOMICHG	-21.232	19.420	-0.027	-1.093	0.275	
POP	0.037	0.069	0.066	0.537	0.592	
PNFLQ	-1235.344	1932.321	-0.020	-0.639	0.523	
MANULQ	2328.548	980.644	0.085	2.375	0.018	**
POPDEN	205.787	30.794	0.697	6.683	0.000	***
HISCHOOL	-13662.426	9595.421	-0.148	-1.424	0.156	
COLLEGE	61048.631	17539.396	0.180	3.481	0.001	***
AVGWAGE	0.612	0.509	0.188	1.202	0.231	
INSTDIST	48.446	15.827	0.099	3.061	0.002	***
MAJCITY	10.774	15.491	0.022	0.696	0.487	
POPCHG	0.282	0.139	0.090	2.030	0.044	**
Y1990	1116.088	2317.580	0.034	0.482	0.631	
Y2000	581.071	5796.429	0.017	0.100	0.920	

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

This model indicates that increased rural employment is attributable to the county road network, urbanization economies, higher human capital, general population growth and higher manufacturing specializations. Highway density is negatively correlated with rural employment growth. This result is somewhat expected in the manufacturing employment tends to attract a higher proportion of non-manufacturing private

employment. And unexpected finding is that increased distances from interstate increase private, non-farm employment. A possible explanation is that those counties with the other necessary factors for growth benefit from not having an interstate highway to displace employment. For this variable, it appears that increased road network coverage inhibits higher employment.

The third variable tested in this set of models is total employment. The R-square for this output indicates that the independent variables account for over 93% of the variation within counties. This iteration shows that total rural employment increases are attributed to higher populations, increased population density, higher numbers of college educated adults, increased distances to the nearest interstate, and slight population growth. Again, highway density is linked to negative employment change.

Table 6: Total Rural Employment

Dependent Variable: EMPL

R Square	Adjusted R Square
0.938	0.934

Model	B	Std. Error	Beta	t	Sig.	
(Constant)	-7703.535	2681.628		-2.873	0.004	***
TOTMILE	3.938	3.022	0.071	1.303	0.194	
HWYDEN	-3048.989	1671.899	-0.079	-1.824	0.070	**
TOMICHG	19.114	16.816	0.020	1.137	0.257	
POP	0.446	0.059	0.659	7.522	0.000	***
PNFLQ	-988.783	1673.196	-0.013	-0.591	0.555	
MANULQ	1297.961	849.139	0.039	1.529	0.128	
POPDEN	108.235	26.664	0.302	4.059	0.000	***
HISCHOOL	1542.378	8308.672	0.014	0.186	0.853	
COLLEGE	30624.412	15187.356	0.074	2.016	0.045	**
AVGWAGE	-0.126	0.441	-0.032	-0.287	0.775	
INSTDIST	34.708	13.704	0.059	2.533	0.012	**
MAJCITY	18.190	13.414	0.031	1.356	0.176	
POPCHG	0.271	0.120	0.071	2.258	0.025	**
Y1990	-2595.302	2006.791	-0.065	-1.293	0.197	
Y2000	-496.902	5019.125	-0.012	-0.099	0.921	

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

Of particular interest is the impact that increased numbers of adults with college degrees has on overall employment differentials among counties. The results suggest that simply increasing the total of college-educated adults by one percent causes a difference of over 30,000 jobs. Additionally, the results for interstate distance are unexpected in that as a county moves away from an interstate, it gains employment with respect to other counties. Finally, it is notable that highway miles and highway mile changes are not significant in this model. Thus, there doesn't seem to be a strong link between lane miles and total employment in rural counties.

Models with Employment Change

The first model in this set tested manufacturing change. The battery of independent variables in this model only account for 14% of the variation among observations as demonstrated by the R-square of .196. For this iteration, three of the coefficients tested as significant above 90%. This iteration indicates that slight increases in total highway miles and population provide for manufacturing employment growth in rural counties. It also appears that higher wages per job contribute to a decline in manufacturing employment. Thus, a slight population and road growth coupled with low wages may help foster change in rural manufacturing employment.

Of particular interest for this model is that there are so few independent variables that demonstrate any level of statistical significance. That being said, the results for accessibility and labor cost are expected; as accessibility increases and total wages decrease, manufacturing employment grows. This is consistent with previous findings and the hypothesis.

