5-2014

Broadband infrastructure in the 21st century : an evaluation of local outcomes and conditions.

Chad Stephen Foster
University of Louisville

BROADBAND INFRASTRUCTURE IN THE 21ST CENTURY: AN EVALUATION OF LOCAL OUTCOMES AND CONDITIONS

By

Chad Stephen Foster
B.S., United States Military Academy, 1996
M.P.A., University of Louisville, 2005

A Dissertation
Submitted to the Faculty of the
College of Arts and Sciences of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy

Department of Urban and Public Affairs
University of Louisville
Louisville, Kentucky

May 2014

BROADBAND INFRASTRUCTURE IN THE 21ST CENTURY:
AN EVALUATION OF LOCAL OUTCOMES AND CONDITIONS

By

Chad Stephen Foster
B.S., United States Military Academy, 1996
M.P.A., University of Louisville, 2005

A Dissertation Approved on

April 7, 2014

by the following Dissertation Committee:

____
David M. Simpson, Ph.D., Dissertation Director

____
Janet M. Kelly, Ph.D., Committee Member

____
Steven G. Koven, Ph.D., Committee Member

____
David J. Roelfs, Ph.D., Committee Member

ABSTRACT

BROADBAND INFRASTRUCTURE IN THE 21ST CENTURY:
AN EVALUATION OF LOCAL OUTCOMES AND CONDITIONS

Chad S. Foster

April 7, 2014

Since 2001, the Federal government has invested approximately $10 billion to expand broadband infrastructure throughout the nation, including various loan programs and grants authorized through Farm Bills and, more recently, the American Recovery and Reinvestment Act of 2009 (Kruger, 2012). These investments dwarf capital investments made by the top telecommunications and cable companies estimated at $50 billion per year (Federal Communications Commission [FCC], 2010, p. 18). While the rage on all levels has been connecting residents, few studies have attempted to measure investments in broadband infrastructure to demonstrate positive outcomes or improvements, especially from a wide variety of economic and social indicators.

This project was implemented to explore the importance of broadband infrastructure to communities in the post-industrial, digitization era or the period defined by Daniel Bell (1998) as the “third technological revolution” (pp. 96-115). Using an economic utilitarian approach, the investigator investigated the relationships between broadband infrastructure and commonly accepted economic indicators. Both quantitative and qualitative methods were used for collecting and analyzing data relating to the broadband infrastructure, economic growth, and social characteristics of counties–the primary unit of measurement in this study. Specifically, the investigator analyzed relationships using ordinary least squares linear regression analysis at the aggregate level, and qualitative comparative analysis using a sample of counties.

The results from this study suggest that some direct effects may exist between broadband and select economic growth indicators. However, broadband more likely provides an interaction effect on economic growth across all industry sectors through variables representing human capital (e.g., educational attainment, worker skills and training), household income and community earnings levels, and industry diversity. There is also a strong relationship between broadband infrastructure and urban influence, which is consistently significant at explaining growth indicators. However, the exact nature of the interaction between broadband and urban influence remains unknown.

Based on both the quantitative and qualitative results, there is evidence that broadband infrastructure and being "wired" does come with benefits at the community level and support economic growth. This study provided empirical data to support these relationships at the local scale in the United States.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In 2010, the U.S. Federal Communications Commission (FCC) released the *National Broadband Plan* citing broadband as "a foundation for economic growth, job creation, global competitiveness and a better way of life" (FCC, 2010). Other countries have put forth similar anecdotal arguments for investments in broadband infrastructure such as a Canadian Task Force, which compared the future impact of broadband to those of railways and highways (National Broadband Task Force, 2001, p. 3). Since 2001, the Federal government has invested approximately $10 billion to expand broadband infrastructure throughout the nation, including various loan programs and grants authorized through Farm Bills and, more recently, the American Recovery and Reinvestment Act of 2009 (Kruger, 2012). These investments dwarf capital investments made by the top telecommunications and cable companies estimated at $50 billion per year (FCC, 2010, p. 18).

Through federal grants and their own initiatives, state and local communities in the United States are also investing in broadband as well as newer wireless networks for the benefit of their residents and businesses. Recently, for example, the Commonwealth of Kentucky (2014) released a solicitation for vendor support of planning for a proposed statewide high speed fiber optic network with the number one goal to "[p]romote economic development" (p. 10) and to enable "broadband connectivity to economically depressed areas, thereby creating new job opportunities to these communities" (p. 11).

Today, there exists an ideology that economic and social improvements will result by providing residents with access to broadband infrastructure. In fact, the authors of a 2012 American Planning Association (APA) broadband report argued "that this new infrastructure has the potential to transform communities" (McMahon, Thomas & Kaylor, 2012, p. 21). While the rage on all levels has been connecting residents, few studies have attempted to measure investments in broadband infrastructure to demonstrate positive outcomes or improvements, especially from a wide variety of economic and social indicators. In other words, is there empirical evidence to support the notion that a transformation is underway? This project investigated broadband infrastructure from the perspective of economic growth measures as well as community conditions that may decrease or increase likelihood of achieving growth.

Summary of Literature

There are various strands of literature on broadband infrastructure that have surfaced primarily since the 1990s. This section introduces these strands according to common traditions of empirical urban theory (e.g., structural, institutional, individual) and supply- and demand-oriented viewpoints. At a *structural-level* of analysis, broadband infrastructure may be viewed as the technical counterpart and an enabling feature of the recent period of globalization. Short (2004) notes that the recent period of globalization has been exceptional given the advancements in international free trade, increased capital flows, and the reduction in state controls. Sassen (2009) recognizes that broadband infrastructure has enabled unprecedented levels of capital flow by, most notably, supporting the transactions and investments of firms located in global cities. Daniel Bell (1998) and Manuel Castells (1999) were early thinkers on the social impacts of the digital era. Castells (1999) describes the technology not as a cause of globalization, but rather a trigger or prerequisite for new productivities and organizational forms that have led to social problems (pp. 1-2). Both Bell and Castells advanced the concept of the "information age" in both a market and social context.

As a result of these structural changes, local communities are pursuing strategies to remain connected and competitive. Technology plays a prominent role in Richard Florida's Creative Class thesis along with human capital and tolerance for diversity (Florida, 2005). Measuring the economic benefits associated with investments in broadband infrastructure is the source of many studies, which have mixed results. For example, Crandall, Lehr, and Litan (2007) found in a study of data between 2003 and 2005 of non-farm employment in 48 states that increase in broadband penetration rates predicted overall employment growth, most noticeably in the services industries and manufacturing. Researchers in a separate study found that economic growth in Lake County, Florida, exceeded that of a control group of counties following implementation of a municipal fiber-optic network in 2001 (Ford & Koutsky, 2005).

A number of studies have focused on the impact of federal grants and loan programs aimed at increasing access to broadband in rural communities (e.g., The U.S. Department of Agriculture's Broadband Loan Program). These programs were put in place under the belief that broadband infrastructure could reduce costs associated with distance and geographic isolation, decentralize jobs and open markets to rural areas, and provide access to education and information for the betterment of the community

(Rowley & Porterfield, 1993, p. 3). Kandilov and Renkow (2010) found that more than $4 billion in federal spending on rural broadband infrastructure since 2000 has led to positive impacts among recipient communities in terms of employment, payroll, and business establishments. However, those improvements were concentrated in select industry sectors (e.g., transportation and warehousing) and in communities adjacent to urban areas (Kandilov & Renkow, 2010).

While linked to structural influences, technology and innovation are commonly cited as fueling the restructuring of employment at the *institutional* level through the substitution of low-skilled jobs for higher-skilled and more productive jobs (Atkinson & Andes, 2010, pp. 4-5). It is reasonable to conclude that broadband infrastructure generally supports the information technologies (IT) behind innovation in all sectors of the economy. Among public institutions, evidence suggests that state and community leaders are embracing and financing IT efforts despite decreasing revenues and budget cuts. A study conducted by the American City & County and the Public Technology Institute (PTI) found that 78 percent of county and municipal officials who responded to a national survey on IT spending indicated that their spending for 2012 would be either the same or up from the current year (American City & County and the PTI, 2011).

The increasing use of mobile devices supported by broadband infrastructure provides an example of an institutional transformation underway that exemplifies the Mobile (M)-Government movement; interestingly, this movement has replaced the Electronic (E)-Government movement in the span of a few years. The availability of the Internet on mobile devices is transforming many aspects of public service delivery today

(International Telecommunication Union [ITU] and the Organization for Economic Co-operation and Development [OECD], 2011).

While many communities rely on infrastructure and networks provided by the markets, there are many that own or manage their own broadband networks in one of many configurations. McMahon et al. (2012) distinguish two simplified models for community-owned networks, which are common in communities such as those found Tennessee and Washington that have longstanding traditions providing electric service and other utilities as a public service (Mitchell, 2011, p. 6). The wholesale model accounts for communities that own the fiber/cable infrastructure, but allow Internet service providers (ISPs) to purchase access and compete for resident business. The retail model involves communities that both own the infrastructure and offer services directly to residents (McMahon et al., 2012, p. 27). While these models require a basic resident fee for service like any other utility, some communities have fully subsidized access to networks such as Wi-Fi hotspots in parks or downtown districts as is the case in Anderson, Indiana (see City of Anderson, n.d.). Two additional models include the Nonprofit Ownership model and the common Private Franchise Model in which private firms own and manage the infrastructure and service and public entities negotiate with those firms for benefits and access for government institutions, schools, and other institutions (Breitbart, 2007).

In addition to institutional perspectives, literature suggests many *individual-level* reasons for providing residents with access to broadband infrastructure. For example, Sassen (2002) notes the importance of the Internet to support civic participation, including sites that allow “non-elites to communicate, support each other’s struggle” (p.

368). Community broadband plans such as the plan released by Portland, Oregon, in 2011 listed civic engagement as a community goal in addition to sustainability (McMahon et al., 2012, p. 18). Robinson (2006) notes how state governments are leveraging the Internet to engage citizens from streaming legislative sessions to collecting citizen ideas for budget priorities.

Overlapping with the structural, institutional, and individual viewpoints are two common frames that appear to influence policy making, planning efforts, and the research agenda. The dominant frame among policymakers and researchers in the 1990s and persisting today are both *market*- and *supply-oriented* approaches that emphasize material access to broadband infrastructure. Analyses of broadband penetration rates, upload and download speeds, the number of cellular towers, and the number of wireline and wireless providers in a given area are examples of supply-oriented approaches favored by national policies and initiatives of the FCC.

While important, broad-based penetration rates and speeds discount residents not connected either because they are unable to afford services or simply chose not to acquire it (McMahon et al., 2012, p. 35). Epstein, Nisbet, and Gillespie (2011) describe research that supports the “skills” frame of reference that emphasizes residents’ ability to search for information online and engage in activities that enhance productivity (p. 95). Other *demand-oriented studies* have focused on the use of the broadband infrastructure, learning and digital literacy, and many social benefits and outcomes (e.g., better healthcare through access to health information, safer communities through access to crime information). For example, the Bill and Melinda Gates Foundation sponsored research of Internet use at public libraries and found that more than half of all residents in

2009, including 44 percent of residents in households below the federal poverty level, used computer resources at libraries for connecting with family and friends via e-mail, education, employment, and health purposes (Becker, Crandall, Fisher, Kinney, Landry & Rocha, 2010, pp. 2-5).

Malecki (2003) notes that there is a tendency for community leaders to favor supply-oriented policies such as the provision of infrastructure as they may be easier to grasp and manage in comparison to demand-side issues (p. 210). They may also be embraced among planners and researchers since they are easier to quantify and measure than demand-oriented factors (Epstein et al., 2011, p. 95). Maps of infrastructure may explain "what" is available in terms of access, but little regarding how households use that infrastructure or why some chose not to use it at all.

The preponderance of supply-oriented policies and research may be a result of markets operating with little planning conducted from an institutional perspective as well as lack of research conducted among social scientists. Dabinett (2002) argues that a "technological determinism" (p. 232) exists in society fueled by the propaganda of high-tech companies, excitement of technologists, and need to remain competitive. Morozov (2013) used the term "technological solutionism" in *To Save Everything, Click Here* as part of his critique of the digitization ideology. Morozov (2013) and Dabinett (2002) voice concerns that new technologies are automatically adopted without critical thought and study of the possible spatial and social impacts. Similarly, Andrew and Petkov (2003) note that planning for telecommunications is largely conducted by technicians and engineers who maintain a "world view" confined to their domain with little external monitoring and measurement of impacts (p. 89).

Literature generally recognizes the importance of broadband infrastructure from the perspective of globalization, or tends to focus on supply- or demand-side facets. Castells (1999) noted “disarray in social and economic policies [that] stems from the lack of a common understanding of the processes of transformation under way” (p. 1). There may be reasons for why a lack of understanding persists in 2014, including the lack of research on broadband infrastructure from multiples perspectives, the unpredictability of markets, and the rapidly changing nature of technology itself.

Only recently has the physical and socials aspects of broadband infrastructure entered into the purview of planners who may be best positioned in communities to tie together the various technical and social aspects in a meaningful way. McMahon et al. (2012) call for an action plan for the new economy that accounts for broadband infrastructure (p. 63). This research project aims to further knowledge of broadband infrastructure to benefit the work of community leaders, planners, and administrators. The results of this study will assist local officials plan for broadband infrastructure, while accounting for the rapidly changing face of technology that makes this type of planning qualitatively different than other types of static infrastructure (e.g., roads, bridges).

Research Questions and Hypotheses

Beginning in the early 1990s, research into the “digital divide” focused primarily on understanding differences in residents’ access to the Internet, and ways to better connect residents through both market mechanisms and subsidized measures (e.g., libraries, community centers). There is growing evidence that access, as defined by simply connecting to the Internet, has become relatively ubiquitous as approximately 85 percent of all adults connect to the Internet on a daily basis (Zickuhr, 2013). Many researchers have shifted their attention to the "broadband divide" (Epstein et al., 2011) focusing on upload and download speeds provided by broadband infrastructure noting differences in bandwidth available between urban and rural areas and other distinguishing characteristics (Malecki, 2003).

Planners and researchers continue to focus on the question of access (e.g., the geographic distribution of access, the characteristics of those with and without access, the type and quantity of access needed, how to deliver access). While material access to broadband infrastructure may be important, planned outcomes may be contingent on other factors that are generally absent from "purely technical interpretation(s)" (Sassen, 2002, p. 365). While some of these variables may be structural and difficult for communities to change in the short term (e.g., types of industries that thrive on access and knowledge), others may be within a community's purview to steer, such as the digital literacy skills often acquired through education (Epstein et al., 2011).

The research questions for this study are based on the notion that broadband infrastructure is a public interest and requires the attention of public actors, including planners. Altshuler (1965) notes that collective goals should "somehow be measured at least roughly as to importance" (p. 194). Therefore, efforts should be made to measure and assess broadband infrastructure at the community level. *In summary, this project is based on the notion that broadband infrastructure is a public interest and requires some degree of measurement.*

For measuring broadband infrastructure, the investigator leveraged the utilitarian approach to investigating social phenomena. The focus on utility places emphasis on the consequences of actions rather than the actions themselves or the motivations of agents, and it requires calculations to determine costs and benefits (Williamson, 2010, pp. 57-59). Following this approach, community-level benefits are defined conceptually in economic terms. There is significant literature to support a claimed relationship between access to broadband infrastructure and economic growth. For example, McMahon et al. (2012) note that "[b]roadband infrastructure is a determining factor in the economic fortunes of places" (p. 55). Whether to remain competitive in the New Economy (Atkinson & Andes, 2010) or as a means of stimulating local innovation, there remain strong claims regarding the importance of broadband infrastructure for achieving economic growth.

Note that the traditional cost-benefit analysis is replaced with an access-benefit analysis since the purpose of the study is primarily concerned with the relationship between broadband infrastructure and community-level benefits and less on fiscal costs. The utilitarian approach may also benefit from a measurement of "happiness" as defined by personal happiness, personal health, and quality of life satisfaction (Williamson, 2010, p. 86). In other words, access to broadband infrastructure may be justified if there is a high correlation between broadband infrastructure and residents' health and other indicators of well-being. For practical reasons, this aspect of the utilitarian approach was not investigated in this study.

This project was implemented to explore the importance of broadband infrastructure to communities in the post-industrial era. Using an economic utilitarian approach, the investigator investigated the following research questions and hypotheses:

Question #1: What are the relationships between broadband infrastructure and commonly accepted economic indicators?

- *Hypothesis #1*: Access to broadband infrastructure does not have a strong relationship to economic growth across all industry sectors.
- *Discussion*: Economic competitiveness and growth are commonly cited as reasons for investing in broadband infrastructure. However, research indicates that the influence of broadband infrastructure on economic growth is contingent on location and local conditions (for example, see Kandilov & Renkow, 2010; Rowley & Porterfield, 1993).

Question #2: What are the relationships between broadband infrastructure and growth in knowledge-based industry sectors?

- *Hypothesis #2*: Access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors.
- *Discussion*: Contemporary theories for economic growth such as Richard Florida's Creative Class thesis (2005) and theories for the New Economy (Atkinson & Andes, 2010) emphasize the importance of technology for supporting growth in jobs and wages in knowledge-based industry sectors, including the professional, scientific, and technical services sector.

Question #3: What community-level factors influence the relationships between broadband infrastructure and economic growth?

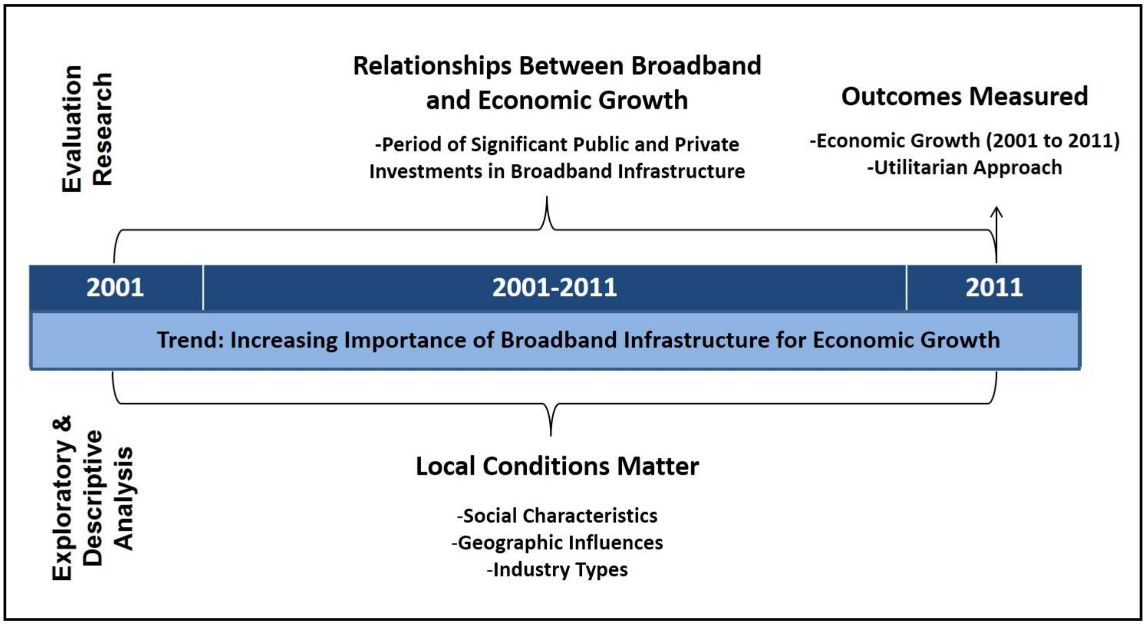
- *Hypothesis #3:* A variety of community characteristics (e.g., location/spatial factors, economic and social conditions) influence the relationships between broadband infrastructure and economic growth.

- *Discussion:* As previously noted, research suggests that the influence of broadband infrastructure on economic growth is contingent on location and local conditions.

Note that for this project, the term "broadband infrastructure" generally refers to all network components that enable the provision of broadband within local communities, including wireline and wireless infrastructure. Broadband is defined by the FCC as access to the "Internet and Internet-related services at significantly higher speeds than those available through "dial-up" Internet access services" (FCC, 2012). Broadband platforms deliver connection speeds greater than 200 Kbps and include digital subscriber lines (DSL), cable modems, fiber, and wireless platforms (FCC, 2012).

Testing the hypotheses associated with research questions #1 and #2 involved *evaluation* and *exploratory* research to describe the relationships between broadband infrastructure and economic growth indicators. To provide insights into economic outcomes, the investigator leveraged the use of utilitarian indicators as explained by Phillips (2003). In support of research question #3, the project involved both *exploratory* and *descriptive* research. Figure 1 provides a concept diagram for the research approach. The following chapter provides an overview of methodologies used for this study.

Figure 1. Research Approach



CHAPTER II

METHODOLOGY

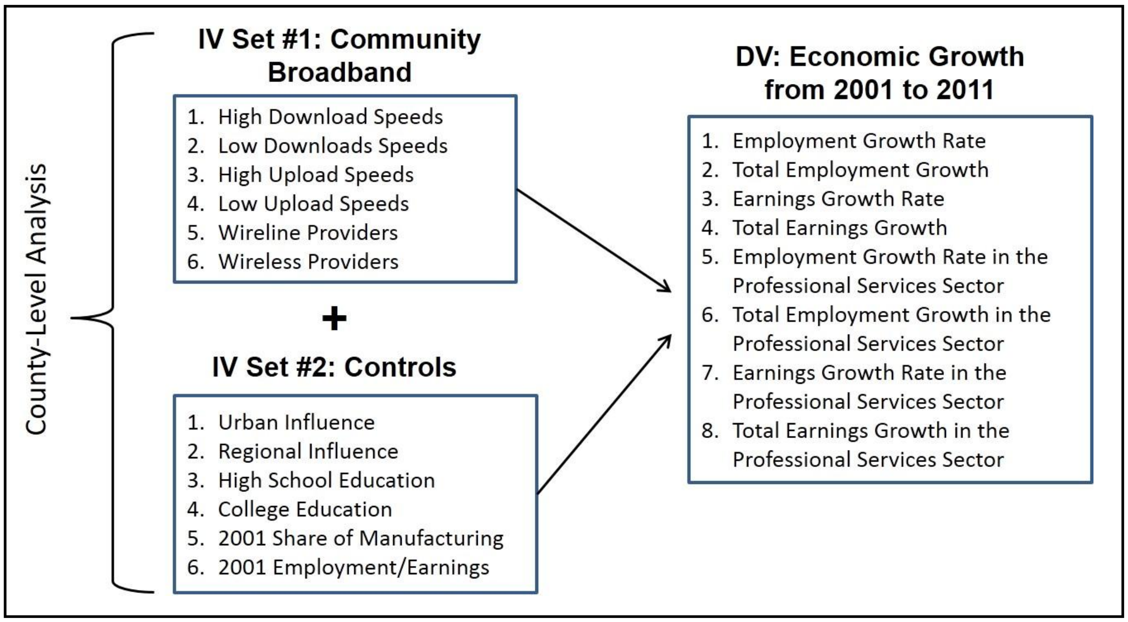
Methodology: Quantitative Analysis

The investigator used quantitative techniques for testing the first two hypotheses: (1) access to broadband infrastructure does not have a strong relationship to economic growth across all industry sectors; and (2) access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors. This sector describes quantitative methods used for testing these hypotheses.

The approach and selection of indicators for measuring economic growth closely mirrors the methodologies used by Gillett, Lehr, Osorio, and Sirbu (2006) and Shideler, Badasyan, and Taylor (2007) to assess the relationships between broadband and economic growth. The investigator selected the period 2001 to 2011 for this study due to the availability of data across all variables for that period. The unit of measurement for the quantitative analysis is counties in the United States, including equivalent units of government such as independent cities and boroughs (see U.S. Census Bureau, 2012). The county is the lowest geographic statistical area that overlaps with publically available datasets that include variables used for measuring broadband infrastructure and economic growth. In addition, the use of data from all counties in the United States (n=3,141) mitigates the impact of state-level policies and state-local traditions that might skew findings from a small sample of states.

Figure 2 provides a high-level illustration of the relationships that were investigated using ordinary least squares (OLS) linear regression analysis. Descriptions of the dependent variables (DVs) and independent variables (IVs) follows this figure.

Figure 2: Independent and Dependent Variables



The investigator selected eight indicators for economic growth using Bureau of Economic Analysis (BEA) datasets. The income and earnings by place of work data from the BEA provided a better fit for this project than alternatives, and the data supported analyses of North American Industry Classification System (NAICS) categories at the county level. The following eight DVs and BEA datasets were used for approximating economic growth at the county level, which are all based on place of work:

- Total employment growth rate
- Total employment growth

- Total earnings growth rate
- Total earnings growth
- Employment growth rate in industry sector 54 (professional, scientific, and technical services)
- Total employment growth in sector 54
- Earnings growth rate in sector 54
- Total earnings growth in sector 54

The total employment and earnings variables account for total full-time and part-time employment and earnings, respectively, across all NAICS categories. To test the aggregate-level results and validate the importance of sector-specific analyses, most notably knowledge-based sectors, the investigator conducted OLS linear regression analysis using NAICS industry sector 54 (professional, scientific, and technical services), which is likely to benefit from broadband infrastructure. According to Hecker (2005), sector 54 has multiple four-digit sectors with technology-oriented occupations. According to the New Economy theory advanced by Atkinson and Andes (2010), occupations in the professional, scientific, and technical services are considered “knowledge jobs” (p. 14) that would benefit from significant broadband infrastructure. The investigator conducted initial data collection and regression analysis using growth data for industry sector 51 (information), which also contains many four-digit sectors with technology-oriented occupations (Hecker, 2005). However, there were a significant number of missing values in the BEA datasets for this sector, and this sector includes data from printing and publishing services that continue to rely on traditional methods for disseminating information that likely offset or skew the information technology-related economic growth data. Therefore, results associated with the information sector are not included in this report.

The BEA provides interactive data tables that present compound annual growth (CAG) rates between two periods for selected variables. Therefore, the investigator conducted regression analysis using CAG rates calculated based on data selected for the period 2001 to 2011. These results are presented using values transformed using natural logarithms of data with the exception of the dummy variable regional influence. The intent of this transformation was to linearize the relationships between the independent and dependent variables (Agresti & Finlay, 2009, pp. 469-473). After additional analysis of statistical diagnostics (see Fox, 1991), including assumptions relating to normality and homogeneity of variance, the investigator determined that this transformation was likely unnecessary. Therefore, linear regression outputs using untransformed values are provided in the Results chapter (see tables 6b and 8b), which are generally consistent with the outputs using transformed values (see tables 6a and 8a). While CAG rates provide an indication of growth relative to a beginning value, they do not reflect the magnitude or scale of the growth for supporting comparisons among counties. Therefore, OLS regression analysis was conducted using total growth figures for each indicator as a supplemental measure.

Relating to the identification of explanatory variables, O'Sullivan (2009) identifies the following four sources of economic growth in cities: capital deepening, increases in human capital, technological progress, and agglomeration economies (pp. 90-91). For the purpose of this study, access to high- and low-speed broadband infrastructure is considered technological progress that increases the productivity of workers, raises earnings, and leads to job growth. Indicators for access to broadband infrastructure included six separate IVs with supporting data from the National Telecommunications and Information Administration (NTIA) and Federal Communications Commission (FCC)'s National Broadband Map dataset (NTIA & FCC, 2012a). Broadband data used to support the quantitative analysis was provided by states in June 2012. The following describes the quantitative variables measured on an interval scale that were used for estimating access to broadband infrastructure. Note that the short-hand descriptions of variables provided in the following sections will be used throughout this report as quick references.

- *High and Low Download Speeds* – These variables provide an indication regarding residents' access to high and low download speeds. The average advertised download speed in the United States is approximately 8 megabits per second (Mbps) (FCC, 2010, p. 21). These variables were measured by the percent of population in a given county that have access to download speeds above and below the average, 25 Mbps and 3 Mbps, respectively.
- *High and Low Upload Speeds* – These variables provide an indication regarding residents' access to high and low upload speeds. The average advertised upload speed in the United States is approximately 1 Mbps (FCC, 2010, p. 21). These variables were measured by the percent of population in a given county that have access to upload speeds above and below the average, 10 Mbps and 768 Kbps, respectively.
- *Wireline Providers* – The number of wireline broadband providers available to residents and businesses provides an indication of infrastructure. This variable

was measured by the percent of population in a given county that has access to three or more wireline providers.

- *Wireless Providers* – The number of wireless broadband providers available to residents and businesses provides an indication of infrastructure. This variable was measured by the percent of population in a given county that has access to three or more wireless providers.

Using the *Analyze* and *Rank* features on the National Broadband Map website, the investigator compiled percentages on a 0 to 1 scale at the county level for all six broadband infrastructure variables.

Control variables included both geographic and other possible sources of growth as identified by O'Sullivan (2009). Educational attainment is used as a proxy for increases in human capital and three variables were applied to the model to help control for agglomeration economies. A sixth control variable accounted for growth differences that occurred at the regional level using U.S. Census Bureau regions. The following describes the control variables used in the regression models.

- *High School and College Education* – The quantitative variables measured on an interval scale that were used to control for the education of residents included separate percentages for the following: (1) the percent of residents in the county over the age of 25 who have a high school degree; and (2) the percent of residents in the county over the age of 25 with a bachelor's degree or higher. The NTIA and FCC National Broadband Map website generated the county-level education data from the U.S. Census Bureau.

- *Urban Influence* – The U.S. Department of Agriculture (USDA)'s Urban Influence Codes for 2013 were used for classifying counties by the population size of their metropolitan area, largest city, or town, and proximity to metropolitan and micropolitan areas (USDA, 2013). The investigator applied this control as a categorical variable measured on an ordinal scale using all 12 USDA codes, which are described in table 1. Note that approximately one third of all counties are coded 1 or 2.

Table 1. Frequencies for the Urban Influence Code (UIC) Ordinal Variable (USDA, 2013)

Code	Description	Frequency
1	In large metro area of more than 1 million residents	414
2	In small metro area of less than 1 million residents	714
3	Micropolitan area adjacent to large metro area	130
4	Noncore adjacent to large metro area	145
5	Micropolitan area adjacent to small metro area	238
6	Noncore adjacent to small metro area and contains a town of at least 2,500 residents	339
7	Noncore adjacent to small metro area and does not contain a town of at least 2,500 residents	162
8	Micropolitan area not adjacent to a metro area	267
9	Noncore adjacent to micro area and contains a town of at least 2,500 residents	182
10	Noncore adjacent to micro area and does not contain a town of at least 2,500 residents	187
11	Noncore not adjacent to metro or micro area and contains a town of at least 2,500 residents	124
12	Noncore not adjacent to metro or micro area and does not contain a town of at least 2,500 residents	179

- *Regional Influence* – According to the U.S. Census Bureau (Mackun & Wilson, 2011), growth occurred at a much faster pace from 2000 to 2010 in states located in the South and West regions in comparison to those in the Northeast and Midwest. A dummy, categorical variable measured on a nominal scale was inserted to the model to control for this regional influence. Counties located in the

South and West, a total of 1,781 counties, were recoded with a value of "1" and the other 1,300 counties were recoded with a value of "0".

- *2001 Share of Manufacturing* – A common feature among select counties investigated during phase 2 that experienced low or negative growth from 2001 to 2011 was a high concentration of jobs in manufacturing at the beginning of the study period, 2001. Expecting this may be a common attribute, a quantitative variables measured on an interval scale was inserted into the model to reflect the share of manufacturing-based earnings as a percent of total earnings from 2001.
- *2001 Employment/Earnings* – The investigator inserted one additional quantitative variable measured on an interval scale to help account for agglomeration economies. The total number of employees for the year 2001 was used to control for agglomeration economies for models using employment growth as the DV. The total earnings from the 2001 was used to control for agglomeration economies for models using earnings growth and earnings associated with the professional services sector. The number of employees in the professional services sector from 2001 was used as the control for models predicting growth in professional services employment.

Table 2 provides descriptive statistics for the broadband infrastructure and control variables. Note that only 1,462 or about half of all counties had sufficient data to support analysis of growth in professional services sector employment.

Table 2. Descriptive Statistics for Independent Variables

Independent Variables	N	Minimum	Maximum	Mean	Standard Deviation
% of population with access to high download speeds (25 Mbps)	3,081	0	1	.406	.380
% of population with access to low download speeds (3 Mbps)	3,081	0	1	.919	.141
% of population with access to high upload speeds (10 Mbps)	3,081	0	1	.218	.331
% of population with access to low upload speeds (768 Kbps)	3,081	0	1	.938	.130
% of population with access to 3 or more wireline providers	3,081	0	1	.222	.291
% of population with access to 3 or more wireless providers	3,081	0	1	.746	.347
Urban influence (1 = highest influence, 12 = lowest influence)	3,081	1	12	N/A	N/A
Regional influence (1 = South & West, 0 = Northeast & Midwest)	3,081	0	1	N/A	N/A
% of population with a high school degree	3,081	.338	.958	.773	.089
% of population with a college degree	3,081	.035	.611	.167	.078
Share of manufacturing (2001)	2,783	0	.772	.166	.121
Total employment (2001)	3,081	71	5,500,965	53,081	186,400
Total earnings (2001) (see note)	3,081	$1,680	$257,159,670	$2,205,511	$9,878,019
Total employment in the professional services (2001)	1,461	10	990	278	237

Note: 2001 earnings and earnings growth figures in this report are provided in thousands (1,000).

For each of the economic growth DVs, the aforementioned IVs were organized into three separate models for conducting OLS linear regression analysis and comparisons among the regression outputs. *Model #1 (No Broadband)* only accounts for control variables significant at the .05 level. *Model #2 (All Variables)* provides regression results using all broadband infrastructure and control variables. *Model #3 (Trimmed)* provides results for all broadband and control variables significant at the .05 level. Note that Economic Growth Rate and Total Economic Growth are the only endogenous variables in the models. The Results chapter provides analysis of interactions among variables and possible indirect effects; however, the initial models are presented with one endogenous variable. The following provides a listing of the models used for generating outputs and supporting analysis.

Model #1 (No Broadband)

Same as Model #2 for control variables only that meet the .05 significance level

Model #2 (All Variables)

$\ln(y)$ (Economic Growth Rate) = $a + b_1\ln(x_1)$ (High Download Speeds) + $b_2\ln(x_2)$ (Low Download Speeds) + $b_3\ln(x_3)$ (High Upload Speeds) + $b_4\ln(x_4)$ (Low Upload Speeds) + $b_5\ln(x_5)$ (Wireline Providers) + $b_6\ln(x_6)$ (Wireless Providers) + $b_7\ln(x_7)$ (Urban Influence) + b_8x_8 (Regional Influence) + $b_9\ln(x_9)$ (High School) + $b_{10}\ln(x_{10})$ (College) + $b_{11}\ln(x_{11})$ (Manufacturing) + $b_{12}\ln(x_{12})$ (2001 Employment/Earnings) + e

where

Economic Growth Rate = Total Employment Growth Rate, Total Earnings Growth Rate, Professional Services Sector Employment Growth Rate, Professional Services Sector Earnings Growth Rate

y (Total Economic Growth) = $a + b_1x_1$ (High Download Speeds) + b_2x_2 (Low Download Speeds) + b_3x_3 (High Upload Speeds) + b_4x_4 (Low Upload Speeds) + b_5x_5 (Wireline Providers) + b_6x_6 (Wireless Providers) + b_7x_7 (Urban Influence) + b_8x_8 (Regional Influence) + b_9x_9 (High School) + $b_{10}x_{10}$ (College) + $b_{11}x_{11}$ (Manufacturing) + $b_{12}x_{12}$ (2001 Employment/Earnings) + e

where

Total Economic Growth = Total Employment Growth, Total Earnings Growth, Professional Services Sector Employment Growth, Professional Services Sector Earnings Growth

Model #3 (Trimmed)

Same as Model #2 for all variables that meet the .05 significance level

The following section describes data cleaning, formatting, analysis, and diagnostics. The investigator compiled, cleaned, and formatted data in preparation for the regression analysis using Microsoft Excel and Access. Separate datasets were joined using 5-digit county Federal Information Processing Standards (FIPS) codes in Access. The linear regressions were conducted using SPSS predictive analytics software.

While datasets for all of the IVs were relatively complete, there were economic growth data entries from the BEA that contained the following coding: “D” indicates the data is not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals; "NA" indicates the data is not available for a requested year; and "NM" stands for "not meaningful". Any missing values that contained these codes were excluded from the analysis. The tables provided in the Results chapter provide the sample sizes for each regression. As expected, there was fewer missing data for the total employment and earning variables than those for the sector-specific variables.

The analysis of and reporting on each model includes: descriptive statistics, F test values, the strength of the explanatory variables (R^2 values), unstandardardized coefficients, and t values and significance levels (p values) for each of the variables in the models. Tables in the Results chapter indicate variables at the .10 and .05 significance levels.

The investigator conducted regression diagnostics iteratively throughout the analysis to ensure that no assumptions were violated (see Fox, 1991; Agresti & Finlay, 2009, pp. 448-462). The following provides a description of the regression diagnostics conducted and the results:

- *Linearity Assumption* – The investigator examined the partial regression plots for all combinations of the IVs and DVs for linearity and no irregular patterns were detected. Note that most scatterplots between IVs and DVs generally showed linear, non-curvature patterns; however, a few IVs were skewed toward the upper or lower limits of the IV for most DV cases. For example, the data for low download speeds and low upload speeds was skewed toward the upper limits of the IV for most DV cases. This is a limitation associated with select data sets used for this study.

- *Normality Assumption* – All histograms of the standardized residuals plotted for each IV followed a normal distribution. Although the normal probability plots of the standardized residuals for the total growth DVs showed some indication of heavy tails, there were no issues noted among the plots for the growth rate DVs.
- *Homogeneity of Variance Assumption* – The scatterplots of the standardized residuals plotted against the predicted values for all IVs and the growth rate DVs showed no unusual patterns and generally constant standard deviation, supporting the homogeneity of variance assumption. However, there was some indication of a downward slanting pattern with the total growth DVs suggesting possible heteroscedasticity.
- *Multicollinearity Diagnostics* – Using the Collinearity Statistics in SPSS, all variance inflation factors (VIFs) were checked after regressing the IVs on the other IVs. All VIFs were under the value of 3 and most were between the values of 1 and 2, which fall within an acceptable level for VIFs.
- *Outliers and Influential Cases* – The investigator checked for possible outliers and influential cases in the data. For each model, the investigator saved and checked Cook's Distance (Cook's D) and standardized DFBETA values. Select outliers with DFBETA values exceeding the absolute value of one were omitted from follow on regression analysis. Also, all outliers beyond three standard deviations were examined and select cases were removed.

Methodology: Qualitative Analysis

The primary objective of phase 2 of the project was to explore and describe the context in which broadband infrastructure influences community outcomes, including the effects among variables. These influences and relationships are likely unforeseen or lost in aggregate-level analysis or not easily measured quantitatively. Methods implemented in support of phase 2 aimed to address hypothesis #3: A variety of community characteristics (e.g., location/spatial factors, economic and social conditions) influence the relationship(s) between broadband infrastructure and economic growth. This section describes the methodology used for selecting counties for detailed descriptive analysis as well as for collecting and analyzing numerical and qualitative data.

To simplify and support the comparison of counties based on their broadband infrastructure, the investigator developed an index (for an overview of indices used for social science purposes, see Simpson & Katirai, 2006). The Community Broadband Index (CBI) is a proxy or estimation for public and private sector investments in broadband infrastructure. This composite measure accounts for the following four broadband variables that showed significance at the .05 level for the total employment and total earnings dependent variables only: high download speeds, low download speeds, high upload speeds, and wireline providers. Although the models used for conducting the OLS linear regressions changed from initial iterations resulting in different results, the four aforementioned variables remained in the calculation of CBI scores as an estimation for broadband infrastructure. For the purpose of this project, each of the broadband indicators received equal weighting. The following provides the calculation for the CBI scores:

$$CBI_x = \sum (B_1 \text{ [High Download Speeds]} + B_2 \text{ [Low Download Speeds]} + B_3 \text{ [High Upload Speeds]} + B_4 \text{ [Wireline Providers]}) / n$$

where

CBI_x = Community Broadband Index Score for County x

B_n = Broadband Indicators 1 through n

To simplify the comparison of counties based on economic growth, an average was calculated using the CAG rates associated with the total employment and total earnings variables for each county. Once calculated, the CBI and Average Growth scores for each county were recoded as different variables representing five equal groups or quintiles in SPSS with a value of "1" assigned to the lowest range of scores and a "5" assigned to the highest range. Next, the investigator sorted the updated spreadsheet using Microsoft Excel to identify counties for the local-level comparison and analysis that met the following criteria: (1) ranked in the highest quintile for both the CBI and Average Growth (scores of 5) and (2) ranked in the highest quintile for the CBI (score of 5), but the lowest quintile for Average Growth (score of 1). Counties that ranked in the lowest quintile for the CBI, but the highest category for Average Growth were initially proposed for analysis, but preliminary results indicated that their growth was largely due to the availability of natural resources or locational advantages. The investigator removed these counties from the study as broadband infrastructure didn't appear to factor into their growth.

In addition, the investigator conducted a separate sorting of counties to identify a diverse mix of counties based on urban influence. The following describes the groups of counties used to support this analysis:

- *High Urban Influence* – The high urban influence category includes counties coded 1 and 2 in the UDSA database, which includes counties in large and small metropolitan areas (n=1,089 counties).

- *Moderate Urban Influence* – The moderate urban influence category includes counties coded 3 (defined as micropolitan area adjacent to a large metropolitan area) through 7 (defined as adjacent to a small metropolitan area and does not contain a town of at least 2,500 residents) (n=1,059 counties).
- *Low Urban Influence* – The low urban influence category includes all counties coded 8 (defined as a micropolitan area not adjacent to a metropolitan area) through 12 (defined as not adjacent to a metropolitan or micropolitan area and does not contain a town of at least 2,500 residents) (n=993 counties).

The final step in reducing the number of counties down for selection required the sorting of counties that met the aforementioned criteria based on Average Growth scores; category 1 was sorted based on largest to smallest Average Growth score, and category 2 was sorted based on smallest to largest Average Growth score. The top 10 counties for each category are listed in the Appendix.

Table 3 provides a listing of counties selected for phase 2 of the project along with their 2010 population figures and CBI and Average Growth scores. Among the counties in the top quintile for both CBI and Average Growth scores, Williamson County, Tennessee, experienced growth in the information-based, high-technology sectors and ranked in the top 10 for counties in the high urban influence category. The investigator selected both Summit County, Utah, and Hood River County, Oregon, from the moderate urban influence category. Summit County has the highest CBI score in this category, while Hood River County category experienced the highest and second highest growth rates for earnings associated with the information and professional, scientific, and technical services sectors, respectively. In the low urban influence category, Bowman

County, North Dakota, displayed the highest CBI value. Among counties in the top quintile for the CBI, but lowest for Average Growth, the investigator selected one county each from the moderate and low urban influence categories. Chattooga County, Georgia, has the highest CBI value among the top 10 counties that declined the most from 2001 to 2011 in the moderate urban influence category. Similarly, Wayne County, Indiana, has the highest CBI value among the top 10 counties that declined the most from 2001 to 2011 in the low urban influence category. Note that the investigator aimed to achieve some degree of regional diversity in selecting counties for phase 2.

Table 3. Phase 2 County Selection and Rationale

State	County Name	Population (2010)	CBI	Average Growth (2001 to 2011)
High CBI-High Growth				
TN	Williamson County	183,182	0.845	6.185
Rationale: Williamson County experienced growth in the information-based, high-technology sectors and ranked in the top 10 for counties in the high urban influence category.				
UT	Summit County	36,324	0.826	5.050
Rationale: Summit County has the highest CBI score among counties in the moderate urban influence category that experienced the highest average growth from 2001 to 2011.				
OR	Hood River County	22,346	.713	3.405
Rationale: In the moderate urban influence category, Hood River County experienced the highest and second highest growth rates for earnings associated with the information and professional, scientific, and technical services sectors, respectively.				
ND	Bowman County	3,151	0.793	5.635
Rationale: Bowman County has the highest CBI score among counties in the low urban influence category that experienced the highest average growth from 2001 to 2011.				
High CBI-Low Growth				
GA	Chattooga County	26,015	0.855	-1.195
Rationale: Chattooga County has the highest CBI score among the top 10 counties that declined the most from 2001 to 2011 in the moderate urban influence category.				
IN	Wayne County	68,917	0.790	-0.295
Rationale: Wayne County has the highest CBI score among the top 10 counties that declined the most from 2001 to 2011 in the low urban influence category.				

Both quantitative and qualitative methods were used for collecting and analyzing data relating to the broadband infrastructure, economic growth, and social characteristics of the selected counties. The investigator compiled select social and economic statistics from the U.S. Census Bureau such as population, educational attainment, and income data. The worksheets found in the results section for each county also provide economic growth data, including CAG rates associated with the DVs in the study (e.g., total employment growth, total earnings growth, etc.) and industry-specific growth data from the BEA. For comparing county employment data to state averages, industry sectors with the highest share of total employment as reported in the U.S. Census Bureau's 2007-2011 American Community Survey are presented in the worksheet. Also, each county worksheet includes a listing of the top private sector employers and their number of employees, if available.

In addition to compiling social and economic statistics, the investigator compiled broadband infrastructure data available for each county, which was downloaded from the NTIA and FCC National Broadband Map dataset for 2011 in support of phase 1 of the project. States maintain interactive maps of broadband coverage by type of technology and download and upload speeds, among other features. Select images of these maps are provided in the Results section for illustrating broadband coverage.

Finally, the investigator conducted secondary content analysis and interviews with key informants regarding social, economic, and broadband infrastructure indicators. A review of historical and strategic documents made available on the Internet provided information on each county's economic competitive advantage and types of businesses gained, sustained, and lost during the 2001 to 2011 period. Interviews with key informants allowed the investigator to probe general and specific questions regarding broadband infrastructure and provided context regarding local economic, social, and geographic conditions. The investigator initially contacted each county's information technology director and a representative from the local office of economic development or chamber of commerce to arrange for phone interviews and to identify additional informants. The following log lists the position of key informants interviewed for this study along with the interview date:

- Director of Information Technology, Summit County, Utah (Oct. 16, 2013)
- Information Technology Director, Park City, Utah (Oct. 16, 2013)
- President and CEO, Park City (UT) Chamber of Commerce & Convention and Visitors Bureau (Oct. 17, 2013)
- Executive Director, Bowman County (ND) Development Corp. (Nov. 21, 2013)
- Information Technology Coordinator, Bowman County, North Dakota (Nov. 25, 2013)
- Director of Information Technology, Williamson County, Tennessee (Dec. 13, 2013)
- Planning Director, Northwest Georgia Regional Commission (Jan. 23, 2014)
- Community Economic Development Representative, Northwest Georgia Regional Commission (Jan. 23, 2014)
- Manager of Community Affairs, Economic Development Corporation of Wayne County, Indiana (February 7, 2014)
- Telecommunications Manager, Richmond (IN) Power & Light: Parallax Division (February 10, 2014)

- Executive Director, Gorge Technology Alliance, Oregon (February 14, 2014)
- Project Manager, Mid-Columbia Economic Development District, Oregon (February 14, 2014)

The Results section provides a profile of each county with discussion regarding the relationship between broadband infrastructure and economic growth.

Limitations

The following describes limitations associated with the data and design of this study. First, the NTIA and FCC dataset on broadband infrastructure is based on the reporting of that data by states; there may be inaccuracies in the data and inconsistencies among the states in how they collect and report the data. The variables for this study included values relating to the percent of a population that has access to the infrastructure. Actual use and the qualitative characteristics of that infrastructure are not included in the quantitative analysis. Also, this study assumes that counties had access to the broadband infrastructure early in the 2001 to 2011 study period in order to benefit from its effects.

Relating to the first limitation, this study explores relationships only between broadband infrastructure and economic growth indicators, and not causal relationships that may exist among variable. Even though this report uses common methods for explaining linear regression results (e.g., explanatory variables, predicts, explains, etc.), the intent of this study is to evaluate relationships only.

Third, the time period 2001 to 2011 was used to measure economic growth; however, that period is marked by a recession/fiscal crisis from 2007 to 2009 (U.S. Department of Treasury, 2012) and many other probable regional and economic shifts that have impacted growth, which are not accounted for in the models. For example, the impact of the recession on the construction and supporting industries impacted one of the phase 2 counties–Chattooga County, Tennessee–which specializes in floor covering products.

Fourth, sufficient economic growth data with few missing values was not available for conducting thorough analysis of sectors likely to benefit from access to high-speed networks. The BEA provided data for approximately one-third of counties to support analysis of the professional services sector, and efforts to compile select high-technology sectors at the NAICS four-digit level provided results for fewer than 400 counties, mostly in the high urban influence category.

Fifth, there is likely considerable variation within counties themselves regarding both access to broadband infrastructure and economic growth, especially in metropolitan counties that span large geographic areas. Use of the county unit of measurement for the quantitative analysis masks this important variation and research at lower scales are recommended in the Discussion chapter.

Finally and from the perspective of the models and use of OLS regression analysis, the scatterplots for select IVs such as low download and upload speeds showed data skewed toward upper limits of IVs when plotted against DVs. This is a possible violation of the linearity assumption.

CHAPTER III

RESULTS

Quantitative Analysis

This chapter presents the results of the quantitative and qualitative analyses aimed at addressing the three primary research questions and hypotheses. The quantitative results associated with each economic growth indicator and the three models used to evaluate the relationship between broadband infrastructure and economic growth are provided in the following sections.

Tables 4 and 5 provide the bivariate correlations between independent variables and between independent and dependent variables. Among independent variables, there are a few strong correlations worth noting as results, and for highlighting as possible candidates for strong interaction in the OLS regression analysis.

As expected, high downloads speeds, high upload speeds, and wireline providers have strong positive correlations with each other ($r = .558$ between high download and upload speeds, $r = .489$ between high download speeds and wireline providers, and $r = .426$ between high upload speeds and wireline providers). There is also a strong correlation, .405, between low upload speeds and wireless providers. These results generally support the phenomena that higher concentrations of wireline providers is associated with higher broadband speeds overall, and the addition of wireless providers in an area is related to a higher percentage of residents and businesses with access to minimum broadband speeds.

High download speeds has the highest number of strong correlations with control variables in comparison to the other broadband variables. Most notable, high downloads speeds has a strong negative relationship with urban influence, -.455, and a positive association with college (r = .407). In other words, higher percentages of residents and businesses with access to high broadband speeds is associated with higher urban influence and educational attainment. Among the control variables, the high school and college variables have a strong positive correlation of .634. The agglomeration variables as a whole–2001 employment, 2001 earnings, and 2001 professional services employment–have stronger positive associations, in the .2 to .4 range, with high download speeds, wireline providers, and college in comparison to other controls.

The correlations displayed in table 5 shows stronger associations between independent variables and the total growth dependent variables than with compound annual growth (CAG) rates. Manufacturing had the largest relationship in absolute terms with both total employment and total earnings CAG rates at -.418 and -.398, respectively. The higher the share of manufacturing earnings in 2001 relates to smaller growth rates overall. Total dependent variable employment growth has a correlation value greater than .300 with many independent variables, including .582 with the 2001 employment totals and .457 with college. There is a nearly one-to-one relationship or correlation of .959 between 2001 earnings totals and total earnings growth from 2001 to 2011. Independent variables do not have strong relationships with the growth rates in professional services employment or earnings, but the total growth in professional services employment is correlated with the 2001 employment levels in that sector (r = .353), college (r = .271), and urban influence (r = -.229). Note that the share of manufacturing earnings in 2001 has a negative correlation with all economic growth indicators.

Table 4. Bivariate Correlations Between Independent Variables

	High Download	Low Download	High Upload	Low Upload	Wireline	Wireless	Urban Influence	Region (South & West)	High School	College	Manuf.
High Download	1	0.371	0.558	0.02	0.489	0.088	-0.455	-0.134	0.276	0.407	0.094
Low Download	0.371	1	0.245	0.05	0.278	0.084	-0.372	-0.14	0.185	0.225	0.11
High Upload	0.558	0.245	1	0.014	0.426	0.045	-0.296	-0.143	0.227	0.361	-0.05
Low Upload	0.02	0.05	0.014	1	0.018	0.405	-0.019	0.02	-0.008	-0.004	-0.009
Wireline	0.489	0.278	0.426	0.018	1	0.032	-0.311	-0.07	0.203	0.414	0.049
Wireless	0.088	0.084	0.045	0.405	0.032	1	-0.086	0.009	0.035	0.045	0.016
Urban Influence	-0.455	-0.372	-0.296	-0.019	-0.311	-0.086	1	-0.038	-0.159	-0.291	-0.131
Region (South & West)	-0.134	-0.14	-0.143	0.02	-0.07	0.009	-0.038	1	-0.45	-0.106	-0.1
High School	0.276	0.185	0.227	-0.008	0.203	0.035	-0.159	-0.45	1	0.634	-0.112
College	0.407	0.225	0.361	-0.004	0.414	0.045	-0.291	-0.106	0.634	1	-0.221
Manufacturing	0.094	0.11	-0.05	-0.009	0.049	0.016	-0.131	-0.1	-0.112	-0.221	1
2001 Employment	0.302	0.14	0.297	0.004	0.368	0.03	-0.266	-0.019	0.11	0.349	-0.063
2001 Earnings	0.261	0.116	0.274	0.002	0.336	0.022	-0.226	-0.023	0.09	0.329	-0.062
2001 Prof. Employment	0.359	0.291	0.142	0.004	0.217	0.323	-0.327	-0.042	0.217	0.336	0.124

Table 5. Correlations Between Dependent and Independent Variables

Independent Variables	Total Emp. CAG	Total Emp. Growth	Total Earnings CAG	Total Earn Growth	Prof. Services Emp. CAG	Prof. Services Emp. Growth	Prof. Earnings CAG
High Download	0.069	0.306	-0.068	0.358	0.037	0.154	-0.009
Low Download	0.126	0.162	0.045	0.181	0.039	0.128	0.017
High Upload	0.03	0.31	0.024	0.361	0.027	0.073	-0.005
Low Upload	0.017	0.024	0.007	0.003	-0.015	0.083	-0.035
Wireline	0.048	0.3	-0.067	0.401	0.033	0.109	-0.002
Wireless	0.076	0.055	0.045	0.031	0.014	0.123	0.017
Urban Influence	-0.226	-0.308	0.041	-0.322	-0.144	-0.229	-0.131
Region (South & West)	0.208	0.093	-0.115	-0.024	0.18	0.121	0.121
High School	0.153	0.203	0.209	0.192	0.012	0.097	0.07
College	0.299	0.457	0.15	0.471	0.137	0.271	0.125
Manufacturing	-0.418	-0.189	-0.398	-0.108	-0.079	-0.023	-0.098
2001 Employment	0.068	0.582	N/A	N/A	N/A	N/A	N/A
2001 Earnings	N/A	N/A	-0.118	0.959	N/A	N/A	0.035
2001 Prof. Employment	N/A	N/A	N/A	N/A	0.008	0.353	N/A

Employment Growth Rate

The investigator measured employment growth from 2001 to 2011 using two indicators: the CAG rate and the total growth in employment for each county from 2001 to 2011. Table 6a provides the OLS linear regression results using compound annual growth rates and the natural logs of all variables with the exception of the dummy variable regional influence. Table 6b provides the OLS linear regression results using untransformed values. The results provided in tables 6a and 6b are consistent with one another. For simplicity, the following results are based on analysis of data in table 6a.

Model 1 indicates that one broadband variable, percent of the population with access to high upload speeds, and all control variables are significant at the 95% confidence level and display *p* values less than .05. These variables account for 31% of all variance associated with employment CAG rates from 2001 to 2011 as reflected by the R^2 value. The trimmed model, Model 3, shows that the percent of the population with access to high upload speeds remains both positive and significant at the .05 level, and all of the control variables remain significant at the .05 level. When all broadband infrastructure variables are removed from the equation (see Model 1), there is very little change among the coefficients for the control variables, and the R^2 value decreases slightly to .307. The following provides specific results associated with table 6a.

- *High upload speeds* shows an effect on the total employment CAG rate in both Models 2 and 3. The positive coefficient suggests that each percent increase in access to high upload speeds corresponds with a .043% increase in the CAG rate controlling all other variables in the model. Even though significant at the .05 level in both models, this broadband variable has a smaller *t* value than all of the

- control variables and the little difference in R^2 value between Models 1 and 3 suggests the effect on CAG rates is weak in comparison to the other variables.
- The control variables *regional influence*, *high school*, and *college* have a positive relationship with CAG rates as reflected by the positive sign on the respective coefficients in Model 3. One percent increase in college is associated with a .718% increase in the employment CAG rate. The influence on growth rates is positive for counties in the South and West, and negative for counties in the Northeast and Midwest.
- An increase in share of *manufacturing* in 2001 corresponds with a decrease in the employment growth rate by -.779%. The manufacturing variable also has the highest bivariate correlation, -.418, with the total employment CAG rate. *Total employment in 2001* has a negative effect on growth rates as each percent increase in 2001 employment corresponds with a -.033% decrease in employment growth from 2001 to 2011. Also, an increase in *urban influence* relates to a slight increase in the CAG rate.

The following diagram illustrates the relationships identified using employment CAG rates as the dependent variable. In addition to illustrating the direct effects on employment CAG rates, the illustration notes partial correlations greater than .200 among independent variables and possible interactions and indirect effects. Darkened lines reflect partial correlations greater than .400.