Table 7: Change in Manufacturing Employment

Dependent Variable: MANUCHG

R Square	Adjusted R Square
0.196	0.142

Model	B	Std. Error	Beta	t	Sig.	
(Constant)	741.826	708.287		1.047	0.296	
TOTMILE	1.498	0.798	0.368	1.877	0.062	**
HWYDEN	-678.867	441.592	-0.240	-1.537	0.126	
TOMICHG	2.660	4.442	0.038	0.599	0.550	
POP	-0.023	0.016	-0.468	-1.476	0.141	
PNFLQ	-315.691	441.934	-0.059	-0.714	0.476	
MANULQ	295.427	224.280	0.122	1.317	0.189	
POPDEN	10.128	7.043	0.387	1.438	0.152	
HISCHOOL	207.161	2194.534	0.025	0.094	0.925	
COLLEGE	2922.006	4011.372	0.097	0.728	0.467	
AVGWAGE	-0.281	0.116	-0.974	-2.412	0.017	**
INSTDIST	-1.279	3.620	-0.030	-0.353	0.724	
MAJCITY	1.916	3.543	0.045	0.541	0.589	
POPCHG	0.056	0.032	0.201	1.760	0.080	**
Y1990	-14.929	530.045	-0.005	-0.028	0.978	
Y2000	1518.818	1325.680	0.513	1.146	0.253	

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

The second model tested the change in private, non-farm employment. The R-square is .667 indicating that the independent variables account for over 66% of the variation. Eight of the independent variables tested at greater than 90% significance. This seems to indicate that highway mileage increases, population density increases, increases in adults with college degrees, and population increases produce increases in rural, private, non-farm employment. Negative growth is attributed to factors such as highway density, specialization in private, non-farm employment, and changes in total miles.

Table 8: Changes in Private, Non-farm Employment

Dependent Variable: PNFCHG

R Square	Adjusted R Square
0.667	0.644

Model	B	Std. Error	Beta	t	Sig.	
(Constant)	-2083.995	1985.880		-1.049	0.295	
TOTMILE	6.952	2.238	0.392	3.107	0.002	***
HWYDEN	-2155.714	1238.125	-0.175	-1.741	0.083	*
TOMICHG	-31.308	12.453	-0.104	-2.514	0.013	**
POP	-0.032	0.044	-0.150	-0.734	0.464	
PNFLQ	-6459.863	1239.086	-0.275	-5.213	0.000	***
MANULQ	640.214	628.830	0.061	1.018	0.310	
POPDEN	56.398	19.746	0.495	2.856	0.005	***
HISCHOOL	2815.536	6152.990	0.079	0.458	0.648	
COLLEGE	42430.000	11247.002	0.324	3.773	0.000	***
AVGWAGE	-0.353	0.327	-0.281	-1.081	0.281	
INSTDIST	11.453	10.149	0.061	1.129	0.260	
MAJCITY	5.408	9.934	0.029	0.544	0.587	
POPCHG	0.305	0.089	0.252	3.424	0.001	***
Y1990	4359.335	1486.130	0.342	2.933	0.004	***
Y2000	2937.072	3716.915	0.228	0.790	0.430	

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

This model specification indicates that road networks are a mixed bag for development whereby differences in highway miles affected higher private, non-farm job growth, but increases in mileage in each individual county can actually decrease employment. Also, an interesting finding is that over-specialization in private, non-farm employment can actually decrease employment in this sectors. This seems to indicate that a tipping point can be reached at which increasing private employment can produce diminishing employment returns. As with the stock variable, a higher incidence of college-educated adults makes a significant difference on the amount of private, non-farm employment, a finding that is wholly in keeping with expectations.

The third variable tested is change in total employment. The R-square of this model is .645, and six of the variable test above 90% significance including the time dummy for 1990. Five of the variables have positive correlations to increases in total rural employment increases among the counties. Total miles, specialization in private, non-farm employment, population density increases, increases in college-educated adults, and increases in population over time are all positively correlated with increases in private, non-farm employment. Thus the road network, human capital, and urbanization economies seem to contribute to higher levels of total rural employment.