Figure 3. Employment Growth Rate Diagram

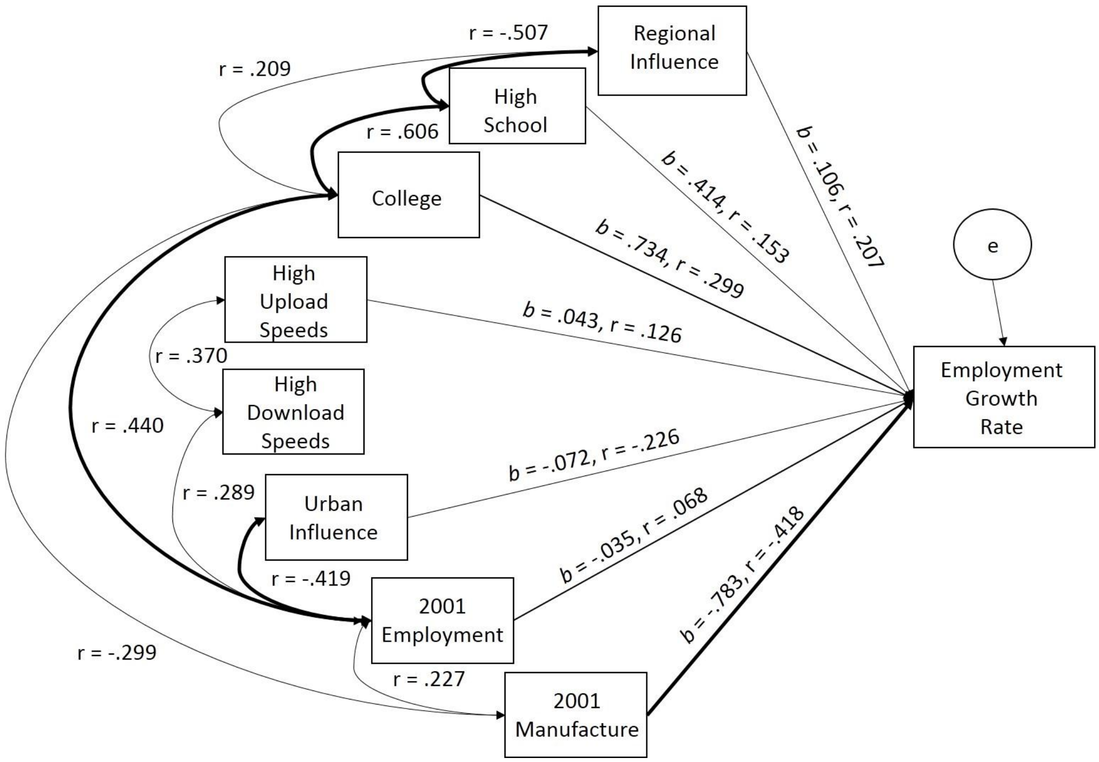


Table 6a. Regression Results for Total Employment (2001 to 2011 Compound Annual Growth [Natural Log.])

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	1.774	1.764	1.778
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	.012 (.664)	N/A
% of population with access to low download speeds (3 Mbps)	N/A	.037 (.586)	N/A
% of population with access to high upload speeds (10 Mbps)	N/A	.043** (2.275)	.043** (2.513)
% of population with access to low upload speeds (768 Kbps)	N/A	.001 (.021)	N/A
% of population with access to 3 or more wireline providers	N/A	-.023 (-1.149)	N/A
% of population with access to 3 or more wireless providers	N/A	.026 (1.438)	N/A
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	-.077** (-13.036)	-.072** (-12.005)	-.075** (-12.622)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	.103** (11.647)	.106** (11.880)	.106** (11.887)
% of population with a high school degree	.403** (3.541)	.387** (3.384)	.414** (3.636)
% of population with a college degree	.746** (7.710)	.734** (7.447)	.718** (7.378)
Share of manufacturing (2001)	-.786** (-19.604)	-.783** (-19.308)	-.779** (-19.406)
Total employment (2001)	-.031** (-7.803)	-.035** (-7.858)	-.033** (-8.142)
Additional Statistics			
n	2,783	2,783	2,783
R^2	.307	.310	.309
F-statistic	205.414	103.871	177.309

Note: Numbers in parentheses following the unstandardized coefficients are *t*-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Table 6b. Regression Results for Total Employment (2001 to 2011 Compound Annual Growth [Untransformed])

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	-.507	-.301	-.565
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	-.036 (-.494)	N/A
% of population with access to low download speeds (3 Mbps)	N/A	.160 (.595)	N/A
% of population with access to high upload speeds (10 Mbps)	N/A	.225** (2.951)	.182** (2.661)
% of population with access to low upload speeds (768 Kbps)	N/A	-.479 (-1.654)	N/A
% of population with access to 3 or more wireline providers	N/A	-.103 (-1.203)	N/A
% of population with access to 3 or more wireless providers	N/A	.081 (1.018)	N/A
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	-.066** (-9.873)	-.064** (-8.543)	-.063** (-9.222)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	.623** (12.614)	.631** (12.649)	.639** (12.856)
% of population with a high school degree	1.508** (4.130)	1.522** (4.153)	1.545** (4.232)
% of population with a college degree	2.512** (6.334)	2.440** (5.785)	2.297** (5.682)
Share of manufacturing (2001)	-3.685** (-20.418)	-3.627** (-19.670)	-3.673** (-20.371)
Total employment (2001)	-.000** (-6.191)	-.000** (-6.170)	-.000** (-6.532)
Additional Statistics			
n	2,783	2,783	2,783
R^2	.278	.281	.280
F-statistic	178.084	90.290	153.989

Note: Numbers in parentheses following the unstandardized coefficients are *t*-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Employment Growth

To supplement the results using CAG rates, the investigator regressed total employment growth figures on all broadband and control variables. Table 7 provides the linear regression results for this analysis. Both Model 2 and 3 indicate that one broadband variable, the percent of the population with access to high upload speeds, has a positive relationship with employment growth and is statistically significant with a *p* value less than .05. With the exception of the high school variable, all other control variables are strong indicators of total employment growth. The R^2 value of .432 for the trimmed model is nearly identical to the value of .433 for Model 2. The following provides specific results associated with table 7.

- Referencing Model 3, an increase in the *percent of the county population with access to high upload speeds* is associated with an increase in 1,792 jobs from 2001 to 2011. This variable has a bivariate and partial correlation value of .31 with the dependent variable, the highest among the broadband variables. Although relatively small, the change in the R^2 value from Model 1 to 3 indicates that some explanatory power was gained with the addition of the broadband variable.
- The counties' *total employment figures for 2001* are the strongest predictors of employment growth from 2001 to 2011 according to the regression results. The *t* values for this variable is the highest for Models 2 and 3, and the bivariate and partial correlation between 2001 employment and total employment growth is .582, the highest among all explanatory variables.
- The coefficients and *t* values for the remaining significant control variables suggest that college, manufacturing, and regional influence are strong predictors

of employment growth. Referencing Model 3, an increase in the *percent of the population with a college degree* is associated with an employment gain of 21,716 jobs. Counties in the South and West *regions* experienced higher employment growth in the magnitude of 2,123 jobs compared to those in the Northeast and Midwest. Each increase in the percent of *manufacturing earnings* in 2001 as a portion of all earnings had a negative impact on employment growth from 2001 to 2011; each percent increase is associated with 8,345 fewer jobs gained. Likewise, the lower the urban influence as reflected in higher values for *urban influence*, the less gain in jobs as reflected in the negative sign on the coefficient.

The following diagram illustrates the relationships identified using total employment growth as the dependent variable. Unlike the illustration for employment CAG rates, the darkened lines indicate that college and 2001 employment totals have the highest partial correlations and *t* values in relation to total employment growth.

Figure 4. Total Employment Growth Diagram

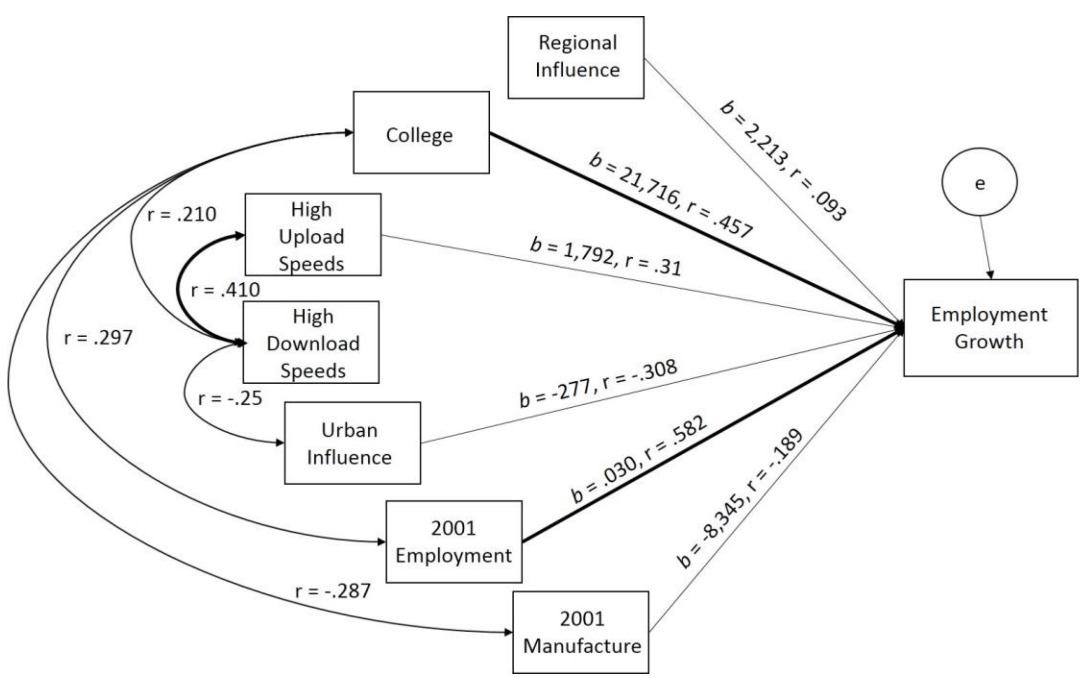


Table 7. Regression Results for Total Employment Change (Total Change from 2001 to 2011)

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	-833	-3,951	-1,155
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	464 (1.053)	N/A
% of population with access to low download speeds (3 Mbps)	N/A	715 (.624)	N/A
% of population with access to high upload speeds (10 Mbps)	N/A	1,464** (3.196)	1,792** (4.345)
% of population with access to low upload speeds (768 Kbps)	N/A	25 (.619)	N/A
% of population with access to 3 or more wireline providers	N/A	468 (.910)	N/A
% of population with access to 3 or more wireless providers	N/A	46 (.921)	N/A
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	-307** (-7.591)	-251** (-5.772)	-277** (-6.773)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	1,997** (7.865)	2,335** (7.783)	2,123** (8.335)
% of population with a high school degree	N/A	2,776 (1.257)	N/A
% of population with a college degree	23,369** (12.222)	18,664** (7.195)	21,716** (11.174)
Share of manufacturing (2001)	-8,445** (-7.831)	-8,706** (-7.914)	-8,345** (-7.761)
Total employment (2001)	.031** (27.171)	.030** (25.101)	.030** (25.991)
Additional Statistics			
n	2,743	2,743	2,743
R^2	.428	.433	.432
F-statistic	409.154	173.819	346.336

Note: Numbers in parentheses following the unstandardized coefficients are *t*-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Earnings Growth Rate

The investigator measured earnings growth from 2001 to 2011 using CAG rates and the total growth in earnings for each county from 2001 to 2011. Table 8a provides the OLS linear regression results using CAG rates and the natural logs of all variables with the exception of the dummy variable regional influence. Table 8b provides the OLS linear regression results using untransformed values. Unlike the results in table 8a, the broadband infrastructure variables *high download speeds* and *wireline providers* are significant at the .05 level in table 8b. However, the following results are based on data provided in table 8a due to difficulty in interpreting the negative values on the coefficients for *high download speeds* and *wireline providers*, and the positive value associated with *urban influence* in table 8b, which may be an outcome of collinearity.

Model 2 indicates that two broadband variables, percent of the population with access to low download speeds and three or more wireless providers, and all control variables with the exception of urban influence are significant at the 95% confidence level and display p values less than .05. These variables account for 22.7% of all variance associated with total earnings CAG rates from 2001 to 2011 as reflected by the R^2 value. The trimmed model, Model 3, shows that the two broadband variables remain significant at the .05 level with positive coefficients, and the same control variables remain significant at the .05 level. The addition of the two significant broadband infrastructure variables increases the R^2 value from .208 to .224 (see Models 1 and 3). The following provides specific results associated with table 8a.

- *Low download speeds* and *wireless providers* remain significant at the .05 level in Models 2 and 3. An increase in the percent of residents and businesses with access to low speeds and three or more wireless providers corresponds with a .285% and .074% increase, respectively, in earnings CAG rates from 2001 and 2011. The *t* values are much lower than the value for manufacturing, but similar in size to regional influence and the educational attainment variables.

- An increase in share of *manufacturing* in 2001 corresponds with a decrease in the earnings CAG rate by -.832%. The manufacturing variable also has the highest bivariate and partial correlation value, -.398, with earnings CAG rates. *Total employment in 2001* also has a negative effect on rates with each percent increase in 2001 employment corresponding with a -.030% decrease in earnings CAG rates from 2001 to 2011.
- Unlike the results for other dependent variables, the percent of the population with a *high school* degree has a slightly stronger influence on earnings CAG rates than an increase in the percent of the population with a *college* degree. Each percentage increase in high school degree corresponds with a .532% increase in earnings CAG rates compared to .207% for the college variable.
- The influence on earnings CAG rates is positive for counties in the Northeast and Midwest, and negative for counties in the South and West.

The following diagram illustrates the relationships identified using earnings CAG rates as the dependent variable. Unlike other dependent variables, urban influence is not a strong indicator of earnings CAG rates.

Figure 5. Earnings Growth Rate Diagram

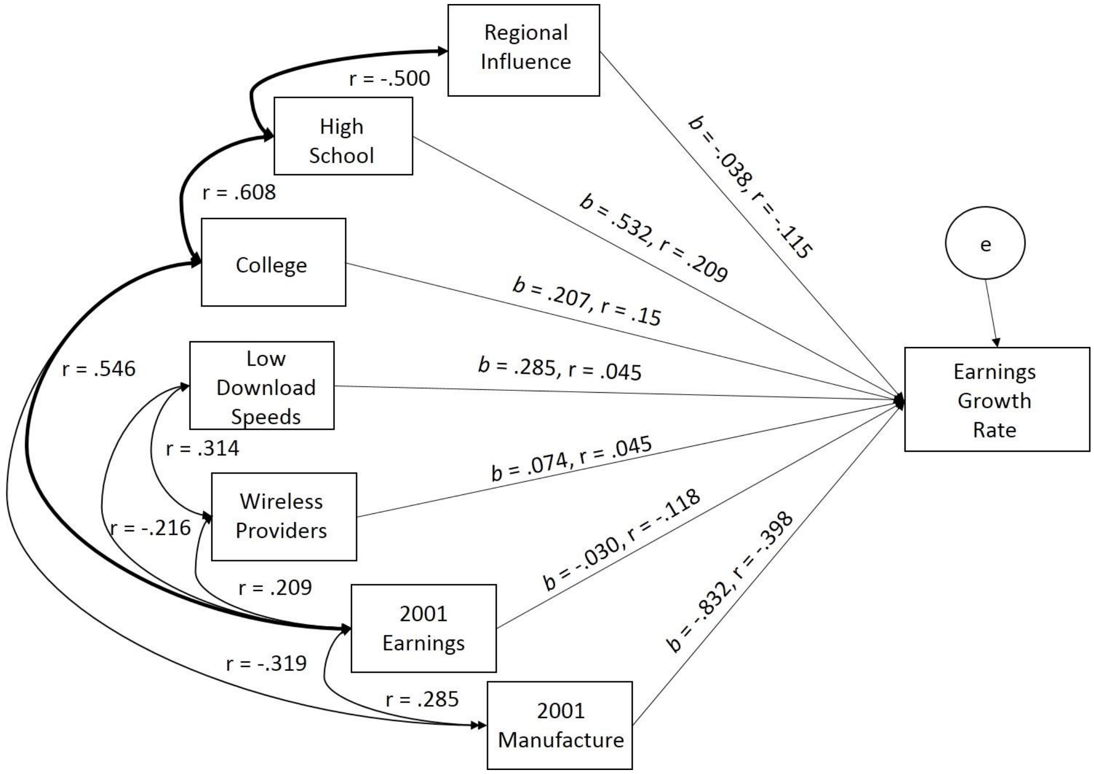


Table 8a. Regression Results for Total Earnings (2001 to 2011 Compound Annual Growth [Natural Log.])

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	2.291	2.221	2.221
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	-.033* (-1.758)	N/A
% of population with access to low download speeds (3 Mbps)	N/A	.319** (5.021)	.285** (4.672)
% of population with access to high upload speeds (10 Mbps)	N/A	.018 (.951)	N/A
% of population with access to low upload speeds (768 Kbps)	N/A	-.038 (-1.365)	N/A
% of population with access to 3 or more wireline providers	N/A	-.036* (-1.732)	N/A
% of population with access to 3 or more wireless providers	N/A	.078** (4.291)	.074** (4.222)
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	N/A	-.006 (-.917)	N/A
Regional influence (1 = South & West, 0 = Northeast & Midwest)	-.040** (-4.482)	-.040** (-4.426)	-.038** (-4.293)
% of population with a high school degree	.598** (5.174)	.518** (4.485)	.532** (4.635)
% of population with a college degree	.201** (2.017)	.235** (2.347)	.207** (2.098)
Share of manufacturing (2001)	-.800** (-19.494)	-.812** (-19.769)	-.832** (-20.189)
Total earnings (2001)	-.021** (-6.532)	-.028** (-6.931)	-.030** (-8.901)
Additional Statistics			
n	2,782	2,782	2,782
R^2	.208	.227	.224
F-statistic	145.816	67.707	114.490

Note: Numbers in parentheses following the unstandardized coefficients are t-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Table 8b. Regression Results for Total Earnings (2001 to 2011 Compound Annual Growth [Untransformed])

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	2.495	.885	1.033
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	-.436** (-3.270)	-.393** (-3.195)
% of population with access to low download speeds (3 Mbps)	N/A	1.356** (3.627)	1.334** (3.574)
% of population with access to high upload speeds (10 Mbps)	N/A	.158 (1.146)	N/A
% of population with access to low upload speeds (768 Kbps)	N/A	-.015 (-1.350)	N/A
% of population with access to 3 or more wireline providers	N/A	-.408** (-2.653)	-.401** (-2.706)
% of population with access to 3 or more wireless providers	N/A	.517** (3.690)	.512** (3.670)
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	.041** (3.418)	.054** (4.005)	.054** (4.003)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	-.416** (-4.737)	-.372** (-4.122)	-.397** (-4.540)
% of population with a high school degree	3.103** (6.066)	3.372** (5.074)	3.115** (5.955)
% of population with a college degree	N/A	-.516 (-.675)	N/A
Share of manufacturing (2001)	-7.068** (-21.879)	-7.112** (-21.324)	-7.099** (-22.029)
Total earnings (2001)	-.000** (-4.250)	-.000** (-2.830)	-.000** (-2.971)
Additional Statistics			
n	2,782	2,782	2,782
R^2	.199	.215	.214
F-statistic	137.517	63.223	83.899

Note: Numbers in parentheses following the unstandardized coefficients are t-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Earnings Growth

To supplement the results using CAG rates, the investigator regressed total earnings growth figures on all broadband and control variables. Table 9 provides the linear regression results for this analysis. Model 2 reflects that one broadband variable, the percent of the population with access to low download speeds, has a positive relationship with earnings growth and is significant at the .10 level. With the exception of the high school variable, all other control variables are strong predictors of total earnings growth. The R^2 value associated with Model 1 (No Broadband) and Model 2 (All Variables) is the same value, .926. The following provides specific results associated with table 9.

- *Low broadband speeds* has a positive coefficient and is significant at the .10 level in Model 2; however, the t value of 1.836 is relatively low compared to the t values for the control variables. No change in the R^2 value between Models 1 and 2 supports the finding that broadband variables do not provide a significant direct effect on earnings growth.
- *Total earnings from 2001* is significant at the .05 level and the strongest predictor of earnings growth according to the t value for this variable in Models 1 and 2, 157.026 and 147.457, respectively. The bivariate correlation between total earnings from 2001 and total earnings growth from 2001 to 2011 is .959. However, the dollar-for-dollar change as reflected by the coefficient of .318 is very low compared to the coefficients for the other control variables.
- Referencing Model 1, an increase in the *percent of the population with a college degree* is associated with an earnings gain of $1,114,754 (note: all coefficients are

in thousands of dollars). *Regional influence* also has a significant relationship with total earnings growth as counties in the South and West predict an increase in earnings by $74,262. A higher share of manufacturing earnings in 2001 predicts lower earnings growth by -$574,806. In addition, each increase in urban influence code reflects an increase in earnings growth by $16,281.

Table 9. Regression Results for Total Earnings Change (Total Change from 2001 to 2011)

Variable	Model 1 (No Broadband)	Model 2 (All Variables)	Model 3 (Trimmed)
Intercept	48,742	-113,498 (see note)	48,742
Broadband Variables			
% of population with access to high download speeds (25 Mbps)	N/A	18,447 (.564)	N/A
% of population with access to low download speeds (3 Mbps)	N/A	156,424* (1.839)	N/A
% of population with access to high upload speeds (10 Mbps)	N/A	-3,941 (-.116)	N/A
% of population with access to low upload speeds (768 Kbps)	N/A	-284 (-.094)	N/A
% of population with access to 3 or more wireline providers	N/A	26,200 (.685)	N/A
% of population with access to 3 or more wireless providers	N/A	-1,366 (-.369)	N/A
Controls			
Urban influence (1 = highest influence, 12 = lowest influence)	-16,281** (-5.449)	-13,951** (-4.330)	N/A
Regional influence (1 = South & West, 0 = Northeast & Midwest)	74,262** (3.959)	80,227** (3.605)	N/A
% of population with a high school degree	N/A	16,023 (.098)	N/A
% of population with a college degree	1,114,754** (7.877)	1,015,916** (5.256)	N/A
Share of manufacturing (2001)	-574,806** (-7.212)	-604,483** (-7.410)	N/A
Total earnings (2001)	.318** (157.026)	.317** (147.457)	N/A
Additional Statistics			
n	2,745	2,745	N/A
R^2	.926	.926	N/A
F-statistic	6,875.637	2,863.771	N/A

Note: All coefficients are provided in thousands of dollars. Numbers in parentheses following the unstandardized coefficients are t-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Professional Services Sector

The investigator measured relationships between independent variable and employment and earnings growth rates, and employment growth in the professional services sector. The two left-hand columns in table 10 provide the OLS linear regression results using employment CAG rates for the professional services sector and the natural logs of all variables with the exception of the dummy variable regional influence. The right-hand columns provide results for total employment growth in the professional services sector. Table 11 provides earnings CAG rates for the professional services sector and the natural logs of all variables with the exception of the dummy variable regional influence. Note that sufficient data was not available to analyze earnings growth for this sector.

None of the broadband variables are significant at the .05 level for any of the models associated with the professional services sector. Note that the R^2 value increases from Model 1 to Model 2 for the employment and earnings CAG rates, but decreases slightly for employment growth in the professional service sector. The following provides specific results associated with tables 10 and 11.

- The *college* variable remains significant at the .05 level and positive in all professional services sector models. Referencing Model 1, an increase in college corresponds with a 1.272% increase in employment CAG rates, an increase in 513 jobs from 2001 to 2011, and a .621% increase in the earnings CAG rate in the professional services sector.

- Likewise, *urban influence* and *regional influence* are consistently positive and significant at the .05 level. Counties in the South and West, and higher urban influence correspond with increases for all professional services sector indicators.
- Unlike models for other indicators, *manufacturing* is not a predictor of growth rates or total growth in the professional services sector. However, *total employment in the professional services sector from 2001* has mixed results (see table 10). It has a small, but significant negative relationship to employment CAG rates, but small and positive relationship to employment growth in the professional services sector.

Table 10. Regression Results for Employment in the Professional Services (2001 to 2011) (See Note)

Variable	Model 1: Rate (No Broadband)	Model 2: Rate (All Variables)	Model 1: Growth (No Broadband)	Model 2: Growth (All Variables)
Intercept	2.469	2.399	-32	.011
Broadband Variables				
% of population with access to high download speeds (25 Mbps)	N/A	.062 (1.472)	N/A	18 (1.276)
% of population with access to low download speeds (3 Mbps)	N/A	.270* (1.675)	N/A	24 (.539)
% of population with access to high upload speeds (10 Mbps)	N/A	-.010 (-.200)	N/A	2 (.096)
% of population with access to low upload speeds (768 Kbps)	N/A	-.230 (-1.505)	N/A	-32 (-.731)
% of population with access to 3 or more wireline providers	N/A	.057 (1.133)	N/A	24 (1.358)
% of population with access to 3 or more wireless providers	N/A	-.011 (-.268)	N/A	-6 (-.453)
Controls				
Urban influence (1 = highest influence, 12 = lowest influence)	-.068** (-5.466)	-.063** (-4.774)	-7** (-5.610)	-7** (-5.266)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	.101** (6.078)	.111** (5.122)	35** (4.811)	35** (3.540)
% of population with a high school degree	N/A	.106 (.400)	N/A	-22 (-.322)
% of population with a college degree	1.272** (6.573)	1.036** (3.728)	513** (6.999)	499** (4.632)
Share of manufacturing (2001)	N/A	-.094 (-.984)	N/A	-42 (-1.158)
Total employment in the professional services (2001)	-.040** (-3.857)	-.039** (-3.217)	.127** (7.484)	.122** (6.332)
Additional Statistics				
n	1,063	983	1,059	980
R^2	.087	.091	.200	.197
F-statistic	25.274	8.090	65.727	19.792

Note: This table presents CAG rates (two left-hand columns) using natural logarithms of data and employment growth in the professional services. Numbers in parentheses following the unstandardized coefficients are t-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Table 11. Regression Results for Earnings in the Professional Services (2001 to 2011 Compound Annual Growth [Natural Log.])

Variable	Model 1 (No Broadband)	Model 2 (All Variables)
Intercept	3.262	3.087
Broadband Variables		
% of population with access to high download speeds (25 Mbps)	N/A	-.035 (-1.301)
% of population with access to low download speeds (3 Mbps)	N/A	.054 (.500)
% of population with access to high upload speeds (10 Mbps)	N/A	-.022 (-.849)
% of population with access to low upload speeds (768 Kbps)	N/A	-.097* (-1.724)
% of population with access to 3 or more wireline providers	N/A	-.033 (-1.155)
% of population with access to 3 or more wireless providers	N/A	.003 (.108)
Controls		
Urban influence (1 = highest influence, 12 = lowest influence)	-.048** (-5.651)	-.050** (-5.715)
Regional influence (1 = South & West, 0 = Northeast & Midwest)	.060** (5.735)	.055** (4.538)
% of population with a high school degree	N/A	.197 (1.207)
% of population with a college degree	.621** (6.633)	.431** (3.312)
Share of manufacturing (2001)	N/A	-.097 (-1.553)
Total earnings (2001)	-.028** (-5.833)	-.016** (-2.834)
Additional Statistics		
n	1,753	1,668
R^2	.059	.063
F-statistic	27.619	9.240

Note: Numbers in parentheses following the unstandardized coefficients are t-statistics and the notations * and ** indicate significance at the .10 and .05 levels, respectively.

Summary of Quantitative Results

The following provides a summary of quantitative results as they apply primarily to broadband infrastructure variables.

- *Result #1*: High download speeds, high upload speeds, and wireline providers have high and positive associations with one another. This group, but most notable high download speeds, has relatively high and positive correlations with college and urban influence. Broadband infrastructure variables may be effecting economic growth indicators through interaction with college and urban influence even though a direct relationship is not strong or revealed in the aggregate-level analysis.
- *Result #2*: High download speeds, high upload speeds, and wireline providers have stronger bivariate correlations–in the .300 to .400 range–with total employment and earnings growth indicators, and weaker associations with rates of growth.
- *Result #3*: The high upload speeds variable is both positive and significant at the .05 level in regressions using employment CAG rates and total employment growth. Analysis of the bivariate and partial correlation values, *t* values, and decreases in R^2 after the broadband variable is removed from the models suggest that high upload speeds has a stronger overall relationship to total employment growth from 2001 to 2011 than the employment CAG rates during that same period.
- *Result #4*: Unlike the employment growth indicators, earnings CAG rates are effected by the percent of county residents and businesses that have access to low

download speeds and multiple wireless providers. In other words, the greater the coverage of access to lower speeds and multiple wireless providers relates to an increase in earnings CAG rates from 2001 to 2011. Interestingly, the earnings CAG rate is the only dependent variable not effected by urban influence.

- *Result #5*: Broadband infrastructure variables do not have strong relationships with the total earnings growth and growth in the professional service sector. Note that college and urban influence have positive and significant effects on these dependent variables. Although not revealed in this analysis, broadband infrastructure may be influencing these variables through indirect effects and interactions with college and urban influence.

It may also be interesting to note that the agglomeration control variables, including the total employment counts and earnings for each county in 2001, are consistently significant at the .05 level, negative in value for growth rates, and positive for total growth. With the exception of analyses using the professional services sector data as the dependent variable, the share of manufacturing earnings in 2001 as a percent of total earnings is significant at the .05 level and consistently negative for all growth indicators.

Qualitative Analysis

This section presents the results of the county subset analysis. The first subsection provides an overview of four counties that ranked in the highest quintile for both average growth from 2001 to 2011 and the Community Broadband Index (CBI). The counties represent three different levels of urban influence as determined using the U.S. Department of Agriculture (USDA)'s urban influence codes.

High Growth Counties with High CBI Values

Williamson County, Tennessee

This section provides a brief profile of Williamson County, Tennessee, which experienced high growth from 2001 to 2011 and has a high CBI value when compared to other counties in the high UIC range of 1 to 2. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 12 provides a summary of select statistics for Williamson County, Tennessee.

Williamson County is situated directly south of Nashville-Davidson County, Tennessee, approximately 22 miles from the Nashville central business district. With a 2010 population of 183,180 and urban influence code of "1", Williamson County is considered a metropolitan county according to the USDA. The population of the county increased by nearly 60,000 residents between 2000 and 2010, and two thirds of all residents lived in the cities of Brentwood, Franklin, and Spring Hill in 2010. Although the county size is 583 square miles, the three communities of Brentwood, Franklin, and Spring Hill and most residents live in close proximity to or within five miles of the Interstate 65 (I-65) corridor. The county government seat is located in Franklin, which is also the most populous city in the county at 62,864 residents.

According to select social statistics, the county is considered both educated and wealthy compared to the rest of the state. The percent of the population of the age 25 and older in Williamson County with a college degree in 2011 was 51.5 percent, nearly 30 percent higher than the state average. The medium household income of $89,063 was approximately twice the state average of $43,989. Commuting data from 2011 indicates that approximately 38 percent of Williamson County residents commuted to and worked in Nashville-Davidson County, while approximately 55 percent both lived and worked in Williamson County (Williamson County Office of Economic Development [OED], 2012, p. 3). Nearly 48 percent of all Williamson County workers resided outside of the county (Williamson County OED, 2012, p. 3).

Employment and earnings data indicates that Williamson County has benefited from growth in and the agglomeration impacts of two industry sectors–the healthcare sector, including corporate management and services, and the management of companies and enterprises in the automotive sector. The top three private sector employers in 2012, accounting for 5,812 employees, were Community Health Systems, Inc., Nissan North America, and Williamson Medical Center (Williamson County OED, 2012, p. 4). At least nine of the top 25 employers in the county provide healthcare and related services such as medical imaging and dialysis services (Williamson County OED, 2012, p. 4), while other top employers in the county that provide professional services such as marketing, accounting, and financial services likely benefit from this clustering of healthcare employers. From an employment perspective, the Educational and Health and Social Services sector grew at an annual compound growth rate of 5.45 from 2001 to 2011, the highest in the county (Bureau of Economic Analysis [BEA], 2012). The earnings associated with this sector grew at a rate of 13.16, the third highest in the county (BEA, 2012). The sector comprising the Management of Companies and Enterprises experienced the highest growth rate, 31.22, from an earnings perspective (BEA, 2012).

In addition to healthcare, the management of automotive companies and enterprises warrants mention. Between 2007 and 2009, Nissan North America located their headquarters to Williamson County from Los Angeles, California, and currently employs 1,600 workers (D. Thomas, personal communication, December 13, 2013; Williamson County OED, 2012, p. 4). Nissan maintains two production plants in nearby counties in Tennessee, but not in Williamson County (Nissan, n.d.). Note that Manufacturing accounts for only 7.6 percent of the workforce in Williamson County, approximately 6 percent less than the state average for 2011 (U.S. Census Bureau, 2011). The county growth rate in Manufacturing was 2.28 between 2001 and 2011 (BEA, 2012).

The county experienced negative and minimal growth from an employment and earnings perspective, respectively, across all industries that comprise North American Industry Classification System (NAICS) code 51 (Information). However, available data on sectors 5112 (Software Publishers) and 5182 (Data Processing, Hosting, and Related Searches), which are considered high-technology sectors (Hecker, 2005), is more indicative of growth that might be expected relative to the significant broadband infrastructure available in the county. The number of employees associated with sector 5182 increased from 717 to 930 between 2003 and 2011, and the annual payroll for that sector increased from $46,266,000 to $69,041,000 (U.S. Census Bureau, 2013). Even though employment in sector 5112 decreased from 2003 to 2011, the annual payroll increased from $16,406,000 to $22,518,000 (U.S. Census Bureau, 2013). Verizon

Wireless houses its state headquarters in Williamson County and employs 1,300 workers; similarly, AT&T employs 500 workers in the county (Williamson County OED, 2012, p. 4).

The industry data from the U.S. Census Bureau likely fails to capture the full scope of high-technology jobs that exist in Williamson County. For example, the number of establishments associated with sectors 5112 and 5182 and as reported by the U.S. Census Bureau remained relatively unchanged between 2003 and 2011. Although noticeable, the increase in employees and annual payroll in those sectors may be marginal compared to the high-technology jobs associated with the top employers in the county–Community Health Systems, Inc., Nissan North America, and Williamson Medical Center–for example. Reflecting on the importance of technology to economic development, the director of the Williamson County Chamber of Commerce reported in January 2013 that “the technology sector is not concentrated in just one or two companies” but rather “spread throughout corporate operations in Middle Tennessee” (McBryde, 2013). Being home to headquarters for companies such as Nissan North America and Mars Petcare (Williamson County, 2012, p. 3), for example, the broadband infrastructure likely supports critical corporate functions not evident in U.S. Census Bureau data.

This broadband infrastructure provides nearly all residents and businesses in the county with access to low download and upload speeds of 3 megabits per second (Mbps) and 768 kilobits per second (Kbps), respectively. Approximately 90 percent of residents and businesses have access to high download speeds greater than 25 Mbps and 77 percent have access to high upload speeds greater than 10 Mbps. The interactive map provided by

Connected Tennessee (see figure 7) shows that a significant portion of the county has access to downloads speeds closer to the 50 to 100 Mbps range, especially along the I-65 corridor. Figure 6 provides a basic map of the county for illustrating the outline of the county and comparison purposes. According to the director of information technology for the county (D. Thomas, personal communication, December 13, 201) and Connected Tennessee data (Connected Tennessee, n.d.), the wireline infrastructure in the county is primarily comprised of a mix of cable and digital subscriber line (DSL) technology and high bandwidth services are provided to residents, businesses, and governmental entities by AT&T, Charter Communications, Inc., and Comcast. United Telephone Company, Inc. provides service in rural areas of the county (D. Thomas, personal communication, December 13, 2013).

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

The five-year, 2009 to 2014, strategic plan for the Williamson County Economic Development Council identified "recruit targeted business sectors" as one of five priority areas with a focus on the following four sectors: corporate headquarters, healthcare, information technology, and energy technology (Williamson County OED, 2008, p. 10). In describing the importance of information technology, the council indicated that "Williamson County is poised to reap the benefits largely because of the concentration of existing high tech companies in the Brentwood/Maryland Farms area and the education and skill level of the existing workforce" (Williamson County OED, 2008, p. 11). It could be argued that information technology today is as much a sector as it is a facet of most every business enterprise regardless of sector. From the viewpoint of economic development leaders in Williamson County, the importance of information technologies and the underlying broadband infrastructure to future growth is high.

The high employment and earnings growth experienced in the county from 2001 to 2011 that coincided with significant private sector investments in broadband infrastructure supports a possible relationship between the two factors. Specifically, the county experienced growth in the health and social services, educational services, and professional, scientific, and technical services sectors. Other community-level factors have likely influenced this growth (see hypothesis #3), including the following:

- Close proximity to Nashville-Davidson County
- Existing industry clusters
- Highly educated workforce

In addition, a key informant identified other amenities, such as high quality of schools in the area, and other tax and development-related incentives provided by public leaders to businesses seeking to relocate likely played an important role in the decisions by Nissan North America and other businesses to move to or expand in Williamson County (D. Thomas, personal communication, December 13, 2013). For example, see Anderson (2012) for an overview of various financial deals and incentives offered by the state, county, and municipalities in Williamson County to attract large corporations. In addition to these other factors, amenities, and incentives, though, the Williamson County example supports the importance of broadband infrastructure as a 21st century economic growth necessity.

Table 12. Select Statistics for Williamson County, Tennessee

General and Social Statistics		
Population Change from 2000 to 2010	126,638 → 183,180	
Urban influence based on scale (1 = highest to 12 = lowest)	1	
Closest Metropolitan Area (22 Miles)	Nashville-Davidson (2010 Pop.: 603,527)	
Largest City/Town	Franklin (2010 Pop.: 62,864)	
% of Population with a High School Degree (2011)	94.5% (State: 83.2%)	
% of Population with a College Degree (2011)	51.5% (State: 23.0%)	
Median Household Income (2011)	$89,063 (State: $43,989)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	100.00%	
% of pop. with access to high download speeds (25 Mbps)	90.03%	
% of pop. with access to low upload speeds (768 Kbps)	99.93%	
% of pop. with access to high upload speeds (10 Mbps)	76.98%	
% of pop. with access to 3 or more wireline providers	70.89%	
% of pop. with access to 3 or more wireless providers	99.55%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	3.98	
Total Earnings by Place of Work	8.39	
Employment in Sector 51 (Information)	-3.20	
Earnings in Sector 51 (Information)	.55	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	6.00	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	10.00	
Top 3 Sectors by Employment Growth (2001 to 2011) *Note: Growth rates were calculated using estimates from 2000 due to the unavailability of 2001 data*	Educational, health and social serv.: 5.45 Professional, scientific, and man., and admin. and waste man. services: 4.50 Arts, entertainment, recreation, accommodation and food services: 4.31	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Man. of companies and enterprises: 31.22 Educational services: 15.15 Healthcare and social assistance: 13.16	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Educational services, and healthcare and social assistance	24.8%	22.0%
Professional, scientific, and management, and administrative and waste management services	13.5%	8.8%
Retail trade	10.0%	12.1%
Top 3 Private Sector Employers (Williamson County OED, 2012, p. 4)	Community Health Systems, Inc.: 2,800 Nissan North America: 1,600 Williamson Medical Center: 1,412	

Figure 6. Williamson County Road Map (Connected Tennessee, 2012)

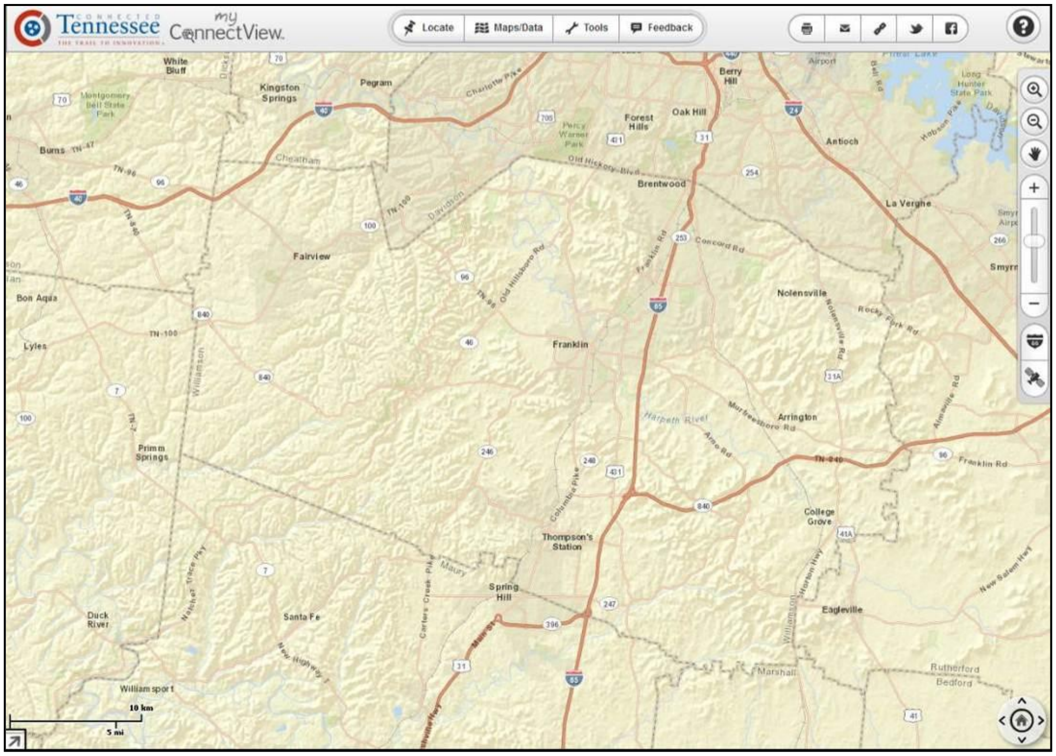
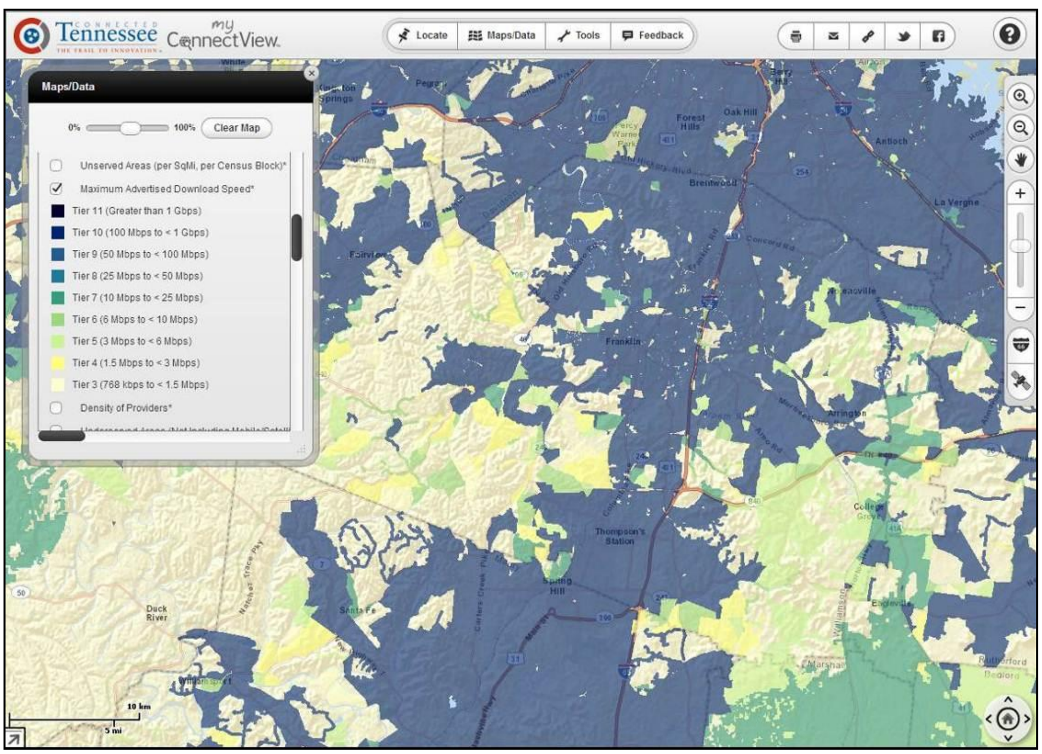


Figure 7. Williamson County: Maximum Advertised Download Speeds (Connected Tennessee, 2012)



Summit County, Utah

This section provides a brief profile of Summit County, Utah, which experienced high growth from 2001 to 2011 and has a high CBI value when compared to other counties in the moderate UIC range of 3 to 7. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 13 provides a summary of select statistics for Summit County, Utah.

Summit County, Utah, is situated northeast of Salt Lake City and adjacent to both Salt Lake County and the Wyoming state boundary. Having an urban influence code of "3" according to U.S. Department of Agriculture (USDA), the county had a population of 36,324 in 2010, an increase by approximately 6,500 from 2000. The county has four cities and two towns, but a low population density–19.4 persons per square mile in 2010–due to significant portions of the county being considered unincorporated and comprised of federal and state public lands, including a segment of the Wasatch Cache National Forest. On the western edge of the county and situated on the eastern slope of the Wasatch Mountains is Park City, the largest city in the county with a 2010 population of 7,558.

According to select social statistics, the county is considered both educated and wealthy compared to the rest of the state. The percent of the population in Summit County with a college degree in 2011 was 49.9 percent, more than 20 percent higher than the state average. The medium household income was $84,752 compared to the state average of $57,783.

According to the Park City Chamber of Commerce (2013), the tourism industry accounts for more than one-third of all employment in the county and is the county's most important economic sector. The top three private sector employers in the county in 2012 were three ski resorts–Deer Valley Resort, Canyons Resort, and Park City Mountain Resort–each employing more than 500 employees (Park City Chamber of Commerce, 2013, p. 50). Likewise, the sector Arts, Entertainment, Recreation, and Accommodation and Food Services accounted for 18.6 percent of all county employment in 2011, more than 10 percent higher than the state average (U.S. Census Bureau, 2011). While the share of employment in the county for many other industry sectors is comparable to state averages, Manufacturing in Summit County accounts for less than half the state average, 5.4 percent compared to 10.8 percent for the state (U.S. Census Bureau, 2011).

According to phone interviews with key informants (R. Boyer & S. Robertson, personal communication, October 16, 2013; B. Malone, personal communication, October 17, 2013), Park City hosted a portion of the 2002 Winter Olympic games and attracted significant international investments in the years following the games, leading to the county becoming a world-class ski and travel destination. Interestingly, the industry sectors growing the most from 2001 to 2011 from an earnings perspective were Healthcare and Social Assistance (11.46), Educational Services (10.74), and Wholesale Trade (9.94) (BEA, 2012). According to the President and CEO of the Park City Chamber of Commerce, the area attracted wealthy executives during the past 10 years, such as high-level executives from Dell and Verizon who maintain homes in the county with incomes and earnings that may not be reflected in industry-specific figures. The limited supply but high demand for housing led to an increase in property values during the past 10 years. In addition to access to world-class ski resorts, key informants listed close proximity to Salt Lake City, which is approximately 30 miles from Park City, and the Salt Lake City International Airport as locational advantages attractive to wealthy executives and businesses. It also boasts upscale amenities such as leisure attractions and arts; for example, the county will host the Sundance Film Festival in January 2014.

The percent of the county population that has access to high speed download and upload speeds is relatively high–86.33 percent have access to download speeds greater than 25 Mbps and 89.61 percent have access to 10 Mbps upload speeds. According to key informants and Utah Broadband Project data (Utah, 2013), the infrastructure in the county is comprised of a mix of cable, DSL, and fiber optic technologies. The primary service providers in the county include Comcast, CenturyLink, and All West Communications. Comcast has invested in and built-out a private fiber optic network in the Park City area for residential and business customers. See figures 8 and 9 for maps of the county with shaded areas reflecting portions with access to low and high download and upload speeds.

Anchor institutions such as schools, higher education institutions, libraries, and many governmental entities are served by the Utah Education Network (UEN)'s fiber optic network, a public initiative. Healthcare facilities in the county, including rural areas, are linked to other facilities throughout the state through the Utah Telehealth Network (UTN), a University of Utah-based initiative. Informants also cited a third public network in the county, the Utah Department of Transportation Smart Roads initiative, which provides connectivity along highways and streets through the use of fiber optic infrastructure for monitoring traffic flow and related data. County officials have access to this infrastructure. In summary, residents and businesses are serviced through private sector providers, while anchor institutions in the county rely on a mix of both public networks and private providers.

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

The investigator explored this question with three key informants representing information technology at the county and city levels, as well as the local chamber of commerce. All informants indicated that broadband infrastructure by itself is hardly a reason or cause for growth during the past 10 years; however, there have been benefits and impacts.

Wealthy executives from Verizon and other companies who desired to live and work from residential properties in Summit County influenced decisions among private sectors providers to invest in high-speed networks. These executives demanded sufficient bandwidth to videoconference remotely for conducting international business. Local businesses have benefited from the infrastructure, including resorts who offer customers high-speed Internet connections, retail companies such as backcountry.com that utilize the infrastructure for marketing and sales, and local movie studios that plan to use the infrastructure for delivering content via digital media (R. Boyer & S. Robertson, personal communication, October 16, 2013; B. Malone, personal communication, October 17, 2013). In fact, Google awarded Park City an eCity award in 2013, which is awarded to the “strongest online business communities in each state” (Google, 2013).

This data provides some support for hypothesis #2 (Access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors.). Local small businesses have thrived online and corporate executives have utilized the infrastructure for telecommuting, which has likely led to jobs in various service industries. However, the infrastructure has not attracted the IT companies or the younger, innovative entrepreneurs that fit Florida's (2005) Creative Class mold according to key informants. One possible reason limiting new establishments in the county, ranging from small start-ups to larger corporations, may be the limited supply of affordable housing. In 2013, the median sales price for a single-family home in the most populous areas of the county was $649,000, while the price of homes in the limits of Park City was $1,077,500 (Park City Chamber of Commerce, 2013, p. 5). Only 37 percent of Summit County employees live in Summit County, and 48 percent of Summit County residents work elsewhere (Park City Chamber of Commerce, 2013, p. 50).

In additional to broadband infrastructure, other community-level factors that have likely influenced economic growth between 2001 and 2011 (see hypothesis #3) include the following:

- Close proximity to Salt Lake City and Salt Lake City International Airport
- Investments associated with the 2002 Winter Olympics and reputation associated with the world-class ski resorts
- Highly educated and wealthy workforce
- Availability of arts and entertainment and other leisure attractions

In summary, one informant stated that "businesses do not set up shop here in Summit County because of broadband, but it may be reason not to set up shop" (S. Robertson, personal communication, October 16, 2013), analogous to a basic city service or utility like power or water. Recognition of this relationship is reflected in the *Park City*

2030 strategic plan. The plan lists “use of technology as a competitive advantage” as one of five long-term strategic approaches with the caveat that “[t]he City should not pursue technology for technology’s sake but use it where appropriate to enhance service provision and to leverage opportunities where none may currently exist” (Park City Municipal Corporation, 2012, p. 3). It remains unclear if broadband and related technologies provide Summit County with a competitive advantage over others given its many locational advantages. It’s clear that broadband may be important to Summit County, but not critical to its economic well-being.

Table 13. Select Statistics for Summit County, Utah

General and Social Statistics		
Population Change from 2000 to 2010	29,763 → 36,324	
Urban influence based on scale (1 = highest to 12 = lowest)	3	
Closest Metropolitan Area (30 Miles)	Salt Lake City (2010 Pop.: 186,440)	
Largest City/Town	Park City (2010 Pop.: 7,558)	
% of Population with a High School Degree (2011)	93.3% (State: 90.6%)	
% of Population with a College Degree (2011)	49.8% (State: 29.6%)	
Median Household Income (2011)	$84,752 (State: $57,783)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	99.05%	
% of pop. with access to high download speeds (25 Mbps)	86.33%	
% of pop. with access to low upload speeds (768 Kbps)	99.08%	
% of pop. with access to high upload speeds (10 Mbps)	89.61%	
% of pop. with access to 3 or more wireline providers	55.45%	
% of pop. with access to 3 or more wireless providers	91.85%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	3.96	
Total Earnings by Place of Work	6.14	
Employment in Sector 51 (Information)	0.90	
Earnings in Sector 51 (Information)	2.88	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	3.69	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	5.60	
Top 3 Sectors by Employment Growth (2001 to 2011)	Transportation and warehousing: 8.77 Real estate and rental and leasing: 7.15 Finance and insurance: 7.10	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Healthcare and social assistance: 11.46 Educational services: 10.74 Wholesale trade: 9.94	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Arts, entertainment, and recreation, and accommodation and food services	18.6%	8.6%
Educational services, and healthcare and social assistance	15.0%	21.2%
Professional, scientific, and management, and administrative and waste management services	13.3%	10.9%
Top 3 Private Sector Employers (2012) (Park City Chamber of Commerce Convention & Visitors Bureau, 2013)	Deer Valley Resorts: 1,000-1,999 Canyons Resort: 700-999 Park City Mountain Resort: 500-699	

Figure 8. Portions of Summit County with Access to Low Download and Upload Speeds (Utah, 2013) (3 Mbps Download and 768 Kbps Upload)

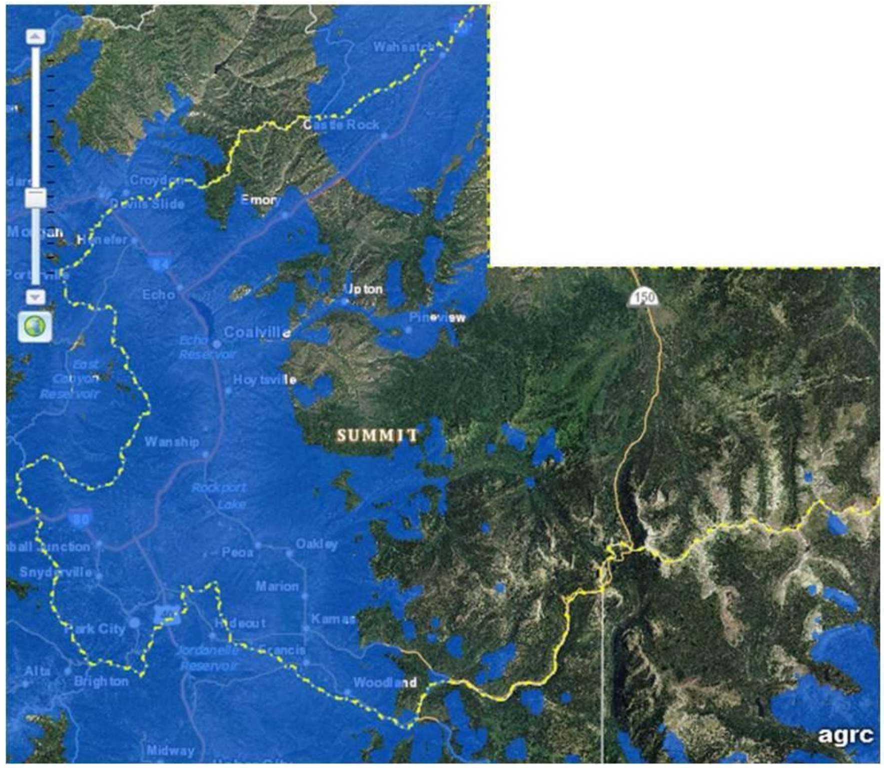
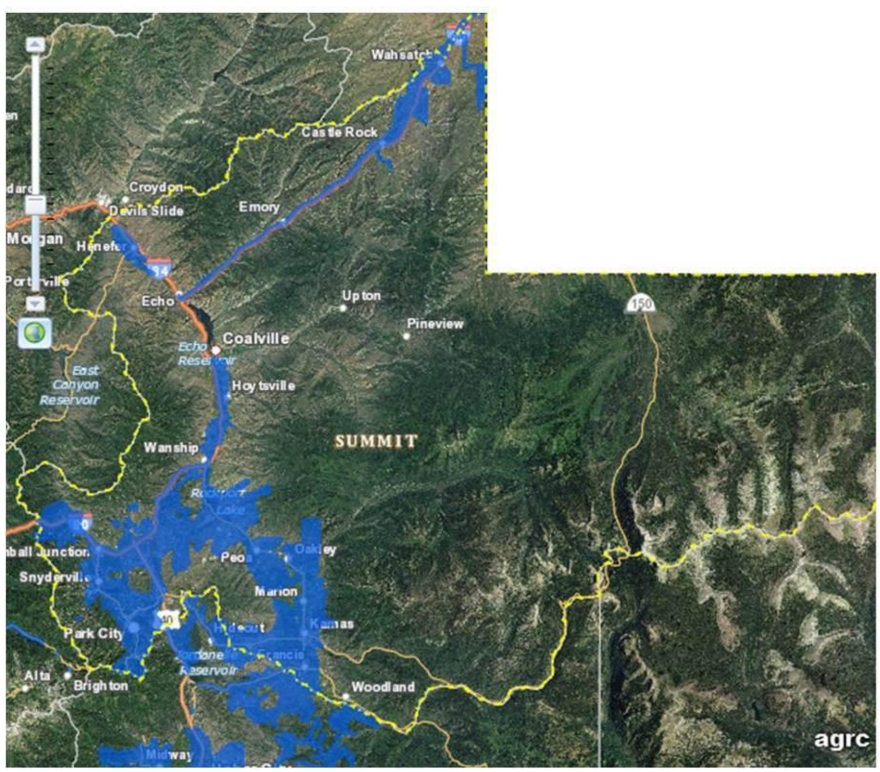


Figure 9. Portions of Summit County with Access to High Download and Upload Speeds (Utah, 2013) (25 Mbps Download and 3 Mbps Upload)



Hood River County, Oregon

This section provides a brief profile of Hood River County, Oregon, which experienced high growth from 2001 to 2011 and has a high CBI value when compared to other counties in the moderate UIC range of 3 to 7. Like Summit County, Utah, Hood River County is positioned in the top quintile of counties according to economic growth and CBI values. Within that cohort of 23 counties, Hood River County experienced the highest and second highest growth rates for earnings associated with the information and professional, scientific, and technical services sectors, respectively, as well as positive employment growth rates in those sectors. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 14 provides a summary of select statistics for Hood River County, Oregon.

Hood River County is located approximately 60 miles east of the city of Portland adjacent to the Columbia River, Interstate 84, and the Oregon-Washington border. The proximity of the county to Portland accounts for the assigned urban influence code of “3”, a “micropolitan area adjacent to a large metropolitan area” (USDA, 2013). However, the county had a population of only 22,346 according to estimates from 2010 and a large portion of the county is considered rural and rugged as the Cascade mountain range occupies the western portion of the county with elevations extending beyond 11,000 feet at the peak of Mount Hood (McMahan, 2011). The county population increased from 2000 to 2010 by approximately 2,000 people and the city of Hood River accounts for 7,167 residents. The other incorporated municipality, Cascade Locks, had a population of 1,144 in 2001 and is situated along the Columbia River in the western portion of the county.

According to select social statistics, the county averages for educational attainment and income are slightly less than state averages. The percent of the county population of the age 25 and older with a high school and college degree are approximately seven and three percent less than the state averages for those statistics in 2011. For example, 26.4 percent of the population had a college degree compared to the state average of 29.2 percent. Conversely, the medium household income of $56,335 in 2011 was approximately $6,000 higher than the state average for that year.