Table 9: Total Rural Employment Change

Dependent Variable: EMPLCHG						
R Square	Adjusted R Square					
0.645	0.621					
Model	B	Std. Error	Beta	t	Sig.	
(Constant)	-3534.260	1354.829		-2.609	0.010	***
TOTMILE	4.012	1.527	0.342	2.628	0.009	***
HWYDEN	-1321.794	844.688	-0.163	-1.565	0.119	
TOMICHG	1.145	8.496	0.006	0.135	0.893	
POP	-0.010	0.030	-0.070	-0.331	0.741	
POPCHG	0.245	0.061	0.307	4.044	0.000	***
PNFLQ	1545.210	845.343	0.100	1.828	0.069	*
MANULQ	-275.281	429.008	-0.040	-0.642	0.522	
POPDEN	38.587	13.472	0.512	2.864	0.005	***
HISCHOOL	3904.919	4197.761	0.166	0.930	0.353	
COLLEGE	19557.542	7673.055	0.226	2.549	0.011	**
AVGWAGE	-0.336	0.223	-0.404	-1.506	0.134	
INSTDIST	8.460	6.924	0.068	1.222	0.223	
MAJCITY	5.476	6.777	0.044	0.808	0.420	
Y1990	-1877.852	1013.884	-0.223	-1.852	0.065	*
Y2000	437.418	2535.795	0.051	0.172	0.863	

*, **, *** denotes significance of at least 90%, 95% and 99%, respectively

However, this iteration indicates that over-specialization in private, non-farm employment can actually increase overall employment in this sector, as does over-

saturation of highways. Additionally, as with other variables, increasing labor force qualifications with respect to higher education seems to increase the incidence if rural employment growth. As such, it is necessary to consider the mix of employment types within a county in order to hedge against a trend toward over specialization. Finally, total change in lane miles is not significant in this model, thus indicating the increasing highway mileage in rural counties does not influence employment.

Implications and Conclusion

The models seem to indicate that a variety of factors play a role in rural employment growth. Among these, population change, manufacturing specializations and some degree of accessibility appear to be important factors. Different highway variables played a role in development, yet, contrary to expectations, higher road mileage appears to produce higher employment. However, the models consistently show that dense highway networks in rural areas have negative employment effects. Thus, it can be generalized that some degree of overall accessibility is necessary, but that too many roads can be harmful to areas. Furthermore, the results of the models indicate that a tipping point can be reached whereby increasing highways can produce diminishing employment returns.

Among non-accessibility variables, the results of the models indicate that increased labor force qualifications and dense population patterns contribute significantly to employment growth in private employment and overall employment. In particular, human capital and urbanization patterns, when coupled with increase distances from interstates, foster growth within rural areas. This would indicate that those counties that

urbanize are better able to control for displacement effects that interstate highways have been shown to result it.

The empirical results have wide-ranging implications for a variety of policy actors in transportation and rural economic development. For state-level transportation officials, this research implies that focusing on enhancing the current road stock through lane-width expansions and improvement may be a tool for increased economic development, but that building additional highway miles may be detrimental to the creation of jobs. Given the potentially high expense of increasing lane miles, the small number of additional jobs attributed to lane mile enhancements may be a costly endeavor for the state. The state may reconsider its funding and construction plans in order to produce the desired economic impacts on a long-term basis as a justification for expenditures. Advocating for additional lane miles is not supported by this research.

Economic development advocates and officials should also take caution in continuing to advance the notion that more highways will automatically lead to more development. It appears that highways contribute to accessibility in some measure, and therefore, in tandem with other factors, like labor cost and human capital, help foster rural growth and development. However, pushing for highway-specific infrastructure development plans is not recommended.

State officials should also be mindful that labor force enhancements appear to contribute significantly to rural development. Increasing workforce training and higher education opportunities to rural residents will probably produce a greater impact on economic outcomes that highways. A well-trained labor force stands to attract more employment either through business growth and/or retention. Thus, connecting college

attendance to employment is vital. At the same time, the state should not continue to encourage low-wage labor as a development mechanism because non-farm employment is inversely related to low wages. Continuing to guide localities into low-wage employment opportunities could have a long-term deleterious effect.

The research also implies that local officials should take certain steps to bring development to their rural areas and prevent negative growth. They should discontinue the advocacy of more highways and try to develop better quality roads and possibly other modes of transportation for individuals. Focusing on developing small cities or other notes of commercial and residential life will probably enhance rural areas through capturing urbanization and localization benefits. Local officials should also seek out opportunities to develop higher education facilities in their counties. Finally, local officials should not seek to attract employment via cheaper labor because this seems to negatively correlate with non-manufacturing employment.

In general, the hypothesis that a mature road network - such as North Carolina's – does not produce additional benefits from increases lane-mile capacity appears to hold true. As the literature indicated, transportation seems to be a contributor to economic development under certain constructs. However, other factors, such as agglomeration economies and labor force qualification have as much or more of an influence on development variables, and appear to produce greater rural economic development.

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