Historically, Hood River County is known for its agricultural products given its mild climate in the lower-lying areas and favorable precipitation and soil conditions (McMahan, 2011). According to the Mid-Columbia Economic Development District (MCEDD) (2013), the production of fruits such as pears and apples account for $60 million dollars of income to the county each year and multiple wineries in the county benefit from favorable environmental conditions (p. 10). Six of the top 20 employers in the county from an employment perspective are fruit, farming, and food processing businesses such as Duckwall Fruit, the second largest private sector employer in the county (Hood River Economic Development Working Group, 2013). The agriculture, forestry, fishing and hunting, and mining sectors account for 17.5 percent of all employment in the county, a significant difference from the state average of 3.5 percent for this sectors (U.S. Census Bureau, 2011).

While these sectors continue to have a significant economic impact, the county experienced notable growth in outdoor tourism and the professional, scientific, and technical services sector from 2001 to 2011. While outdoor recreational activities such skiing and snowboarding have been more mainstay attractions during the winter months, the region is now considered “a world class sailing destination” as interest in windsurfing along the Columbia River now attracts younger visitors year round (MCEDD, 2013, p. 10). These outdoor attractions have spawned new active wear retail establishments and entrepreneurs according to a key informant (J. Metta, personal communication, February 14, 2014). The employment and earnings growth rates associated with the arts, entertainment, and recreation, as well as the accommodation and food services sectors in the county are positive. However, their respective rates are much lower than growth rates associated with the professional, scientific, and technical services sector, which grew at a rate of 14.13 in earnings from 2001 to 2011, and 5.02 from an employment perspective (BEA, 2012).

The largest employer in the county is Insitu Inc., a subsidiary of the Boeing Company, which develops systems for unmanned aircraft and related products for the defense industrial base (Insitu Inc., 2013). The company began in 2004 with fewer than 10 employees and increased in size to approximately 800 employees today (J. Metta, personal communication, February 14, 2014). According to a key informant, the county’s growth in the technology sectors in recent years may be attributed to Insitu’s success and related agglomeration effects such as the many smaller IT-related establishments that took root in the region (J. Metta, personal communication, February 14, 2014; Bell, 2012). In fact, growth rates for employment and earnings are generally positive across all sectors for Hood River County (BEA, 2012). Growth in Hood River County may also be a result of regional effects. For example, Google opened a data center in the nearby city of The Dalles in 2006 partly due to the favorable climate and the endless supply of wind energy (Google, n.d.; Bell, 2012). Intel Corporation operates facilities in west Portland,

and small technology companies in the Hood River County region have attracted staff from Intel among others (Metta, 2011).

There is concentration of broadband infrastructure in the City of Hood River, which is illustrated in figure 10. More than three quarters of county residents and businesses have access to high download speeds and nearly half have access to high upload speeds. As reflected in table 14, nearly all residents have access to low download and uploads speeds and at least three wireless providers. Oregon Broadband Mapping Project data indicates that more than 20 wireline and wireless service providers operate in Hood River County (Oregon Public Utility Commission, 2013). Fiber is provided in the cities of Hood River and Cascade Locks, while cable and DSL are available to residents and businesses in the surrounding areas. Mobile wireless service is available to most all areas of the county (Oregon Public Utility Commission, 2013). Businesses have access to high-speed wireless service provided to the greater Portland-Salem-Eugene region by Freewire Broadband LLC. CenturyLink and Gorge Networks, Inc. are common providers of wireline broadband access to county residents and businesses (J. Metta, personal communication, February 14, 2014).

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

The region’s economic development strategy notes the following as an asset: “Telecommunications and broadband capacity that supports a high level of high tech self-employed workers” (MCEDD, 2013, p. 20). Seeking resources for broadband planning is noted as a “quick win” for the region under the infrastructure strategic area and broadband is listed as a “critical strategy and economic development effort” (MCEDD, 2013, p. 33 & 55). It is highly likely that broadband infrastructure and the more than 20 service providers in the county helped with fueling the growth in the information and professional, scientific, and technical services sectors from 2001 and 2011.

Unlike other counties investigated for this study, Hood River County economic development documents emphasize the importance of entrepreneurs for strengthening existing industry clusters and stimulating the growth of new ones (MCEDD, 2013, p. 40). This emphasis on small-scale initiatives and the "bottom-up" approach to growth stands in stark contrast with other counties investigated for this study that are working to attract larger firms. However, the region continues to regard the retention of agricultural industry establishments as critical (MCEDD, 2013, p. 20). Even though county population figures are low and residents consider the area rural (J. Metta, personal communication, February 14, 2014), data suggests that Hood River County is successfully growing their economy through industries that thrive on information technologies, while retaining more traditional jobs. In addition to leveraging broadband infrastructure, the county has the following advantages:

- Close proximity to Portland and transportation assets such as I-84 that supports the exporting of agricultural products.
- Favorable climate and environmental conditions for supporting the agricultural industry.
- Mountainous and wooded areas, as well as areas around the Columbia River Gorge, which are considered scenic and support outdoor recreational activities and businesses.

- An endless supply of wind to stimulate growth in renewable energy businesses (MCEDD, 2013, pp. 19-20).

A key informant from the region indicated that outdoor recreational activities has been critical to attracting younger, high-skilled workers (J. Metta, personal communication, February 14, 2014). The region lacks a four-year university and expanding education and training opportunities to address this void is a priority (MCEDD, 2013, p. 21). As previously noted, the educational attainment of county residents is slightly lower than state averages. However, the quality of life appears to be an important factor for attracting skilled workers to the county.

Table 14. Select Statistics for Hood River County, Oregon

General and Social Statistics		
Population Change from 2000 to 2010	20,411 → 22,346	
Urban influence based on scale (1 = highest to 12 = lowest)	3	
Closest Metropolitan Areas (60 Miles)	Portland, OR (2010 Pop.: 583,778)	
Largest City/Town	Hood River (2010 Pop.: 7,167)	
% of Population with a High School Degree (2012)	82.3% (State: 89.2%)	
% of Population with a College Degree (2012)	26.4% (State: 29.2%)	
Median Household Income (2012)	$56,335 (State: $50,036)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	98.90%	
% of pop. with access to high download speeds (25 Mbps)	77.48%	
% of pop. with access to low upload speeds (768 Kbps)	99.42%	
% of pop. with access to high upload speeds (10 Mbps)	44.62%	
% of pop. with access to 3 or more wireline providers	64.24%	
% of pop. with access to 3 or more wireless providers	99.78%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	1.85	
Total Earnings by Place of Work	4.96	
Employment in Sector 51 (Information)	2.92	
Earnings in Sector 51 (Information)	9.24	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	5.02	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	14.13	
Top 3 Sectors by Employment Growth (2001 to 2011)	Educational services: 8.64 Healthcare and social services: 5.15 Prof., scientific, and tech. services: 5.02	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Prof., scientific, and tech. services: 14.13 Educational services: 11.06 Nondurable goods manufacturing: 9.52	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Educational services, and health care and social assistance	18.5%	21.6%
Agriculture, forestry, fishing and hunting, mining	17.5%	3.5%
Arts, entertainment, recreation, and accommodation and food services	10.4%	9.4%
Top 3 Private Sector Employers (2013) (Hood River Economic Development Working Group, 2013)	Insitu Inc.: > 500 Duckwall Fruit: > 100 Cardinal Glass Industries: > 100	

Figure 10. Hood River County: Maximum Download Speeds (Oregon Public Utility Commission, 2013)

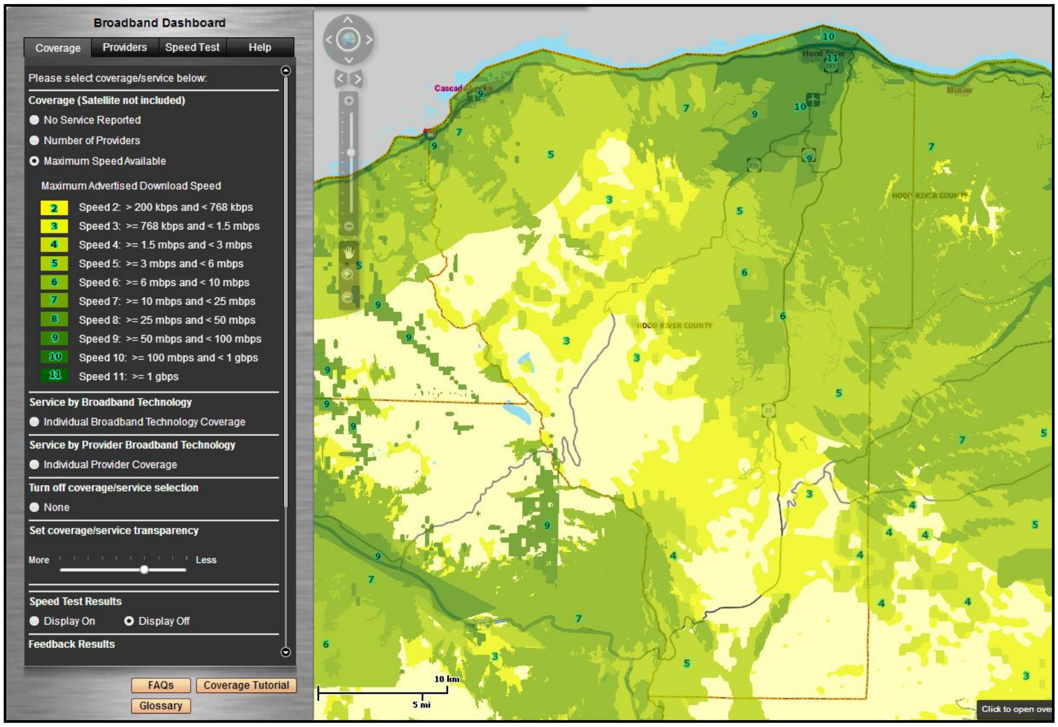
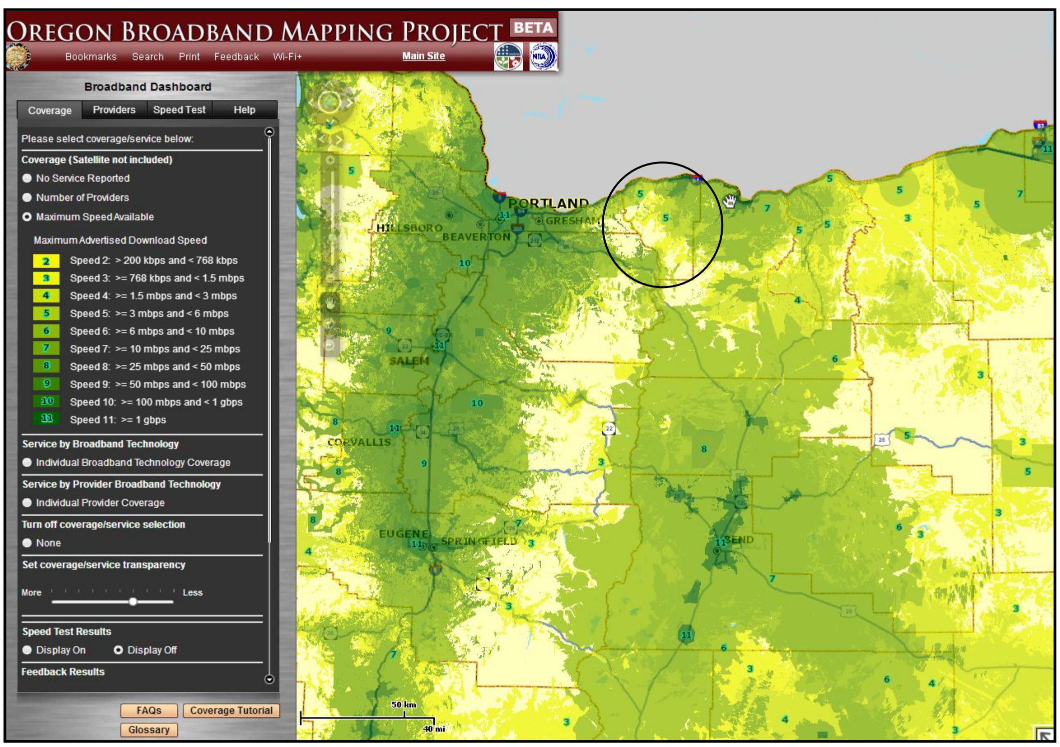


Figure 11. Hood River County Region: Maximum Download Speeds (Oregon Public Utility Commission, 2013)



Bowman County, North Dakota

This section provides a brief profile of Bowman County, North Dakota, which experienced high growth from 2001 to 2011 and has a high CBI value when compared to other counties in the low UIC range of 8 to 12. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 15 provides a summary of select statistics for Bowman County, North Dakota.

Bowman County borders both Montana to the east and South Dakota to the north and is located in the southwestern corner of the state. Having a UIC code of “12”, Bowman County is considered by the USDA as a “noncore [area] not adjacent to metro or micro area and does not contain a town of at least 2,500 residents” (USDA, 2013). The population of the county in 2010 was 3,151, which was nearly 100 less than the population of the county in 2000. The closest metropolitan areas to the county–Bismarck, North Dakota, and Rapid City, South Dakota–are both more than 170 miles from the county seat of Bowman. More than half of county residents, 1,650, live in the incorporated city of Bowman and most others reside in the cities of Scranton, Rhame, and Gascoyne. From a transportation perspective, the county is approximately 50 miles south of I-94 and contains the intersection of U.S. Highways 85 and 12. A geographic reference, the south entrance to the Theodore Roosevelt National Park (“the Badlands”) is located approximately 70 miles north of Bowman County along I-94 (National Park Service, 2013).

According to select social statistics, Bowman County is close to the state averages for both educational attainment and income. Approximately 20.3 percent of the population had a college degree in 2011, which was less than the state average of 26.5

percent. However, the medium household income of $50,487 was slightly higher than the state average of $49,415. The county has a greater share of residents over the age of 65, 20.9 percent, in comparison to the state average of 14.4 percent. In fact, the 2009 Bowman County Leadership Plan cited "Attracting Young People" as a priority (DLN Consulting, Inc., 2009).

From 2001 to 2011, the county experienced a growth rate of 8.92 in total earnings by place of work, as well as a growth rate of 2.35 in total employment (BEA, 2012). This growth may be attributed to the Construction and Mining sectors; the compound annual growth rates for these sectors exceeded 15 from an earnings perspective (BEA, 2012). Mining registered the highest rate of increase, 14.17, from an employment perspective (BEA, 2012). Companies such as Continental Resources, Inc. have invested significant resources in the county exploring for oil and gas in the Three Forks Formation, which extends into Bowman County and most all counties in western North Dakota (T. Doerr, personal communication, December 13, 2013; Martin, 2013). The category Mining, Quarrying, and Oil and Gas Extraction accounted for an annual payroll of nearly $7,000,000 in 2010, second only to Wholesale Trade (North Dakota Department of Commerce, n.d., p. 5). However, this category accounted for the highest average annual salary of $62,473 in Bowman County, which was followed by Professional and Technical Services with an average annual salary of $51,963 (North Dakota Department of Commerce, n.d., p. 5). The share of workers in the Professional and Technical Services in the county, 4.1 percent, is less than the state average of 6.6 percent (U.S. Census Bureau, 2011). Also, the share of employment in Manufacturing across the county is approximately 4 percent less than the state average of 7.4 percent (U.S. Census Bureau, 2011).

Even though the share of total employment associated with the category of Agriculture, Forestry, Fishing and Hunting, and Mining was 16 percent, nearly twice the state average, the category with the highest share of total employment in Bowman County was Educational Services, and Healthcare and Social Assistance at 19.7 percent (U.S. Census Bureau, 2011). During a phone interview, the Executive Director for the Bowman County Development Corporation identified the following three employers as ones that hire a large number of workers in the county: Southwest Healthcare Services, Scranton Equity, and IVM Construction, Inc. The director noted that agriculture remains a critical component of the Bowman County economy. For example, Scranton Equity is a grain and feed business in the county that, according to its website, exceeds $70 million dollars in sales each year (Scranton Equity, 2010).

Given the economic profile and rural attributes of the county, it is surprising that the county ranks very high from the perspective of broadband infrastructure compared to other counties in the UIC range of 8 to 12. More than 80 percent of residents and businesses have access to infrastructure providing high download speeds greater than 25 Mbps and upload speeds of 10 Mbps, and 9 out of 10 residents have access to download speeds greater than 3 Mbps. According the information technology coordinator for Bowman County (K. Germann, personal communication, November 21, 2013) and the North Dakota Information Technology Department (2013), the primary provider of wireline infrastructure is the company Consolidated Telecom. The company provides both DSL and fiber to residents and businesses, and fiber/optical technology covers most of the populous areas of the county (see figure 12 for a map displaying the areas of Bowman County that have access to fiber technology). Investments in fiber technology for rural areas is not common; for example, see figure 13, which shows areas of mid-western states that provide fiber to end users. Using funding provided by the American Recovery and Reinvestment Act of 2009 and through the Broadband Technology Opportunities Program, North Dakota chose to lay fiber through many rural counties to connect anchor institutions such as schools, but also to "facilitate more affordable and accessible broadband service for…households and…businesses" (NTIA, 2010; see also USDA, 2010). It is unclear if local community conditions factored into decisions to construct the fiber network.

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

The 2013 Bowman County Economic Development Strategic Plan lists high-speed Internet as a comparative advantage for Entrepreneurial Development, one of 11 strategies outlined in the plan (Building Communities, Inc., 2013). Both high-speed Internet and adequate telecommunications infrastructure are viewed as key success factors under the infrastructure category of the plan (Building Communities, Inc., 2013). As is the case in Williamson County, Tennessee, the importance of information technologies and the underlying broadband infrastructure to future growth in Bowman County is viewed as high according to local officials. Unlike Williamson County, however, there is no evidence that broadband infrastructure has contributed to or may be related to economic growth in Bowman County. Key informants indicated that small businesses and anchor institutions such as government facilities, schools, and libraries have benefited from the broadband infrastructure, and even expressed their own personal satisfaction with the high-speed Internet access from a residential point-of-view. However, they were not able to draw a relationship between the infrastructure and the growth in employment and earnings that occurred between 2001 and 2011.

The Bowman County example does not support or provide evidence against hypothesis #2 (Access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors.), primarily because the growth in the county occurred outside of the knowledge-based industry sectors. The oil and gas resources available in the county impacted economic growth between 2001 and 2011 the most. Note that the fiber networks were built more recently, during the past two to three years, so growth in the knowledge-based sectors may be forthcoming.

Table 15. Select Statistics for Bowman County, North Dakota

General and Social Statistics		
Population Change from 2000 to 2010	3,242 → 3,151	
Urban influence based on scale (1 = highest, 12 = lowest)	12	
Closest Metropolitan Area (175 Miles)	Bismarck, ND (2010 Pop.: 61,290) Rapid City, SD (2010 Pop.: 67,969)	
Largest City/Town	Bowman (2010 Pop.: 1,650)	
% of Population with a High School Degree (2011)	87.9% (State: 90.0%)	
% of Population with a College Degree (2011)	20.3% (State: 26.5%)	
Median Household Income (2011)	$50,487 (State: $49,415)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	93.52%	
% of pop. with access to high download speeds (25 Mbps)	82.19%	
% of pop. with access to low upload speeds (768 Kbps)	97.95%	
% of pop. with access to high upload speeds (10 Mbps)	82.19%	
% of pop. with access to 3 or more wireline providers	59.25%	
% of pop. with access to 3 or more wireless providers	10.24%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	2.35	
Total Earnings by Place of Work	8.92	
Employment in Sector 51 (Information)	-2.70	
Earnings in Sector 51 (Information)	-6.05	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	3.35	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	6.24	
Top 3 Sectors by Employment Growth (2001 to 2011)	Mining: 14.17 Arts, Entertainment, and Recreation: 10.22 Construction: 8.67	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Construction: 18.69 Mining: 17.80 Arts, Entertainment, and Recreation: 9.97	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Educational services, and healthcare and social assistance	19.7%	24.6%
Agriculture, forestry, fishing and hunting, and mining	16.0%	8.6%
Retail trade	12.6%	12.1%
Top 3 Private Sector Employers (T. Doerr, personal communication, December 13, 2013)	Southwest Healthcare Services Scranton Equity IVM Construction, Inc.	

Figure 12. Portions of Bowman County with Access to Fiber to the End User (North Dakota Information Technology Department, 2013)

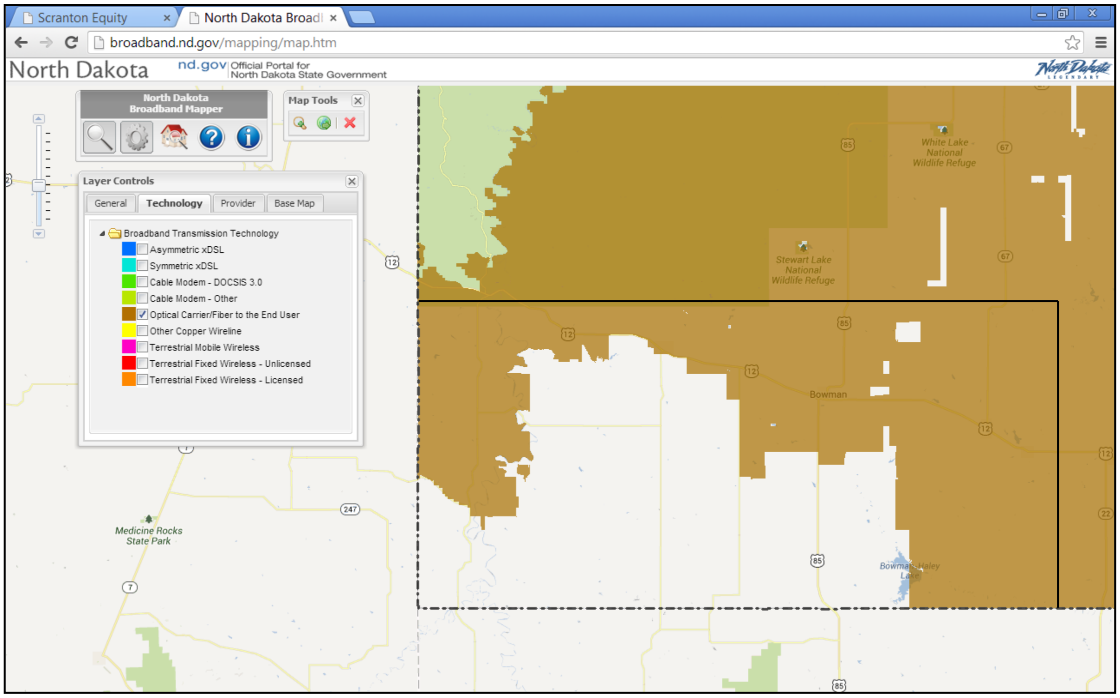
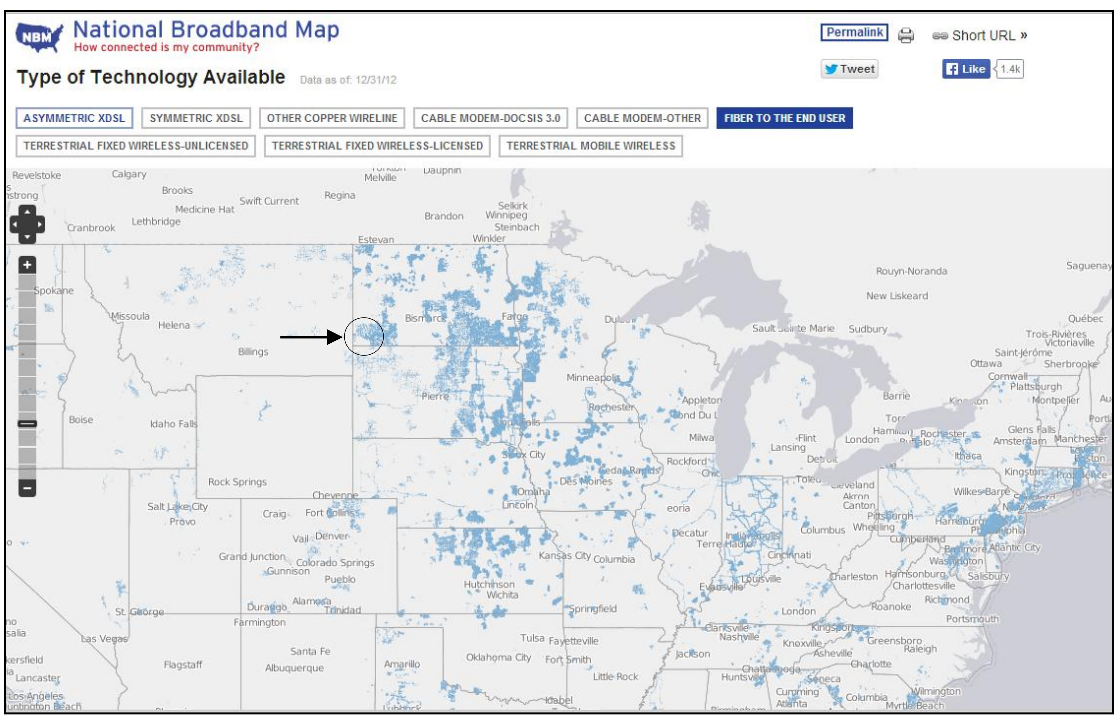


Figure 13. Portions of Mid-Western States with Access to Fiber to the End User (NTIA and FCC, 2012b)



Low Growth Counties with High CBI Values

Chattooga County, Georgia

This section provides a brief profile of Chattooga County, Georgia, which experienced low or negative growth from 2001 to 2011 and has a high community broadband index (CBI) value when compared to other counties in the moderate urban influence code (UIC) range of 3 to 7. In other words, Chattooga County scored in the highest quintile according to the CBI, but the lowest category for economic growth. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 16 provides a summary of select statistics for Chattooga County, Georgia.

Chattooga County is situated approximately 44 miles south of Chattanooga, Tennessee, and situated adjacent to the Georgia-Alabama border and between Interstates 75 and 59, which connect Chattanooga with Atlanta and Birmingham, respectively. The county experienced a small population increase between 2000 and 2010, increasing from 25,470 to 26,015, and is coded by the USDA as a "5" according to urban influence, which is considered a "micropolitan area adjacent to small metro area" (USDA, 2013). The two most populous localities, the City of Summerville and the Town of Trion, are situated along highway US 27 to the west of the Johns Mountain and Taylor Ridge, mountainous terrain occupying the eastern portion of the county.

According to select social statistics, the county averages for educational attainment and income are significantly less than state averages. The percent of the county population of the age 25 and older with a high school degree is 68.2, approximately 15 percent less than the state average of 84 percent. U.S. Census Bureau estimates suggest that only 7.8 percent of the county population had a college degree in 2011, which is significantly less than the state average of 27.5 percent. In addition, the medium household income of $32,224 was nearly $18,000 less than the state average. From a commuting perspective, nearly 80 percent of Chattooga County workers also reside in the county, and a majority of employed residents of the county (57.1 percent) also work in the county (Georgia Department of Labor, 2013, p. 3). Fourteen percent of employed county residents work in the Chattanooga Metropolitan Statistical Area (Georgia Department of Labor, 2013, p. 3).

Chattooga County is one of many counties in northwest Georgia positioned in a "floor covering industry cluster" (Northwest Georgia Regional Commission, 2013, p. 13) region home to many large carpeting and textile company operations. Producing various apparel and carpet products, the companies Mount Vernon Mills, Inc., Mohawk Industries, Inc., and Showa Best Glove, Inc. have consistently ranked in the top five private sector employers in Chattooga County since 2004 (Georgia Department of Community Affairs, 2006; Southeast Industrial Development Association [SEIDA], 2011; Georgia Department of Labor, 2013).

As a result, the manufacturing sector, specifically the manufacturing of textiles and carpeting, accounts for 28.1 percent or the greatest share of employment in the county. This manufacturing figure exceeds the state average by 17 percent. On the other hand, the percentage of county employment in the following three sectors is approximately half the state averages for these sectors: information; finance and insurance, and real estate and rental and leasing; and professional, scientific, and management, and administrative and waste management services. Despite the low share of employment in these sectors, the county experienced positive growth from 2001 to 2011 in earnings associated with the information and professional, scientific, and technical services sectors at rates of 6.38 and 3.82, respectively. The county experienced growth in employment in the professional, scientific, and technical services at a rate of 4.57. However, loss in employment and earnings associated with the manufacturing sector from 2001 to 2011 had a larger impact on economic conditions overall, especially given the high concentration of manufacturing jobs in the county at the turn of the century. Job loss in the manufacturing sector, -5.04, exceeded all other sectors during that period.

According to Grillo (2009), the 2007-2008 recession period had a significant impact on the economies of counties in the floor covering industry cluster due to the downturn in residential construction that decreased demand for construction materials such as flooring and carpeting. The average unemployment rate in Chattooga County from 2000 to 2004 of 3.7 percent was less than both state and national averages (Georgia Department of Community Affairs, 2006). However, those rankings flipped by 2011; the county unemployment rate of 11.1 exceeded the state average of 9.9 (U.S. Department of Labor, 2013). Interviews with key informants confirmed that the loss of manufacturing jobs across the entire northwest Georgia region have had significant impacts on economic conditions overall.

Similar to other counties in this section, Chattooga County ranks in the top quintile of counties according to access to broadband infrastructure in 2012. As displayed in figure 14, nearly 85 percent of county residents have access to wireline download speeds greater than 25 Mbps and many populous areas have access to speeds beyond 100

Mbps (Georgia Technology Authority, 2013). The wireline technology primarily consists of DSL, cable modem, and fiber optical cables with service to end users provided through AT&T, Charter Communications, Comcast, and Windstream (Georgia Technology Authority, 2013). Near the latter part of the decade under study, in 2010, the Appalachian Valley Fiber Network (AVFN) received approximately $21 million to install 150 miles of fiber across the region for connecting anchor institutions and to eventually provide access to Internet service providers (ISPs) in the region for delivering access to residents and businesses (AVFN, 2010; D. Howerin, personal communication, January 23, 2014). Similar to the network in Bowman County, North Dakota, funding for the network in northwest Georgia was provided through the Federal Broadband Technology Opportunities Program (AVFN, n.d.).

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

Despite the more recent investments in broadband infrastructure, the economic conditions in Chattooga County were clearly impacted during the 2007-2008 recession due to the concentration of jobs in manufacturing so closely linked to trends in construction. Also, the installation of the high-speed fiber network was only recently completed so economic benefits associated with the network may not accrue for years to come. Reasons that Chattooga County may be at a disadvantage for leveraging the infrastructure includes: heavy reliance on a single industry cluster and difficulty diversifying beyond manufacturing; and the lack of high-skilled and educated workforce. Informants also indicated a general lack of concern or indifference regarding the use of digital technologies among businesses in the county–local cultural and/or attitudinal factors impeding use (D. Howerin & J. Meadows, personal communication, January 23, 2014).

Although data collected on Chattooga County from 2001 to 2011 does not support hypothesis #2 (Access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors.), a longitudinal study beginning in 2010 with the installation of the fiber network and extending through 2020 may produce different results.

Worth noting in this profile are the initiatives underway in the northwest Georgia region to expand into knowledge-based industry sectors. Unlike other counties investigated for this study, planning in Chattooga County is supported by the Northwest Georgia Regional Commission, which has numerous initiatives underway tied to the digital economy that may serve as a model for similar regions nationwide. Supporting these initiatives and, in the investigator's opinion, making progress possible is the presence of a strong regional planning institution with authority and expertise to work for the betterment of its constituent counties. This level of planning appears to be an imperative given the lack of institutions and staffing at the county or sub-county levels and rural character of the region. In addition to the expansion of broadband infrastructure, notable initiatives supported by the Northwest Georgia Regional Commission include the following:

- The development of a Northwest Digital Economy Plan to "ensure that Northwest Georgia is competitive in today's networked, global, digital economy" (Northwest Georgia Regional Commission, 2013, p. 8).

- Capitalize on competitive advantages associated with the floor covering industry sector by pursuing advanced manufacturing, high-technology strategies (e.g., automation, electronics, robotics) (Northwest Georgia Regional Commission, 2013, p. 13).
- Promote training and develop the high-technology skills of the workforce through the use Georgia Highlands College and West Georgia Technical College systems (D. Howerin & J. Meadows, personal communication, January 23, 2014).

According to informants, the pursuit of advanced manufacturing, high-technology jobs is intended to develop and attract a skilled and higher paid labor force. Anecdotal evidence suggests that the larger industries in Chattooga County are embracing these initiatives. For example, Mount Vernon Mills, Inc. operates a fully automated warehouse for treating denin and other fabrics (Mount Vernon Mills, Inc., n.d.; D. Howerin & J. Meadows, personal communication, January 23, 2014). In October 2013, Mohawk Industries, Inc. announced expansion at its plants in Chattooga County where it recycles plastic bottles and containers for use in carpet products (Espy, 2013). These regional strategies leverage broadband infrastructure and digital technologies, but are uniquely tailored to support local competitive advantages.

Table 16. Select Statistics for Chattooga County, Georgia

General and Social Statistics		
Population Change from 2000 to 2010	25,470 → 26,015	
Urban influence based on scale (1 = highest to 12 = lowest)	5	
Closest Metropolitan Area (44 Miles)	Chattanooga, TN (2010 Pop.: 167,674)	
Largest City/Town	Summerville (2010 Pop.: 4,534)	
% of Population with a High School Degree (2011)	68.2% (State: 84.0%)	
% of Population with a College Degree (2011)	7.8% (State: 27.5%)	
Median Household Income (2011)	$32,224 (State: $49,736)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	99.58%	
% of pop. with access to high download speeds (25 Mbps)	84.44%	
% of pop. with access to low upload speeds (768 Kbps)	99.79%	
% of pop. with access to high upload speeds (10 Mbps)	96.81%	
% of pop. with access to 3 or more wireline providers	61.34%	
% of pop. with access to 3 or more wireless providers	14.09%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	-1.73	
Total Earnings by Place of Work	-.66	
Employment in Sector 51 (Information)	0.00	
Earnings in Sector 51 (Information)	6.38	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	4.57	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	3.82	
Top 3 Sectors by Employment Growth (2001 to 2011)	Admin. and waste man. services: 6.49 Prof., scientific, and tech. services: 4.57 Arts, entertainment, and recreation: 2.92	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Information: 6.38 Durable goods manufacturing: 5.58 Personal and laundry services: 4.38	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Manufacturing	28.1%	10.9%
Educ. services, and health care and social assistance	20.4%	20.4%
Arts, entertainment, and recreation, and accommodation and food services	6.3%	8.6%
Top 3 Private Sector Employers (2013) (J. Meadows, personal communication, January 23, 2014)	Mount Vernon Mills, Inc. – 2,500 Mohawk Industries, Inc. – 312 Showa Best Glove, Inc. – 214	

Figure 14. Chattooga County: Maximum Wireline Download Speeds (Georgia Technology Authority, 2013)

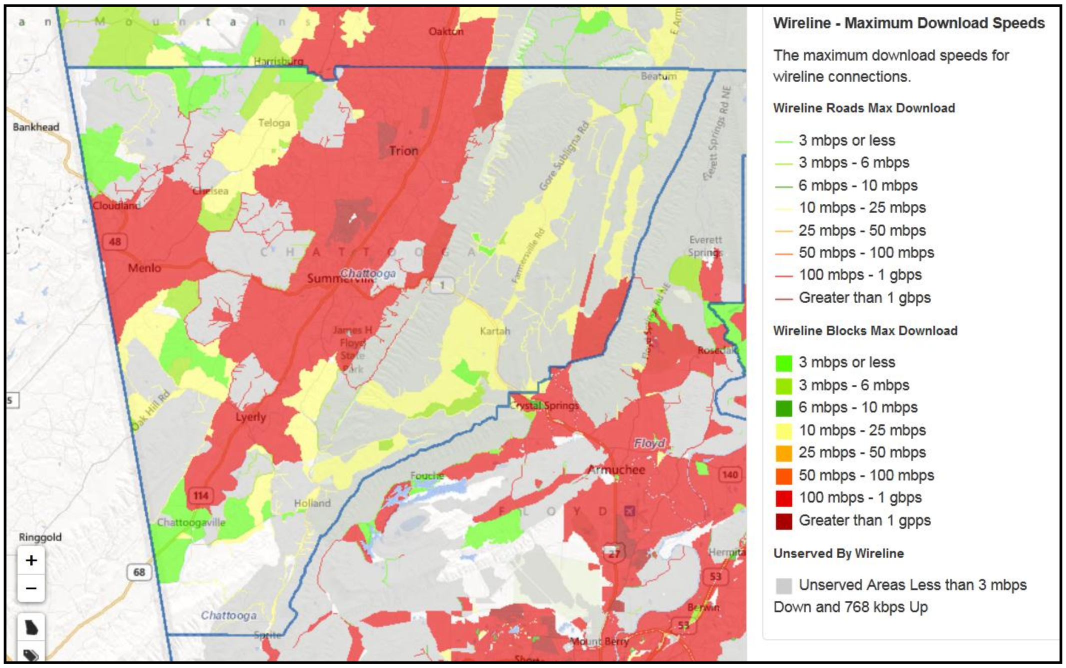
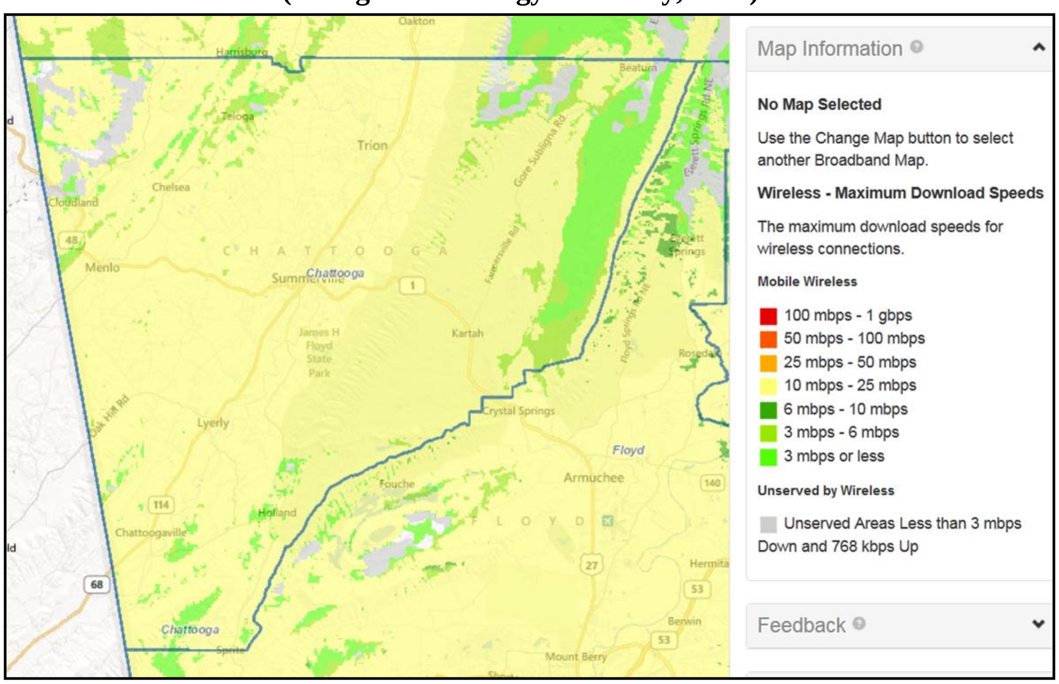


Figure 15. Chattooga County: Maximum Wireless Download Speeds (Georgia Technology Authority, 2013)



Wayne County, Indiana

This section provides a brief profile of Wayne County, Indiana, which experienced low or negative growth from 2001 to 2011 and has a high CBI value when compared to other counties in the low UIC range of 8 to 12. Unless otherwise noted, the source for data in this section is the U.S. Census Bureau (e.g., State and County QuickFacts, etc.). Table 17 provides a summary of select statistics for Wayne County, Indiana.

Wayne County is located approximately 88 miles directly east of Indianapolis along Interstate 70 and adjacent to the Indiana-Ohio border. Muncie, Indiana, and Dayton, Ohio, are the closest metropolitan areas to the county at distances of 41 and 55 miles, respectively. The county experienced a slight decline in population from 2000 and 2010, decreasing from 71,097 to 68,917 during that period, and is coded by the USDA as a “8” according to urban influence, which is considered a “micropolitan area not adjacent to a metro area” (USDA, 2013). Approximately half of all county residents or 36,812 reside in the city of Richmond.

According to select social statistics, the county averages for educational attainment and income are slightly less than state averages. The percent of the county population of the age 25 and older with a high school and college degree are approximately five percent less than the state averages for those statistics in 2011. For example, 16.6 percent of the population had a college degree compared to the state average of 22.7 percent. The medium household income of $40,427 in 2011 was nearly $8,000 less than the state average for that year. In 2012, the county had 17.2 percent of residents 65 years of age and older, which was slightly higher than the state portion of 13.6 percent.

Similar to Chattooga County, Wayne County began the 21st Century with a largely manufacturing-based economy (Economic Development Corporation [EDC] of Wayne County, 2014, p. 34; R. Doty, personal communication, February 7, 2014). In 2012, three of the top four and a majority of the top 20 private sector employers in the county manufacture products such as machinery, fabricated metal products, and transportation and automotive equipment (EDC of Wayne County, 2012). For example, Belden, Inc. manufacturers various types of wire and cable and employed nearly 700 people in 2012, the second highest private sector employer behind Reid Hospital and Health Care Services (EDC of Wayne County, 2012).

The manufacturing sector accounted for 20.5 percent of all employment in the county in 2011, two percentage points greater than the state average for that sector. However, the educational services, and health care and social services sector accounted for the largest share or 28.1 percent of all county employment in 2011. Reid Hospital & Health Care Services and the Richmond State Hospital employ approximately 22,000 and 500 people, respectively, the largest and fourth largest public and private sector employers in the county (EDC of Wayne County, 2012). The county is also home to four institutions of higher education–Indiana University East, Ivy Tech Community College, Purdue College of Technology, and the private institution Earlham College–and Ball State University and Miami University of Ohio are located within 50 miles of the county (EDC of Wayne County, n.d.).

These healthcare and educational institutions likely benefit from access to high-speed fiber broadband infrastructure. However, this access is not associated with significant growth from 2001 to 2011. According to BEA statistics, most sectors experienced a loss of jobs during that period, including manufacturing and transportation and warehousing; the growth rates for these two sectors from 2001 to 2011 were -4.33 and -4.64, respectively (BEA, 2012). The sector with the greatest loss of earnings from a growth rate perspective was the computer and electronic product manufacturing sector, which experienced a -11.16 growth rate during that period (BEA, 2012). The losses associated with manufacturing in general, including the manufacturing of transportation equipment and computer and electronic products, from 2001 to 2011 were greater than national averages for these categories, which were also negative (EDC Corporation of Wayne County, 2014, p. 32). Conversely, the county experienced less loss than neighboring communities due to the diversity of jobs in the county according to key informants. For example, the county experienced positive growth from 2001 to 2011 in the agribusiness and food processing and technology, business and financial services, and the aforementioned healthcare and educational services sectors (EDC of Wayne County, 2014, p. 32; BEA, 2012).

From the perspective of broadband infrastructure, Wayne County ranks in the top quintile of counties in the low urban influence category according to statistics from 2012. Nearly 80 percent of the county population has access to download speeds greater than 25 Mbps. According to key informants interviewed for this project, businesses and residents have access to fiber optic, cable, and DSL technologies provided through Parallax Systems, a division of the Richmond Power & Light utility, Comcast Cable

Communications, Inc., and Frontier Communications Corporation (R. Cody, personal communication, February 10, 2014). Through a partnership with the Indiana Fiber Network, LLC, Parallax Systems provides companies with access to fiber networks. The reach of the fiber network in the county increased from 40 miles in 2001 to 240 miles as of February 2014 (R. Cody, personal communication, February 10, 2014). Fiber is available to companies located at one of two industrial parks in the county as well as others on demand. The fiber also supports institutions of higher education and other anchor institutions in the community of Richmond. Outside of the Richmond city limits, businesses and residents have access to cable, DSL, and wireless telecommunications (R. Cody, personal communication, February 10, 2014).

Discussion: What is the relationship between this broadband infrastructure and economic growth in the county?

Key informants indicated that broadband infrastructure has contributed to the retention of jobs in the county. For example, they cited the decision by Wolverine Worldwide, Inc., the parent company for the Stride Rite Corporation, to locate and expand a customer care center in the county (R. Doty & R. Cody, personal communication, February 7 & 9, 2014). The EDC Corporation of Wayne County representative interviewed for this study indicated that high-speed broadband is a necessity for attracting companies and facilities such as the Stride Rite customer care center, especially when competition among sites is intense. The informants also noted that companies are expanding billing and other office-based functions in the county, additional benefits associated with the broadband infrastructure (R. Doty, personal communication, February 7, 2014). Combined with other incentives, connecting the two industrial parks in the county with fiber networks has been an important strategy for local economic development. One key informant noted, “I wouldn’t say we leverage it [fiber] to attract certain companies, but not having it would an issue” (R. Doty, personal communication, February 7, 2014).

In summary, the following three factors may have contributed to low growth in Wayne County from 2001 to 2011 despite the availability of broadband infrastructure: (1) the concentration of manufacturing across the county, (2) the lack of a highly trained and skilled workforce, and (3) the lack of natural resources and related advantages. Note that the county has recognized the “growing the skill level of the labor force” as a strategic priority (EDC of Wayne County, 2014, p. 5). For example, a program titled Manufacturing Matters is a regional initiative in partnership with Ivy Tech Community College that offers scholarships to qualified individuals toward becoming a Certified Production Technician (Ivy Tech Community College, n.d.).

Conversely and potentially mitigating negative economic impacts on the county are the following factors: (1) employment/economic sector diversity, (2) agglomeration effects associated with a large healthcare provider and multiple institutions of higher education, and (3) close proximity to an interstate highway and urban areas.

One final issue worth noting is the lack of access to broadband infrastructure in rural areas of the county (see figures 16 and 17). The EDC of Wayne County representative noted that “while this doesn’t impact our attraction efforts for businesses, it does limit entrepreneurial efforts by individuals who live in areas not served” (R. Doty, personal communication, February 7, 2014). Finding Internet service providers (ISPs) willing to offer service in rural areas where the demand and return on investment remain low compared to more populous areas may be a challenge even for counties with high-speed broadband infrastructure in place like Wayne County. If attracting small start-ups and entrepreneurs is part of a community's portfolio for diversifying and growing the economy, then finding ways to connect businesses and homes in small communities and rural areas may be a worthwhile goal.

Table 17. Select Statistics for Wayne County, Indiana

General and Social Statistics		
Population Change from 2000 to 2010	71,097 → 68,917	
Urban influence based on scale (1 = highest to 12 = lowest)	8	
Closest Metropolitan Areas	Muncie, IN (41 Miles) (2010 Pop.: 70,085) Dayton, OH (55 Miles) (2010 Pop.: 141,527)	
Largest City/Town	Richmond (2010 Pop.: 36,812)	
% of Population with a High School Degree (2011)	82.2% (State: 86.6%)	
% of Population with a College Degree (2011)	16.6% (State: 22.7%)	
Median Household Income (2011)	$40,427 (State: $48,393)	
Broadband Infrastructure		
% of pop. with access to low download speeds (3 Mbps)	98.13%	
% of pop. with access to high download speeds (25 Mbps)	79.57%	
% of pop. with access to low upload speeds (768 Kbps)	99.08%	
% of pop. with access to high upload speeds (10 Mbps)	62.23%	
% of pop. with access to 3 or more wireline providers	75.89%	
% of pop. with access to 3 or more wireless providers	99.85%	
Economic Growth Indicators (Compound Annual Growth Rates from 2001 to 2011)		
Total Employment by Place of Work	-1.68	
Total Earnings by Place of Work	1.09	
Employment in Sector 51 (Information)	-1.35	
Earnings in Sector 51 (Information)	1.61	
Employment in Sector 54 (Professional, Scientific, and Technical Services)	Not available	
Earnings in Sector 54 (Professional, Scientific, and Technical Services)	Not available	
Top 3 Sectors by Employment Growth (2001 to 2011)	Utilities: 4.78 Healthcare and social assistance: 1.48 Educational services: .31	
Top 3 Sectors by Earnings Growth (2001 to 2011)	Utilities: 7.61 Electronics and appliance stores: 7.45 Gasoline stations: 7.30	
Top 3 Sectors by Share of Total Employment (2011)	County	State
Educational services, and health care and social assistance	28.1%	22.5%
Manufacturing	20.5%	18.6%
Retail trade	10.9%	11.4%
Top 3 Private Sector Employers (2012) (EDC of Wayne County, 2012)	Reid Hospital & Health Care Serv.: 2,200 Belden Inc.: 693 Primex Plastics Corporation: 300	

Figure 16. Wayne County: Areas with Access to High Wireline Speeds (Indiana Office of Technology, n.d.) (~25 Mbps Download and 10 Mbps Upload)

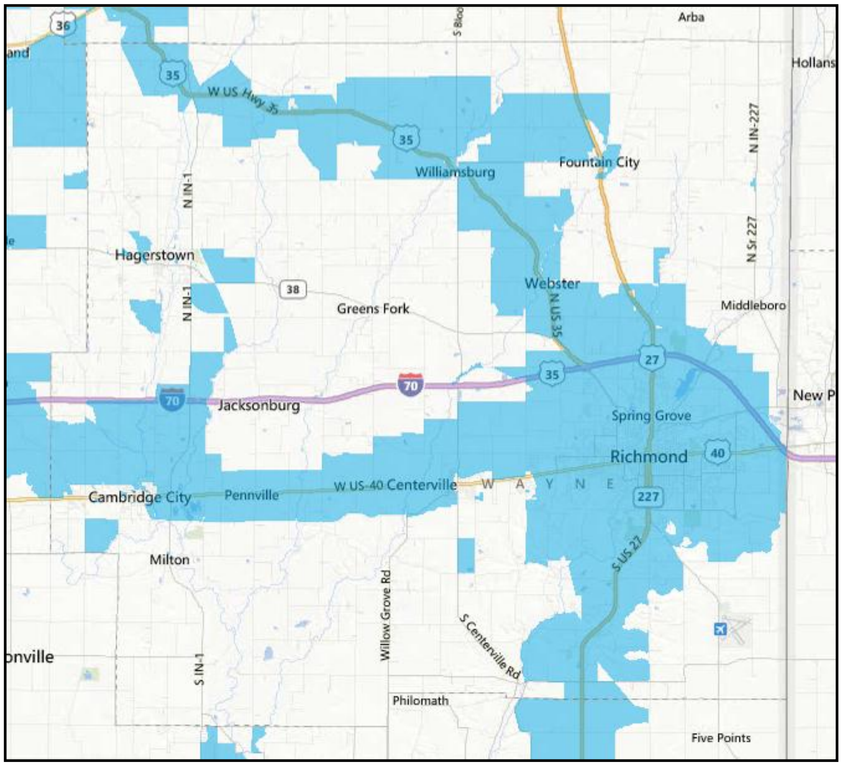
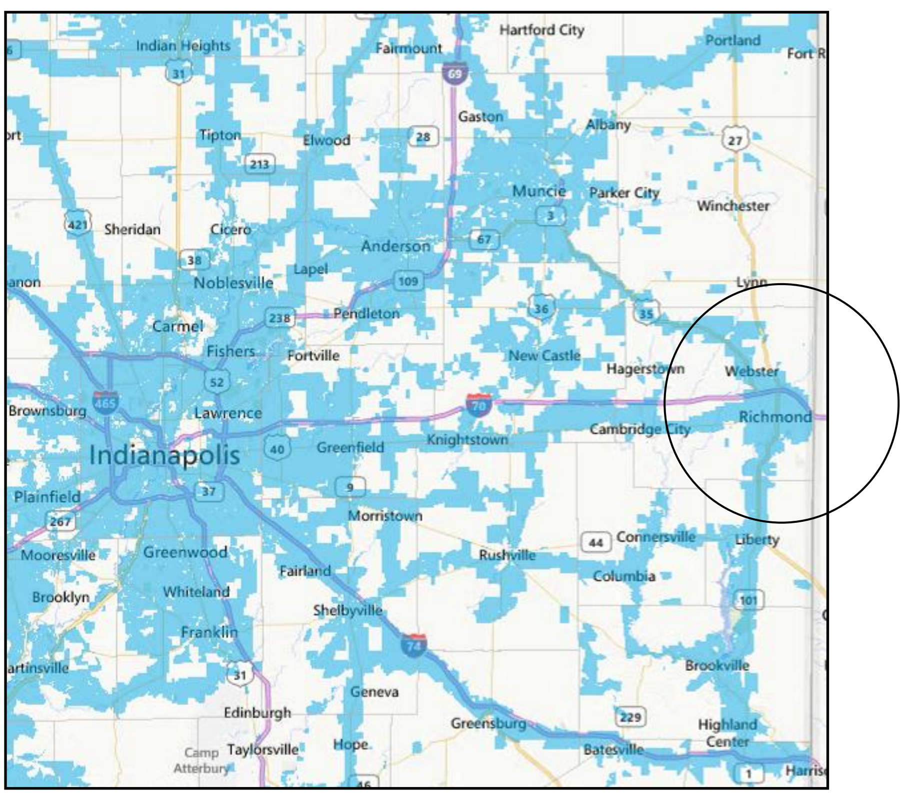


Figure 17. Eastern Indiana: Areas with Access to High Wireline Speeds (Indiana Office of Technology, n.d.)



Qualitative Comparative Analysis

Table 18 provides a summary of key social, economic, geographic, recreational, and other characteristics for the counties investigated during phase 2 to support comparative analysis. The intent of this section is to identify patterns that exist among counties to help explain why select counties may have benefitted economically from being "wired", while others have not. A limitation of this study is the small number of counties investigated during phase 2. However, the following results may provide additional support to quantitative findings and be used for follow on research at larger scales.

The investigator intentionally identified counties from a mix of urban influence code categories. Therefore, this section provides little analysis on urban influence as well as the extent of economic growth or decline as those criteria were used for selecting the counties. Rather, this analysis focuses on the context and characteristics shared among: counties with significant growth, counties with low growth, all or most counties, or few counties. A common attribute to keep in mind is that all counties were in the top CBI quintile for their respective urban influence category. Note that short-hand descriptions are used in the table for the following U.S. Census Bureau industry sectors: Educ. & Health = Educational services, health care, and social assistance; Arts & Rec. = Arts, entertainment, recreation, accommodation, and food services; Ag. & Mining = Agriculture, forestry, fishing and hunting, and mining; and Manuf. = Manufacturing.

Three criteria show a clear divide between the high-growth and low-growth counties. First, all of the high-growth counties had a *median household income* greater than the state average, while the two low-growth counties fell under the state average.

Second, the two low-growth counties had at least 10% of total employment from 2011 in the *manufacturing industry sector*, while none of the high-growth counties reached that level. Third, the two low-growth counties had at least 25% of total employment in 2011 in *one industry sector*, and none of the high-growth county industry sectors met that share of total employment. These results suggest that broadband infrastructure may favor growth in counties with relatively high rates of income, lower shares of employment in manufacturing, and lower shares of employment across all sectors.

From the perspective of social criteria, the *educational attainment* and the *population change* from 2001 to 2011 is generally mixed between the two groups of counties. Consistent with the linear regression results that showed educational attainment as a significant predictor of economic growth, Williamson County and Summit County exceeded state averages in the percent of the population with a college degree by more than 20 percentage points. Conversely, educational attainment rates for Hood River County, Bowman County, and Wayne County were all under the state average for both high school and college degree in the -2% to -6% range. Chattooga County had the lowest educational attainment compared to the state average at approximately -15% or more for both measures. Interestingly, Bowman County experienced population loss from 2001 to 2011 despite the significant growth in employment and earnings, while Chattooga County gained in population despite low growth rates.

From an *economic perspective*, the two counties with the highest educational attainment–Williamson and Summit Counties–also had more than 10% of total employment in the professional, scientific, and management sectors in 2011. Both low-growth counties had a share of manufacturing earnings in 2001 exceed 10% of total earnings, and they also exceeded that level for the share of employment in that sector relative to total employment. The top sector by share of employment varied among counties. Three of four high-growth counties had either Ag. & Mining or Arts. & Rec. as top sectors, possibly indicating favorable *locational advantages, attractions, natural resources, or recreational activities*. Bowman County clearly benefited from the availability of oil and gas, and Hood River County's moderate climate and favorable soil conditions favor the production of multiple agricultural products. Both Hood River County and Summit County benefit tremendously from tourism and outdoor recreational activities.

Educ. & Health topped the list for three counties, and healthcare-related employers are listed as the largest employer in three counties. Williamson County and Wayne County have significant employment in the Educ. & Health sector and provide an interesting comparison. Nine of the top 25 employers in Williamson County provide healthcare and related services, while Wayne County has four institutions of higher education, and a large hospital and state hospital facility. However, Williamson County has other strong sectors such as management of companies and little share of employment in manufacturing. In contrast to Williamson County, Wayne County has lower educational attainment levels, lack of skilled workers according to informants, and a high concentration of jobs in manufacturing outside of the Educ. & Health sector.

Although focus on *improving workforce training and skills* appears common across all counties, there is significant emphasis on these initiatives in Wayne County, Chattooga County, and Hood River County. Training workers to meet demand in advanced manufacturing is the focus in Wayne County and Chattooga County. Hood

River County has high demand for high-technology jobs and skilled laborers to work in more traditional sectors, but low supply given the rural characteristics, sparse population, and lack of a four-year university to attract high-skilled workers. However, the agglomeration effects resulting from Insitu's growth and Google's data center in The Dalles appears to be attracting entrepreneurs and smaller companies to the region. Although there is evidence of growth in Wayne County and Chattooga County since the 2007-2008 recession, gains have not been as significant as those in Hood River County.

Hood River County is the only county with a more traditional high-technology employer, Insitu Inc. Based on the employment data and other characteristics, it appears as though Hood River County and Williamson County are benefiting from broadband infrastructure the most. After peeling away other advantages and disadvantages, the qualitative comparative analysis reveals that broadband infrastructure and being "wired" supports growth in areas with:

- household income levels higher than state averages;
- educational attainment levels higher than state averages;
- more diverse economies with less concentration in any one sector, especially manufacturing;
- high employment in the professional, scientific, and management sector; and
- favorable quality of life that includes attractions and recreational activities.

The findings above are generally consistent with O'Sullivan (2009) sources for economic growth with technological progress being one source that increases productively of workers. However, providing evidence of strong ties between technological progress and growth is difficult given the presence of the other indicators. The next chapter provides additional discussion on the importance of broadband infrastructure to growth and other benefits, epistemological challenges, and critical perspectives on select contemporary theories of urban development.

Table 18. Phase 2 Comparative Analysis

Criteria	Williamson County, TN	Summit County, UT	Hood River County, OR	Bowman County, ND	Chattooga County, GA	Wayne County, IN
Social						
Positive population change from 2000 to 2010?	✓	✓	✓	-	✓	-
Percent of population with a high school degree > state average?	✓	✓	-	-	-	-
Percent of population with a college degree > state average?	✓	✓	-	-	-	-
Median household income greater than state average?	✓	✓	✓	✓	-	-
Economic						
Percent of manufacturing earnings in 2001 greater than 10%?	-	-	✓	-	✓	✓
Percent of manufacturing employment in 2011 greater than 10%?	-	-	-	-	✓	✓
Information or professional, scientific, and management sectors account for more than 10% of employment in 2011?	✓	✓	-	-	-	-
One sector account for more than 25% of employment in 2011?	-	-	-	-	✓	✓
Top sector by share of employment in 2011 (Note: For Hood River County, two sectors are very close to the top, so they are both listed.)	Educ. & Health	Arts & Rec.	Educ. & Health + Ag. & Mining	Ag. & Mining	Manuf.	Educ. & Health
Top private sector employer (2011-2013)	Community Health Systems Inc.	Deer Valley Resorts	Insitu Inc.	Southwest Healthcare Services	Mount Vernon Mills, Inc.	Reid Hospital & Health Care Services
Geographic, Recreational, and Other						
Percent of agriculture, forestry, fishing and hunting, and mining employment in 2011 greater than 10%?	-	-	✓	✓	-	-
Percent of arts, entertainment, recreation, and accommodation and food services employment in 2011 greater than 10%?	-	✓	✓	-	-	-
Main reasons for growth or lack of growth cited in profile	*Growth:* healthcare industry cluster; manage. of companies; prox. to Nashville; quality of life	*Growth:* capital investments from 2002 Olympics; World-class ski resorts; prox. to Salt Lake City; leisure and attractions	*Growth:* recreational activities; quality of life; prox. to Portland and IT industry cluster; favorable climate	*Growth:* oil and gas production; agricultural industries	*Lack of Growth:* Manuf. industry cluster; single industry; lack of skilled workforce	*Lack of Growth:* Manuf. industry cluster; lack of skilled workforce; lack locational advantages

CHAPTER IV

DISCUSSION

Key Findings

This chapter provides a discussion of three key findings, epistemological issues and difficulties studying broadband infrastructure and effects of being “wired”, and areas in need of additional research. Select findings are compared to general theories for economic development espoused by Edward Glaeser in *Triumph of the City* (2011) and Richard Florida’s thesis as evidenced in *Cities and the Creative Class* (2005). In addition, select findings are reviewed in relationship to the location of counties in Indiana that ranked high according to growth rates and total growth indicators.

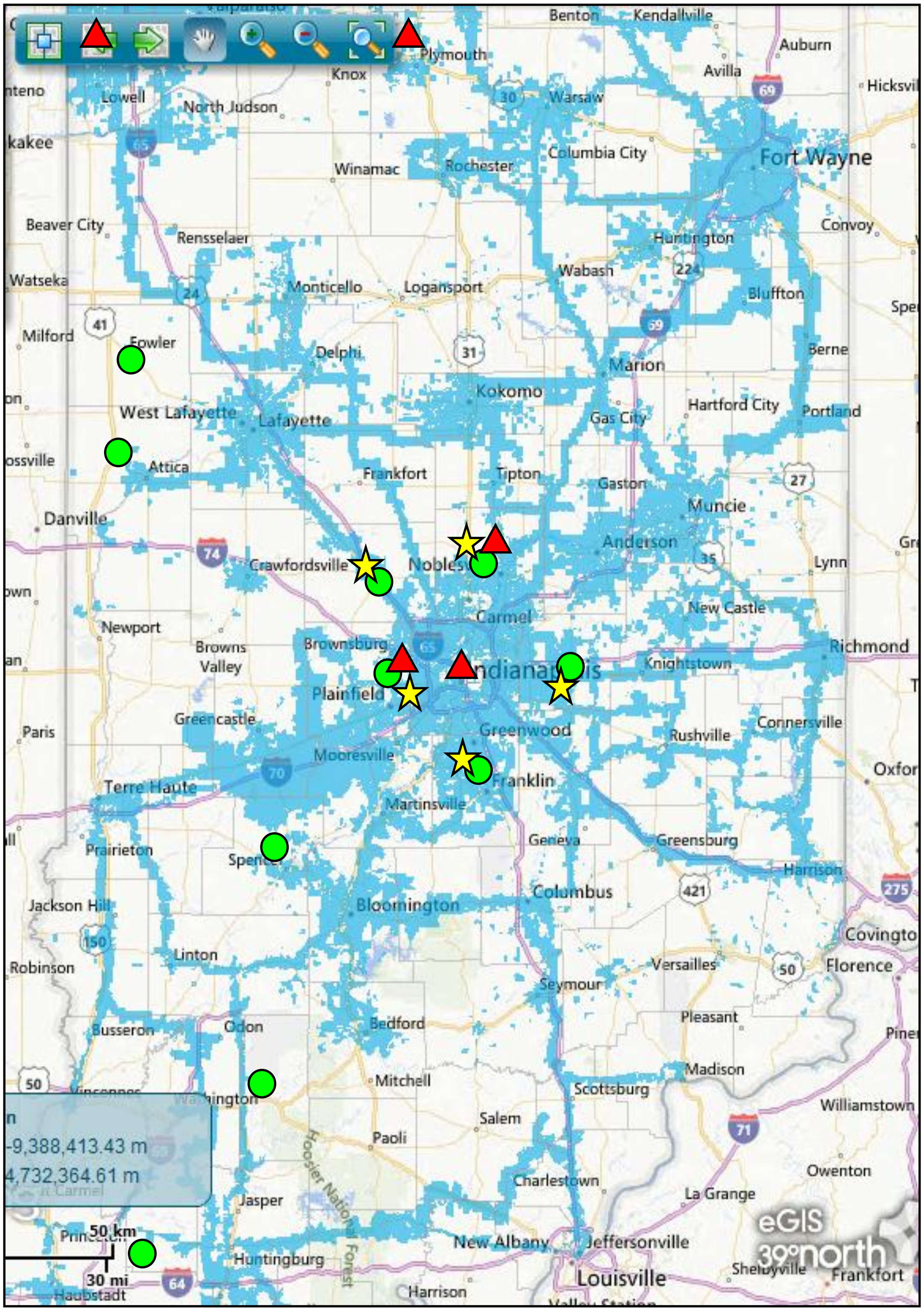
First, local conditions outside of access to broadband infrastructure appear to have much stronger influences on economic growth indicators, and likely determine how well a community leverages broadband for growth purposes. When compared to the influences of control variables such as urban influence, educational attainment, and agglomeration variables as indicated in the linear regression results, broadband infrastructure had little influence in general on economic growth indicators. In addition, the results of the qualitative analysis suggest that local conditions, including nuances, idiosyncrasies, and distinctions unique to each county, provide reasonable explanations for counties’ attractiveness and growth from 2001 to 2011. For example, the educational services, and health care and social services sector occupied the highest share of 2011 employment in both Williamson County and Wayne County. Even though both counties shared access to high broadband speeds, other conditions such as the overall share of jobs in the manufacturing sector and urban influence provided a much thorough explanation for differences in economic growth. Similarly, understanding nuances in social, economic, and geographic conditions is necessary for explaining how Hood River County could achieve high employment and earnings growth in the high-technology sectors with educational attainment levels below state averages. The results from this study suggest that having an understanding of local conditions and knowing how broadband may be applied against the backdrop of those conditions may be important.

Second, the appearance of direct effects between broadband infrastructure variables and economic growth indicators in the quantitative analysis may be a result of *spurious relationships* involving urban influence and other predictors. Figure 18 provides a map of Indiana that displays, in blue, areas that have access to the high broadband speeds, including 25 Mbps download and 10 Mbps upload speeds. The green dots identify counties that ranked in the top 10 according to growth rates from 2001 to 2011, the yellow stars identify the top five counties in the state according to employment growth, and the red triangles identify the top five counties according to earnings growth. The results for this study indicate that high upload speeds may have a direct effect on employment growth rates and total employment growth from 2001 to 2011. The relationship between high upload speeds and employment growth is the stronger of the two relationships according to the regression results. Referencing figure 18, note that the top five counties in Indiana from an employment growth perspective as illustrated with yellow stars are located in the suburbs of Indianapolis.

The other possible direct effect identified in the quantitative analysis relates to earnings growth rates, which may be impacted directly by access to low download speeds most likely provided via wireless service. However, the urban influence categorical variable was not a significant predictor of earnings growth rates for the period 2001 to 2011. Note the positions of the green dots throughout the state in figure 18. There is a likelihood that the 12 codes used for controlling urban influence were insufficient at capturing the urban effect expected for all dependent variables, and any direct effects noted between broadband infrastructure and growth are the result of *spurious relationships* involving urban influence and other predictors such as household income and community-level earnings. In other words, both broadband infrastructure and economic growth indicators may be endogenous variables influenced by household income and community-level earnings.

In addition, note the difference between the location of the 10 counties that experienced the highest growth rates, which are generally evenly divided between urban and rural areas, and counties noted with stars and triangles that experienced the highest employment and earnings growth from 2001 to 2011. The highest growth rate counties are generally split between areas with high-speed broadband infrastructure and those without, an example that illustrates the lack of relationship between most broadband variables and growth rates. Conversely, the total growth counties are more closely aligned to areas shaded blue near Indianapolis. This example is provided to highlight the difficulties in teasing out effects of broadband infrastructure using economic models and purely statistical analysis.

Figure 18. Areas with Access to High Wireline Speeds in Indiana (Indiana Office of Technology, n.d.) (~25 Mbps Download and 10 Mbps Upload)



Third, there is evidence that broadband infrastructure and being "wired" does come with benefits at the community level and support economic growth based on both the quantitative and qualitative results. The following findings regarding interaction effects between broadband infrastructure and select variables are conjectures and proposed only based on the results of this study; these ideas require additional inquiry.

There is relatively high bivariate correlation between select broadband infrastructure variables with college and urban influence. There is a high likelihood that broadband is interacting with these variables to effect economic growth. In other words, an increase in broadband effects growth, but indirectly and contingent on increases in educational attainment, which may also correspond to worker skills, job training, and similar measures of human capital. Two of four counties investigated during phase 2 in the high growth category exceeded state averages for educational attainment. In addition, improving worker skills was commonly addressed in local economic development plans and there was general consensus among key informants regarding the importance of worker training and skills for taking advantage of the digital economy. An educated workforce is a key ingredient in both Glaeser's and Florida's theories of economic growth. For example, an educated workforce would fall under "Talent" in Florida's "3 T" model of economic growth (Florida, 2005, pp. 49-109). Without human capital, there is low probability that being "wired" has much effect on economic growth.

A similar interaction may exist between broadband infrastructure and income. The results of the qualitative analysis indicate a perfect split between high-growth and low-growth counties according to the medium household income measure. Although income levels were not included as controls in the quantitative analysis, a high correlation between income and educational attainment may be expected. It is reasonable to expect that higher-income households are more likely to afford purchases of computers and mobile devices, and payments for related Internet services than lower-income households. The quantitative analysis included 2001 earnings levels as a control, which had a correlation of .959 with earnings growth and it also achieved correlations in the .3's with wireline providers and college. Using business institutions as an example, fewer earnings may inhibit the purchase of servers, networks, databases, and applications in comparison to higher-earning firms. Both income at the household level and earnings at the community level may relate to capital deepening, one of four source for economic growth according to O'Sullivan (2009, p. 90). Crandall, Lehr, and Litan (2007) describe capital as a "complementary input" to benefits associated with information technologies (p. 5). In short, broadband infrastructure may effect growth through interaction with higher-income households and higher-earning communities.

A third interaction may exist between broadband infrastructure and industry diversity to effect economic growth. Each of the low-growth counties–Chattooga and Wayne Counties–had one sector account for more than 25% of total employment in 2011, while none of the sectors in the high-growth counties exceeded this level. In addition, the qualitative results suggest that broadband infrastructure may interact positively with higher shares of employment in the professional, scientific, and technical services interacts. Glaeser (2011) notes industrial diversity as a factor influencing innovation in cities citing New York City's recent growth and Detroit's decline as a symptoms of diversity and lack of diversity, respectively (pp. 8-9 and 56-57). Likewise, O'Sullivan (2009) notes that "a diverse city has a rich variety of products and production processes, providing fertile ground for new ideas about how to produce new products" (p. 75). Being "wired" with high-speed broadband infrastructure likely facilitates the exchanges, social connections, and knowledge spillovers that occur among smaller, diverse firms.

In summary and though not investigated rigorously in this study, it is proposed that broadband increases the influence of human capital, income/earnings, and industry diversity on economic growth, controlling for all other variables. Likely tangled with the aforementioned variables is the influence of urban influence. In addition to the strong bivariate correlation between broadband infrastructure and urban influence, close proximity to a metropolitan area was cited as a reason supporting growth in three of the four high-growth counties during phase 2. However, Chattooga County and Wayne County are located near the metropolitan areas of Chattanooga, Tennessee, and Dayton, Ohio, respectively. This outcome indicates that, regardless of urban influence and broadband infrastructure, larger regional effects and the performance of nearby metropolitan areas may have a strong influence on economic growth in surrounding counties.

Epistemological Issues and Additional Research

The problem of entanglement is one of many epistemological issues encountered when studying the benefits associated with broadband infrastructure. A second limitation is the lack of sufficient data necessary to investigate relationships between broadband and various sectors at the local scale. Using employment and earnings growth rates and total growth figures likely masks important differences that exist at the three- or four-digit NAICS code level. Interestingly, these and other epistemological challenges are nothing new. The economist Robert Solow coined the phrase *Information Productivity Paradox* in the 1980s when noting the difficulties identifying changes in worker productivity resulting from information technologies (Crandall, Lehr & Litan, 2007, p. 4).

The use of economic models is one tool for studying benefits associated with broadband infrastructure and being “wired”, but new approaches are needed for investigating relationships more broadly. In this study, for example, the qualitative analysis provided meaningful results and the discovery of nuances specific to each locale, which supports more bottom-up approaches to theory formation. According to Mara Sidney (2010), constructivism allows the researcher to construct theories based on their interpretation of problems and the perceptions of subjects over time (p. 28). For proponents of constructivism, knowledge is limited and generalizations are appropriate to specific contexts only (Sidney, 2010). Collective knowledge of broadband would benefit from a constructivist approach at the community, institutional, and individual levels of inquiry.

Referencing the results from the qualitative portion of this study, for example, more in-depth research of the six high-growth and low-growth counties would help address the following questions:

- What are the differences in adoption and use between urban and rural areas within counties?
- How are firms specific to these counties using broadband infrastructure and information technologies?
- What are the characteristics of workers and are they attracted to firms from the outside or developed through local initiatives?

- What role do anchor institutions such as schools and libraries play in support of communities' efforts to compete in the digital economy?

The following provides three additional research questions or topics worth exploring to further knowledge of broadband infrastructure. First and from the perspective of urban planning, what are the digital components of sustainability? In addition to economic growth, for example, how does access to broadband infrastructure among residents and businesses relate to social equity and environmental concerns? Issues relating to social equity are of particular concern from a planning perspective as residents, including youth, unable to afford computers and service, and lacking minimum computer literacy skills, may find it increasingly difficult to find work in the future. What policies and programs may be needed if schools, libraries, and workplaces aren't adequately addressing this need?

Next and in support of communities interested in attracting and retaining firms from various sectors, knowing how firms view access to infrastructure such as broadband and knowing what factors into their decisions to locate or grow in one area over another may be important. According to an interview with the Director of Economic Growth & Innovation for the Louisville Metro Government, businesses may view broadband infrastructure as one or more of the following: (1) as an opportunity cost, (2) as an opportunity lost, or (3) as a main attraction (T. Smith, personal communication, December 18, 2013). Efforts to install broadband in rural areas as a primary economic development strategy assumes number three is true, that business decisions are highly influenced by the availability of infrastructure. Although the key informant from Louisville indicated that most businesses likely view broadband as an opportunity cost only, key informants from Wayne County viewed broadband infrastructure as an opportunity lost in cases when competition is fierce among multiple locations seeking to entice a large firm. In these situations, not having sufficient broadband capability could be determining factor.

Third and finally, the investigator came across and struggled with meanings behind various terms during this project, such as: new economy, digital economy entrepreneurs, and knowledge jobs. For example, Short (2004) and Savitch and Kantor (2005) define the entrepreneurial state or city as one favoring free markets and businesses, and in contrast to welfare cities. Florida (2011) describes “entrepreneurial hot spots” (p. 55) as areas more likely to support the start and growth of businesses with a focus on high technology industries such as software developers. Knowing who constitutes an entrepreneur or what conditions favor entrepreneurs may be important for local economic developers. For example, an entrepreneur in Hood River County who happens to be a retiree from Intel wishing for a better quality of life and change of pace from the pressures of working for a large corporation may be qualitatively different than an entrepreneur who settles in Chattooga County to be close to clients in the apparel industry. Similarly, placing parameters and classifications on select occupations that rely heavily on information technologies (e.g., “knowledge jobs”) may be short-sighted and not productive for measuring digital trends that may be impacting all industries. It is the investigator’s opinion that new concepts and frameworks are needed to help think about current digital trends and the future.

CHAPTER V

SUMMARY AND CONCLUSIONS

This project was implemented to explore the importance of broadband infrastructure to communities in the post-industrial, digitization era or the period defined by Daniel Bell (1998) as the "third technological revolution" (pp. 96-115). Using an economic utilitarian approach, the investigator investigated the following research questions and hypotheses:

Question #1

What are the relationships between broadband infrastructure and commonly accepted economic indicators? *Hypothesis #1*: Access to broadband infrastructure does not have a strong relationship to economic growth across all industry sectors.

Key Findings: Economic competitiveness and growth are commonly cited as reasons for investing in broadband infrastructure. The results from this study suggest that some direct effects may exist between broadband and select economic growth indicators. However, broadband has a relatively weak relationship with growth indicators in comparison to other variables and there exists concerns regarding spurious relationships. Broadband more likely provides an interaction effect on economic growth across all industry sectors through variables representing human capital, income/earnings, and industry diversity.

Question #2

What are the relationships between broadband infrastructure and growth in knowledge-based industry sectors? *Hypothesis #2*: Access to broadband infrastructure has a stronger relationship with economic growth in knowledge-based industry sectors than growth across all sectors.

Key Findings: Contemporary theories for economic growth such as Florida's Creative Class thesis (2005) and theories for the New Economy (Atkinson & Andes, 2010) emphasize the importance of technology for supporting growth in jobs and wages in knowledge-based industry sectors, including the professional, scientific, and technical services sector. Based on results from the quantitative analysis, there is no evidence to support a strong relationship between counties' access to broadband (e.g., high and low broadband speeds, number of wireline and wireless providers), and employment and earnings growth associated with the professional services sector from 2001 to 2011. However, data was available for only about one-third of counties nationwide to evaluate this sector at the aggregate level. Two of the four high-growth counties investigated during phase 2 exceeded the share of total employment in the professional services sector in 2011 in comparison to other counties. It was also noted that information technology today is a facet of most every business enterprise regardless of sector. For example, Hood River County's largest employer, Insitu Inc., manufactures high-technology products for Boeing and the healthcare industry cluster in Williamson County benefits significantly from knowledge jobs.

Question #3

What community-level factors influence the relationships between broadband infrastructure and economic growth? Hypothesis #3: A variety of community characteristics (e.g., location/spatial factors, economic and social conditions) influence the relationships between broadband infrastructure and economic growth.

Key Findings: As previously noted, research indicates that location and local conditions matter for broadband infrastructure to succeed in influencing economic growth. The strongest candidates for factors interacting with broadband infrastructure to effect growth include human capital (e.g., educational attainment, worker skills and training), household income and community earnings levels, and industry diversity. There is also a strong relationship between broadband infrastructure and urban influence, which is consistently significant at explaining growth indicators. However, the exact nature of the interaction between broadband and urban influence remains unknown. As previously noted, communities with higher shares of employment in the professional services sector appear to benefit from access to broadband. Although their ties with broadband are unclear, additional community characteristics noted that support recent growth include favorable quality of life, recreational activities, and the availability of natural resources. In the case of Bowman County, there was no relationship between fiber networks and growth experienced in the county from 2001 to 2011.

Implications for Policy and Practice

Results from this study indicate that local conditions outside of access to broadband infrastructure appear to have much stronger influences on economic growth indicators, and likely determine how well a community leverages broadband for growth purposes. Specifically, the results suggest that having an understanding of local social, economic, and geographic conditions and knowing how broadband may be applied against the backdrop of those conditions may be important with special attention on human capital, household income and community earnings, and use of information technologies among the range of industry sectors and different-sized businesses.

There is evidence that local economic development personnel recognize the need to view broadband infrastructure as a critical supporting technology that must be integrated into more holistic strategies. For example, the Northwest Georgia Regional Commission's Northwest Digital Economy Plan, which aims to "ensure that Northwest Georgia is competitive in today's networked, global, digital economy" (Northwest Georgia Regional Commission, 2013, p. 8), is framed to exploit the region's competitive advantages associated with the floor covering industry sector and address human capital limitations through the use of workforce training associated with advanced manufacturing processes. Conversely, Hood River County economic development documents emphasize the importance of entrepreneurs, one form of human capital, for strengthening existing industry clusters and stimulating the growth of new ones (MCEDD, 2013, p. 40). The region's economic development strategy notes the following as an asset: "Telecommunications and broadband capacity that supports a high level of high tech self-employed workers" (MCEDD, 2013, p. 20).

Economic development strategies associated with broadband differ significantly between Chattooga and Hood River Counties based on their local conditions. In other words, county leaders view broadband infrastructure differently and through the lens of their unique interpretations of the "digital economy".

Greater attention to local conditions may be needed for entities responsible for broadband infrastructure planning at the National and state levels to encourage holistic planning for achieving economic and other social goals. The provision of broadband infrastructure alone does not appear to be a panacea for economic growth. Clearly, an easy case may be made for investments in fiber and other technologies to improve social conditions in communities, but linking this “wiring” to economic growth without first considering many other conditions and complementary strategies is misguided.

REFERENCES

Agresti, A., & Finlay, B. (2009). *Statistical Methods of the Social Sciences – Fourth Edition.* Upper Saddle River, NJ: Pearson/Prentice Hall.

Altshuler, A. (1965). The Goals of Comprehensive Planning. *Journal of the American Institute of Planners, 31*, 193-209.

American City & County and the Public Technology Institute (PTI). (2011, November). Tech trends 2012. Retrieved from: http://americancityandcounty.com/technology/2012-technology-trends-201111/

Anderson, S. (2012, September 27). *Incentives to lure, retain businesses in county reach $241M.* Brentwood Home Page. Retrieved from: http://www.brentwoodhomepage.com/ incentives-to-lure-retain-businesses-in-county-reach-241m-cms-10129#.Uqyu-_RDvrM

Andrew, T.N. & Petkov, D. (2003). The Need for a Systems Thinking Approach to the Planning of Rural Telecommunications Infrastructure. *Telecommunications Policy, 25*, 75-93.

Appalachian Valley Fiber Network. (2010, August 18). $21,000,000 Broadband Grant Awarded for Northwest Georgia. Retrieved from: http://avfn.net/2011/02/21000000-broadband-grant-awarded-for-northwest-georgia/

Appalachian Valley Fiber Network. (n.d.). BTOP Grant. Retrieved from: http://avfn.net/about/btop-grant/

Atkinson, R.D. & Andes, S.M. (2010, November). *The 2010 State New Economy Index.* Washington, DC: The Information Technology and Innovation Foundation (ITIF). Retrieved from: http://www.kauffman.org/uploadedfiles/snei_2010_report.pdf

Becker, S., Crandall, M.D., Fisher, K.E., Kinney, B., Landry, C. & Rocha, A. (2010). *Opportunity for All: How the American Public Benefits from Internet Access at U.S. Libraries (IMLS-2010-RES-01).* Washington, DC: Institute of Museum and Library Services.

Bell, D. (1998). The third technological revolution and its possible socioeconomic consequences. In P. O'Brien (Ed.), *Industrialisation: Critical Perspectives on the World Economy, Volume 2* (96-115). New York, NY: Routledge.

Bell, J. (2012, April 23). Tech triumph. *Oregon Business.* Retrieved from: http://www.oregonbusiness.com/articles/114-may-2012/7168-tech-triumph

Brietbart, J. (2007). *The Philadelphia Story: Learning from a Municipal Wireless Pioneer*. Washington, DC: New America Foundation. Retrieved from: http://oti.newamerica.net/events/2007/philadelphia_story_learning_municipal_wireless_pioneer

Building Communities, Inc. (2013, September). *Bowman County North Dakota Economic Development Strategic Plan.* Retrieved from: http://www.visionwestnd.com/pdf/strategic_plans/Bowman%20County%20Strategic%20Plan.pdf

Bureau of Economic Analysis. (2012). Regional Data: Personal Income by Major Source and Earnings by NAICS Industry for: Bowman County, North Dakota; Chattooga County, Georgia; Hood River County, Oregon; Williamson County, Tennessee; Summit County, Utah; and Wayne County, Indiana [Data Files]. Retrieved from: http://www.bea.gov/

Castells, M. (1999, September). Information Technology, Globalization and Social Development. *United Nations Research Institute for Social Development (UNRISD) Discussion Paper No. 114*, 1-15.

City of Anderson, Indiana. (n.d.). WiFi. Retrieved from: http://www.cityofanderson.com/wifi.aspx

Commonwealth of Kentucky. (2014, January). *Solicitation, KY ShareNet (KSN) - KY High Speed Fiber Optic Infrastructure (RFP# 079-1400000126-3).* Frankfort, KY: Commonwealth of Kentucky Finance and Administration Cabinet.

Connected Tennessee. (n.d.). *County Info // Explore Your Community: Williamson County.* Retrieved from: http://www.connectedtn.org/community_profile/find_your_county/tennessee/williamson

Connected Tennessee. (2012). My ConnectView Interactive Map [Interactive Map]. Retrieved from: http://www.connectedtn.org/mapping/_interactive_map_interface/?q=map

Crandall, R., Lehr, W. & Litan, R. (2007, July). The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data. *Issues in Economic Policy, 6*, 1-34.

Dabinett, G. (2002). Reflections on Regional Development Policies in the Information Society. *Planning Theory & Practice, 3* (2), 232-237.

DLN Consulting, Inc. (2009). *Bowman County Leadership Plan.* Retrieved from: http://www.bowmannd.com/development/strategicPlan-RevisedJanuary2011.pdf

Economic Development Corporation of Wayne County, Indiana. (2012). Employers. Retrieved from: http://edcwc.com/site-selection/data/employers/

Economic Development Corporation of Wayne County, Indiana. (2014, January 21). *Wayne County Economic Development Strategic Plan.* Richmond, IN: Economic Development Corporation of Wayne County, Indiana. Retrieved from: http://edcwc.com/wp-content/uploads/Wayne-County-EDC-Strategic-Plan_FINAL-1-20-14.pdf

Economic Development Corporation of Wayne County, Indiana. (n.d.). Education. Retrieved from: http://edcwc.com/site-selection/data/education/

Epstein, D., Nisbet, E.C. & Gillespie, T. (2011). Who's Responsible for the Digital Divide? Public Perceptions and Policy Implications. *The Information Society, 27*, 92-104.

Espy. J. (2013, October 21). Summerville Project Wins "Deal of the Year" Award. *Summerville News.* Retrieved from: http://www.nwgajda.com/News/News/Summerville-Project-Wins--Deal-of-the-Year--Award.aspx

Federal Communications Commission. (2010). *Connecting America: The National Broadband Plan.* Retrieved from: http://www.broadband.gov/plan/

Federal Communications Commission. (2012, March 2). *Getting Broadband.* Retrieved from: http://transition.fcc.gov/cgb/consumerfacts/highspeedinternet.pdf

Florida, R. L. (2005). *Cities and the Creative Class*. New York, NY: Routledge.

Ford, G.S. & Koutsky, T.M. (2005, November). Broadband and Economic Development: A Municipal Case Study from Florida. *Review of Urban & Regional Development Studies, 17* (3), 216-229.

Fox, J. (1991). *Regression Diagnostics (Sage University Papers: Number 07-079).* Newbury Park, CA: Sage Publications, Inc.

Georgia Department of Community Affairs. (2006). Georgia County Snapshots – Chattooga County. Retrieved from: http://www.dca.ga.gov/CountySnapshotsNet/countysnapshot.aspx?stype=3&cicoid=1027027

Georgia Department of Labor. (2013, September). *Georgia Area Labor Profile: Chattooga County.* Atlanta, GA: Georgia Department of Labor. Retrieved from: https://explorer.dol.state.ga.us/mis/Profiles/Counties/Chattooga.pdf

Georgia Technology Authority. (2013). Georgia Online Interactive Map Tool [Interactive Map]. Retrieved from: http://digital.georgia.gov/map/

Gillett, S.E., Lehr, W.H., Osorio, C.A. & Sirbu, M.A. (20fl06, February). *Measuring the Economic Impact of Broadband Deployment (Final Report: National Technical Assistance, Training, Research, and Evaluation Project #99-07-13829).* Washington, DC: U.S. Department of Commerce.

Glaeser, E. (2011). *Triumph of the City.* New York, NY: The Penguin Press.

Google. (2013). Google Economic Impact: eCities. Retrieved from: http://www.google.com/economicimpact/ecities/index.html#UT

Google. (n.d.). Data Centers: The Dalles, Oregon. Retrieved from: http://www.google.com/about/datacenters/inside/locations/the-dalles/index.html

Grillo, J. (2009, April). Northwest: Challenging Times. *Georgia Trend.* Retrieved from: http://www.georgiatrend.com/April-2009/Northwest-Challenging-Times/

Hecker, D.E. (2005, July). High-Technology Employment: A NAICS-Based Update. *Monthly Labor Review, 128*(7), 57-72.

Hood River Economic Development Working Group. (2013, June/July). *Hood River Major Employers List.* Compiled by the Mid-Columbia Economic Development District and shared through personal communication.

Indiana Office of Technology. (n.d.). Broadband Map [Interactive Map]. Retrieved from: http://indianabroadbandmap.com/

Insitu Inc. (2013). About. Retrieved from: http://www.insitu.com/

International Telecommunication Union (ITU) and the Organization for Economic Co-operation and Development (OECD). (2011). *M-Government: Mobile Technologies for Responsive Governments and Connected Societies*. Retrieved from: http://www.pti.org/index.php/ptiee1/inside/759

Ivy Tech Community College. (n.d.). Manufacturing Matters: Training. Retrieved from: http://www.manufacturingmatters.info/#!training/galleryPage

Kandilov, I.T. & Renkow, M. (2010, June). Infrastructure Investment and Rural Economic Development: An Evaluation of USDA's Broadband Loan Program. *Growth and Change, 41* (2), 165-191.

Kruger, L.G. (2012, July). *Broadband Loan and Grant Programs in the USDA's Rural Utilities Service (CRS Report RL33816).* Washington, DC: Congressional Research Service. Retrieved from: http://www.nationalaglawcenter.org/assets/crs/RL33816.pdf

Mackun, P. & Wilson, S. (2011, March). *Population Distribution and Change: 2000 to 2010 (2010 Census Briefs).* Washington, DC: U.S. Census Bureau. Retrieved from: http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf

Malecki, E.J. (2003). Digital Development in Rural Areas: Potentials and Pitfalls. *Journal of Rural Studies, 19*, 201-214.

Martin, B. (2013, September 13). Oil giant announces findings in lower Three Forks Formation. Bowman County Development Corporation News. Retrieved from: http://www.bowmannd.com/county/news/details.asp?ID=216

McBryde, J. (2013, January 7). *Franklin, TN's Economic Development.* Retrieved from: http://livability.com/franklin/tn/business/franklin-tns-economic-development

McMahan, H. (2011, February 23). *Climate and Precipitation of Hood River County.* Hood River, CO: Hood River County Government. Retrieved from: http://www.co.hood-river.or.us/vertical/sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/HRC_Climate__Precipitation.pdf

McMahon, K., Thomas, R.L., & Kaylor, C. (2012, July). *Planning and Broadband: Infrastructure, Policy, and Sustainability (Planning Advisory Service Report Number 569).* Washington, DC: American Planning Association.

Metta, J. (2011, March 24). *Media Release: Columbia Gorge Quality of Life Lures Two Refugees to Positions with Fast-Growing Maker of Electronic Cables.* The Dalles, OR: Georgia Technology Alliance. Retrieved from: http://crgta.org/files/2011/07/PR-GTA-Custom-Interface.pdf

Mid-Columbia Economic Development District. (2013, March). *Mid-Columbia Comprehensive Economic Development Strategy.* The Dalles, OR: Mid-Columbia Economic Development District. Retrieved from: http://www.mcedd.org/documents/CEDS/CEDS2013.pdf

Mitchell, C. (2011, March). *Publicly Owned Broadband Networks*. Retrieved from: http://www.ilsr.org/publicly-owned-broadband-networks-averting-looming-broadband-monopoly/

Morozov, E. (2013). *To Save Everything, Click Here.* New York, NY: PublicAffairs.

Mount Vernon Mills, Inc. (n.d.). Business Divisions – Apparel Fabrics. Retrieved from: http://mvmills.com/Divisions

National Broadband Task Force, Canada. (2001). *The New National Dream: Networking the Nation for Broadband Access.* Retrieved from: http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/C2-574-2001E.pdf/$FILE/C2-574-2001E.pdf

National Park Service. (2013). Theodore Roosevelt National Park: Directions. Retrieved from: http://www.nps.gov/thro/planyourvisit/directions.htm

National Telecommunications and Information Administration. (2010, August). *Broadband Technology Opportunities Program (BTOP) Project Description: Dakota Carrier Network, LLC's CCI Broadband Project.* Washington, DC: National Telecommunications and Information Administration. Retrieved from: http://www2.ntia.doc.gov/files/grantees/dcn.pdf

National Telecommunications and Information Administration and Federal Communications Commission. (2012a). National Broadband Map: Analyze [Interactive Tool]. Retrieved from: http://www.broadbandmap.gov/analyze

National Telecommunications and Information Administration and Federal Communications Commission. (2012b). National Broadband Map: Type of Technology Available [Map Application]. Retrieved from: http://www.broadbandmap.gov/technology

Nissan. (n.d.). *Corporate Info. – Overview.* Retrieved from: http://www.nissanusa.com/about/corporate-info

North Dakota Department of Commerce. (n.d.). *Community Profiles: Bowman.* Bismarck, North Dakota: North Dakota Department of Commerce. Retrieved from: http://www.business.nd.gov/searchCenter/Community/profile.asp?Page=5&FIPS=08700

North Dakota Information Technology Department. (2013). North Dakota Broadband Map [Map Application]. Retrieved from: http://broadband.nd.gov/mapping/map.htm

Northwest Georgia Regional Commission. (2013, October 30). *Northwest Georgia Digital Economy Plan [PowerPoint Slides]*. Rome, GA: Northwest Georgia Regional Commission. Retrieved from: http://www.ruralgeorgia.org/documents/2013%20Council%20Activities/NORTHWEST%20GEORGIA%20DIGITAL%20ECONOMY%20PLAN%20PowerPoint%20E.pdf

Oregon Public Utility Commission. (2013, June 30). Oregon Broadband Mapping Project [Interactive Map]. Retrieved from: https://broadband.oregon.gov/StateMap/

O'Sullivan, A. (2009). *Urban Economics.* New York, NY: McGraw-Hill/Irwin.

Park City Chamber of Commerce Convention & Visitors Bureau. (2013). *Economic Profile: Park City and Summit County, Utah.* Park City, Utah: Park City Chamber of Commerce Convention & Visitors Bureau. Retrieved from: http://www.visitparkcity.com/includes/media/docs/FULL-EP-2013.5.pdf

Park City Municipal Corporation. (2012, July). *Park City 2030: Keeping Park City "Park City".* Park City, Utah. Retrieved from: http://www.parkcity.org/Modules/ShowDocument.aspx?documentid=9932

Phillips, R. (2003, December). *Community Indicators (Planning Advisory Service Report Number 517).* Washington, DC: American Planning Association.

Robinson, D. (2006, August). *Bowling for Broadband 2: Toward Citizen-Centric, Broadband-Based E-Government.* Retrieved from: http://www.nascio.org/publications/documents/NASCIO-Bowling_for_Broadband2.pdf

Rowley, T.D. & Porterfield, S. L. (1993). Can Telecommunications Help Rural Areas Overcome Obstacles to Development? *Rural Development Perspectives, 8* (2), 2-6.

Sassen, S. (2002, May). Towards a Sociology of Information Technology. *Current Sociology, 50* (3), 365-388.

Sassen, S. (2009). Cities in Today's Global Age. *SAIS Review, XXIX* (1), 3-34.

Savitch, H.V. & Kantor, P. (2002). *Cities in the International Marketplace.* Princeton, NJ: Princeton University Press.

Scranton Equity. (2010). General Manager Comments. Retrieved from: http://www.scrantonequity.org/index.cfm?show=10&mid=5

Shideler, D., Badasyan, N. & Taylor, L. (2007, November). The Economic Impact of Broadband Deployment in Kentucky. *Regional Economic Development*, *3*(2), 88-118.

Short, J. R. (2004). *Global Metropolitan: Globalizing Cities in a Capitalist World*. New York, NY: Routledge.

Simpson, D.M. & Katirai, M. (2006, September). *Indicator Issues and Proposed Framework for a Disaster Preparedness Index (DPi) (Working Paper 06-03).* Louisville, KY: Center for Hazards Research and Policy Development, University of Louisville.

Southeast Industrial Development Association (SEIDA). (2011). Chattooga County, GA. Retrieved from: http://www.seida.info/www/docs/123.67/chattooga-county-georgia.html

Sydney, M. (2010, November). Critical Perspectives on the City: Constructivist, Interpretive Analysis of Urban Politics. In J. Davies & D. Imbroscio (Eds.), *Critical Urban Studies: New Directions* (23-39). Albany, NY: State University of New York Press.

U.S. Census Bureau. (2011). American FactFinder: 2007-2011 American Community Survey (Selected Economic Characteristics for: Bowman County and North Dakota; Chattooga County and Georgia; Hood River County and Oregon; Summit County and Utah; Williamson County and Tennessee, and Wayne County and Indiana). Retrieved from: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03&prodType=table

U.S. Census Bureau. (2012, December). Geographic Terms and Concepts - County or Statistically Equivalent Entity. Retrieved from: http://www.census.gov/geo/reference/gtc/gtc_cou.html

U.S. Census Bureau. (2013). County Business Patterns: 2003 and 2011 [Data Files] (Downloaded Employment and Annual Payroll Data for Williamson County, Tennessee). Retrieved from: http://www.census.gov/econ/cbp/download/

U.S. Department of Agriculture. (2010, September 13). USDA Announces Recovery Act Broadband Project to Bring Jobs, Economic Opportunity to Rural North Dakota and Minnesota [Press Release]. Retrieved from: http://www.usda.gov/wps/portal/usda/usdahome?contentid=2010/09/0463.xml

U.S. Department of Agriculture. (2013, July). Urban Influence Codes: Overview [2013 Urban Influence Codes Data File]. Retrieved from: http://www.ers.usda.gov/data-products/urban-influence-codes.aspx

U.S. Department of Labor. (2013, April 19). Local Area Unemployment Statistics [Data Files] (Selected Unemployment Rates by States and Labor Force Data by County, 2011 Annual Averages). Retrieved from: http://www.bls.gov/lau/tables.htm

U.S. Department of Treasury. (2012, April). *The Financial Crisis Response*. Washington, DC: U.S. Department of Treasury. Retrieved from: http://www.treasury.gov/resource-center/data-chart-center/Documents/20120413_FinancialCrisisResponse.pdf

Utah Governor's Office of Economic Development, the Public Service Commission, and the Department of Technology Services' Automated Geographic Reference Center. (2013). The State of Utah Broadband Project [Online Mapping Application]. Retrieved from: http://broadband.utah.gov/map/

Williamson County Office of Economic Development. (2008). *A Vision for Continued Prosperity: Williamson County, Tennessee Economic Development Five Year Strategic Plan, 2009-2014.* Williamson County, Tennessee: Williamson County Office of Economic Development. Retrieved from: http://www.wcs.edu/career_tech/WCo%20Econ%20Dev%20Strategic%20Plan.pdf

Williamson County Office of Economic Development. (2011). *Williamson 101.* Williamson County, Tennessee: Williamson County Office of Economic Development. Retrieved from: http://williamsonprospers.com/wp-content/uploads/2011/12/WILLIAMSON-101-for-digital.pdf

Williamson, T. (2010). *Sprawl, Justice, and Citizenship*. New York, NY: Oxford University Press, Inc.

Zickuhr, K. (2013, September 25). Who's Not Online and Why. Washington, DC: Pew Research Center. Retrieved from: http://www.pewinternet.org/2013/09/25/whos-not-online-and-why/

APPENDIX

County Analysis Candidates (Phase 2)

Tables 19 through 21 provide counties in the high, moderate, and low urban influence categories that ranked in the top quintile for both the Community Broadband Index (CBI) and Average Growth values. Each table also presents counties that ranked in the top quintile for the CBI, but lowest quintile for Average Growth. Only the top 10 counties in each category are provided in this appendix.

Table 19. County Analysis Candidates – High Urban Influence (Coded 1 and 2)

State	County Name	Population (2010)	CBI	Average Growth (2001 to 2011)
High CBI-High Growth (Sorted by Highest Average Growth)				
SD	Lincoln County	44,828	0.834	10.655
VA	Stafford County	128,961	0.903	7.195
MS	Madison County	95,203	0.909	6.850
TN	Williamson County	183,182	0.845	6.185
CO	Douglas County	285,465	0.867	6.050
IN	Hendricks County	145,448	0.843	5.755
GA	Forsyth County	175,511	0.983	5.525
GA	Paulding County	142,324	0.955	5.290
WA	Franklin County	78,163	0.889	4.945
GA	Columbia County	124,053	0.898	4.910
High CBI-Low Growth (Sorted by Lowest Average Growth)				
IN	Howard County	82,752	0.827	-1.350
MI	Genesee County	425,790	0.839	-1.010
MI	Wayne County	1,820,584	0.956	-0.755
IN	Madison County	131,636	0.828	-0.590
MI	Oakland County	1,202,362	0.928	-0.245
MI	Macomb County	840,978	0.973	-0.055
GA	McDuffie County	21,875	0.829	0.180
CA	Santa Cruz County	262,382	0.942	0.215
GA	Whitfield County	102,599	0.828	0.245
CA	San Mateo County	718,451	0.986	0.320

Table 20. County Analysis Candidates – Moderate Urban Influence (Coded 3 through 7)

State	County Name	Population (2010)	CBI	Average Growth (2001 to 2011)
High CBI-High Growth (Sorted by Highest Average Growth)				
UT	Summit County	36,324	0.826	5.050
CA	Colusa County	21,419	0.535	4.825
ND	Emmons County	3,550	0.514	4.805
UT	Wasatch County	23,530	0.688	4.725
OR	Morrow County	11,173	0.546	4.660
IN	Gibson County	33,503	0.549	4.390
SD	Moody County	6,486	0.611	4.380
ND	McLean County	8,962	0.585	3.890
ND	Kidder County	2,435	0.556	3.865
MS	Lafayette County	47,351	0.559	3.745
High CBI-Low Growth (Sorted by Lowest Average Growth)				
GA	Jenkins County	8,340	0.632	-3.480
IN	Fayette County	24,277	0.640	-3.325
GA	Warren County	5,834	0.657	-1.255
GA	Chattooga County	26,015	0.855	-1.195
GA	Macon County	14,740	0.722	-1.085
IN	Henry County	49,462	0.795	-0.875
GA	Wilkes County	10,593	0.665	-0.795
MI	Hillsdale County	46,688	0.585	-0.750
NC	Vance County	45,422	0.722	-0.670
NC	Surry County	73,673	0.647	-0.590

Table 21. County Analysis Candidates – Low Urban Influence (Coded 8 through 12)

State	County Name	Population (2010)	CBI	Average Growth (2001 to 2011)
High CBI-High Growth (Sorted by Highest Average Growth)				
ND	Mountrail County	7,673	0.506	11.620
ND	McKenzie County	6,360	0.539	11.090
NE	Keya Paha County	824	0.664	7.730
ND	LaMoure County	4,139	0.746	6.940
NE	Morrill County	5,042	0.575	5.890
ND	Cavalier County	3,993	0.687	5.695
ND	Bowman County	3,151	0.793	5.635
SD	Spink County	6,415	0.581	5.535
SD	Edmunds County	4,071	0.566	5.520
ND	Dickey County	5,289	0.725	5.490
High CBI-Low Growth (Sorted by Lowest Average Growth)				
MS	Clay County	20,634	0.625	-1.700
TN	Van Buren County	5,548	0.488	-0.590
MI	Otsego County	24,164	0.511	-0.400
GA	Rabun County	16,276	0.485	-0.375
IN	Wayne County	68,917	0.790	-0.295
MI	Antrim County	23,580	0.496	-0.280
MI	Wexford County	32,735	0.507	-0.275
MS	Sunflower County	29,450	0.550	-0.110
MS	Coahoma County	26,151	0.666	-0.045
MS	Washington County	51,137	0.553	-0.025

CURRICULUM VITA

NAME: Chad Stephen Foster

ADDRESS: Justice & Safety Center
College of Justice and Safety
Eastern Kentucky University
50 Stratton Building, 521 Lancaster Ave.
Richmond, Kentucky 40475

Current Positions

- Associate Director, Incident Management Programs, Justice & Safety Center, EKU
- Adjunct Instructor, School of Safety, Security & Emergency Management, College of Justice and Safety, EKU

Education

2014	Ph.D.	In Progress (All But Dissertation [ABD]) – Doctor of Philosophy in Urban and Public Affairs (Concentration in Planning), University of Louisville, Kentucky
2005	M.P.A.	Masters in Public Administration, University of Louisville, Kentucky
1996	B.S.	Bachelor of Science, Mathematical Science, United States Military Academy, West Point, New York

Research Interests

- Homeland Security and Emergency Management Policy
- Community Preparedness and Incident Management Systems
- Critical Infrastructure Security and Resilience
- Public Safety Communications
- Broadband Infrastructure Planning
- Technology and Society: Theory and Impacts

Employment Summary

Dec. 2006 – Present	Associate Director, Incident Management Programs, Justice & Safety Center, Eastern Kentucky University

Rural Domestic Preparedness Consortium (RDPC) (Sept. 2012 – Present)
Mr. Foster provides oversight and project management support to multi-year, national-level projects for the EKU Justice & Safety Center. Mr. Foster currently manages projects in support of the U.S. Department of Homeland Security (DHS)-sponsored Rural Domestic Preparedness Consortium (RDPC), a program that offers certified training to emergency responders nationwide. Since 2012, Mr. Foster has supported curriculum development efforts, including research and updates to the following three courses: Isolation and Quarantine for Rural Communities, Event Security Planning for Public Safety Professionals, and Dealing with the Media: A Short Course for Rural First Responders.

Integrated Public Alert and Warning System (IPAWS) (Sept. 2009 – Aug. 2011)
From 2009 to 2011, Mr. Foster managed the IPAWS Conformity Assessment Program through a contract with the Federal Emergency Management Agency (FEMA) National Continuity Programs Office. Expanding upon the traditional audio-only radio and television Emergency Alert System (EAS), IPAWS provides Federal, state, territorial, tribal, and local warning authorities the capabilities to alert and warn their respective communities of all hazards impacting public safety. For the benefit of broadcasters and emergency managers, the conformity assessment program provided objective tests of EAS and other alert and warning equipment used for disseminating alerts through cellular and other networks against data interoperability standards.

National Incident Management System Support Center (Dec. 2006 – Aug. 2012)
Mr. Foster provided oversight of and project management support to the National Incident Management System (NIMS) Support Center program–a cooperative agreement between FEMA and EKU. He provided programmatic and administrative oversight of contractors to ensure they met milestones, authored and contributed to numerous publications, and participated as a team member in many task areas. Among other accomplishments, Mr. Foster:

- Contributed to national publications to assist emergency responders with NIMS implementation, including an Incident Command System (ICS) field operations guide, standard ICS forms, and guidance documents for Public Information Officers (PIOs) and Multi-Agency Coordination Systems (MACS).
- Managed the development of software tools for emergency responders, including a resource inventory application and an exercise simulation system for the Emergency Management Institute (EMI).
- Managed multiple DHS System Assessment and Validation for Emergency Responders (SAVER) projects, including assessments and projects focused of mobile command systems and vehicles, incident decision support and propagation modeling software, portable identification card systems, and ruggedized computers.

July 2005 – Nov. 2006 Special Projects Coordinator, Emergency Management Accreditation Program

Mr. Foster was responsible for managing and coordinating special projects of the Emergency Management Accreditation Program (EMAP), a voluntary assessment and accreditation process for state/territorial, tribal, and local government emergency management programs. He served as project manager for a pilot regional assessment of the National Capital Region, the first application of emergency management standards in a regional context. He also assisted in planning for EMAP committee meetings and authored *Assessing Your Disaster Public Awareness Program* and *A Legislator's Checklist to Emergency Preparedness & Public Communications* through a grant from the Alfred P. Sloan Foundation.

Jan. 2002 – June 2005 Chief Policy Analyst and Policy Analyst, Public Safety and Justice Group, The Council of State Governments

Mr. Foster directed and managed the public safety and justice policy work for the Council of State Governments (CSG), a national association of state officials. He was responsible for the planning and oversight of national policy meetings, developing and implementing research projects, and writing articles and reports on various public safety and homeland security topics. During his service at CSG, he served as principal investigator/project manager for two U.S. Department of Justice (DOJ)-sponsored projects, including a multi-year study of state law enforcement agencies following 9/11. In addition, he supported numerous National Emergency Management Association (NEMA) meetings and Emergency Management Assistance Compact (EMAC) after-action reviews, including the review of EMAC implementation in response to the 2004 hurricane season–Hurricanes Charley, Frances, Ivan, and Jeanne.

Military Experience

Dec. 1996 – July 2001 Captain and Lieutenant, Armor, United States Army
Ft. Riley, Kansas, and Schweinfurt, Germany

As a captain, Mr. Foster served as Battalion Personnel and Assistant Plans Officer for an armor unit of 486 soldiers and 44 M1A1 tanks. His primary responsibilities as the Assistant Plans Officer included the planning and coordination of all aspects of training and preparations for combat operations. As a lieutenant, Mr. Foster served in a variety of leadership positions including Tank Platoon Leader, Company Executive Officer, and Support Platoon Leader within an armor unit. He was responsible for the management and supervision of units consisting of 15 to 60 soldiers with various operational and logistical specialties. During his service, he was deployed to Bosnia/Herzegovina and Kosovo for peacekeeping missions that involved base camp and logistical convoy security planning and operations.

Teaching Experience: Undergraduate Courses Taught (EKU)

- APS 210 – Physical Security (Ft. Knox, 2012; Online, 2012)
- HLS 101 – Introduction to Homeland Security (Ft. Knox, 2011)
- HLS 201 – Emergency Management (Ft. Knox, 2011)

- HLS 301 – Critical Infrastructure Protection (Ft. Knox & EKU, 2013; Online, 2014)

Curriculum Development Activities (Rural Domestic Preparedness Consortium)

- AWR 209 Dealing with the Media: A Short Course for Rural First Responders
- MGT 335 Event Security Planning for Public Safety Professionals
- Isolation and Quarantine for Rural Communities
- Isolation and Quarantine for Rural Public Safety Personnel

Publications: Project Reports and Papers (Primary Author)

Foster, C., Simpkins, B. & Poynter, E. (2012, August). *System Assessment and Validation for Emergency Responders (SAVER) Program Report: Touch Screens for Ruggedized Computers Technology Guide (Through U.S. Department of Homeland Security [DHS] Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2012, May). *SAVER Program Report: Ruggedized Computers Selection and Procurement Guide (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2011, October). *SAVER Program Report: Portable Identification Card Systems Assessment Report (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2011, October). *SAVER Program Report: Portable Identification Card Systems Application Note (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2011, April). *SAVER Program Report: Portable Identification Card Systems Focus Group Report (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2010, August). *SAVER Program Report: Mobile Command Systems Assessment Report (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2010, August). *SAVER Program Report: Mobile Command Systems Application Note (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C., Simpkins, B. & Poynter, E. (2010, August). *SAVER Program Report: Incident Decision Support Software Application Note (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Foster, C. & Bentley, E. (2006, October). *Assessing Your Disaster Public Awareness Program, A Guide to Strengthening Public Education (Through a Grant from the Alfred P. Sloan Foundation).* Lexington, KY: Emergency Management Accreditation Program and The Council of State Governments.

Foster, C. (2006, October). *A Legislator's Checklist to Emergency Preparedness & Public Communications (Through a Grant from the Alfred P. Sloan Foundation).* Lexington, KY: Emergency Management Accreditation Program and The Council of State Governments.

Foster, C. & Abner, C. (2006, June). *Public Safety Brief: Overcoming the Jurisdictional Divide – Compacts for Sharing Law Enforcement Intelligence and Resources (Grant No. 2003-DT-CX-0004 awarded by the National Institute of Justice, U.S. Department of Justice).* Lexington, KY: The Council of State Governments.

Foster, C. & Bentley, E. (2006, May). *A Framework for Assessing Regional Preparedness – A White Paper on Applying Emergency Preparedness Standards to Multijurisdictional Areas*. Lexington, KY: Emergency Management Accreditation Program.

Foster, C.S., Abner, C. & Rinehart, K. (2005, December). *Public Safety Brief: Regional Solutions for Enhanced Public Safety, Strengthening Terrorism Prevention and Emergency Response Capabilities (Grant No. 2003-DT-CX-0004 awarded by the National Institute of Justice, U.S. Department of Justice).* Lexington, KY: The Council of State Governments.

Foster, C. & Cordner, G. (2005, June). *The Impact of Terrorism on State Law Enforcement – Final Report (Grant No. 2003-DT-CX-0004 awarded by the National Institute of Justice, U.S. Department of Justice)*. Lexington and Richmond, KY: The Council of State Governments and Eastern Kentucky University.

Foster, C. & Cordner, G. (2005, April). *The Impact of Terrorism on State Law Enforcement – Project Overview, Key Findings and Recommendations (Grant No. 2003-DT-CX-0004 awarded by the National Institute of Justice, U.S. Department of Justice)*. Lexington and Richmond, KY: The Council of State Governments and Eastern Kentucky University.

Foster, C.S. (2005, April). *Leaders Lens: "Change Drivers" Impact Public Safety and Justice.* Lexington, KY: The Council of State Governments.

Foster, C.S, & Orr, C. (2004, October). *Homeland Security Brief: Protecting Rural America, State Challenges and Solutions.* Lexington, KY: The Council of State Governments.

Foster, C.S. & Kinsella, C.J. (2004, May). *Homeland Security Brief: Order the Quarantine! Assessing State Health Powers and Readiness.* Lexington, KY: The Council of State Governments.

Foster, C.S. & Kinsella, C.J. (2003, December). *Homeland Security Brief: Right to Know vs. Need to Know, States Are Re-examining Their Public-Records Laws in the Wake of Sept. 11.* Lexington, KY: The Council of State Governments.

Foster, C.S. & Kinsella, C.J. (2003, August). *Homeland Security Brief: Color-Coding Security, State Homeland Security Advisory Systems.* Lexington, KY: The Council of State Governments.

Foster, C.S. & Kinsella, C.J. (2003, April). *Homeland Security Brief: Bridging the Public and Private Gap, Infrastructure Security in the States.* Lexington, KY: The Council of State Governments.

Foster, C. (2002, December). *State Official's Guide to Homeland Security.* Lexington, KY: The Council of State Governments.

Publications: Project Reports and Papers (Reviewer and Contributor)

Poynter, E., Foster, C. & Simpkins, B. (2012, August). *SAVER Program Report: Mobile Computing Through the Cloud TechNote (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2011, December). *SAVER Program Report: Mobile Command Vehicles Selection Guide (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2011, May). *SAVER Program Report: Portable Identification Card Systems Market Survey Report (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2010, September). *SAVER Program Report: Propagation Modeling Software Application Note (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2010, September). *SAVER Program Report: Market Survey Report on Propagation Modeling Software (Through DHS*

Cooperative Agreement # EMW-2005-CA-0378). Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2009, November). *SAVER Program Report: Market Survey Report on Incident Decision Support Software (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2009, November). *SAVER Program Report: Mobile Command Systems Market Survey Report (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Simpkins, B., Foster, C. & Poynter, E. (2009, October). *SAVER Program Report: Focus Group Recommendations on Mobile Command Systems (Through DHS Cooperative Agreement # EMW-2005-CA-0378).* Richmond, KY: Eastern Kentucky University.

Publications: Articles

Foster, C. (2010, July). Enhancing Alert & Warning Systems via Open Standards. *Public Safety Communications, 76* (7), 28-30.

Foster, C. & Simpkins, S. (2010, May). Evolving Mobile Command – Available & Needed Standards for Disaster Communications. *Public Safety Communications, 76* (5), 24-25.

Foster, C. & Osterloh, C. (2009, June). NIMS Evaluation Program Aims to Improve Interop Solutions. *Public Safety Communications*, *75* (6), 31.

Foster, C. (2007, January). Components of an Effective Public Education Program. *Natural Hazards Observer*, *XXXI* (3), 9-11.

Foster, C. (2006, February). Regional Solutions to Homeland Security. *State News, 49* (2), 9-12.

Foster. C. (2005, November). Assessing Preparedness in the National Capital Region. *International Association of Emergency Managers (IAEM) Bulletin*, *22* (11).

Foster, C. & Cordner, G. (2005). The Impact of Terrorism on State Law Enforcement. *The Book of the States, 37*, 532-539.

Foster, C.S. (2005, April). Reshaping Public Safety and Justice. *State News*, *48* (4), 8-10, 37.

Foster, C. & Cordner, G. (2005, March). Terrorism's Impact on State Law Enforcement. *State News, 48* (3), 28-32, 35.

Foster, C.S. & Orr, C. (2005, January). Protecting Rural America. *State News, 48* (1), 24-26.

Foster, C.S. (2004, November). States' Role in Fighting Terrorism. *State News*, *47* (9), 28-30, 37.

Foster, C. (2004, August). States Prepare for Attacks on Public Health. *State News*, *47* (7), 22-24, 37.

Foster, C. (2004, April). Solving the Identity Theft Puzzle. *State News*, *47* (4), 19-21, 34.

Foster, C.S. (2004, March). The Juvenile Justice Jam. *State Government News, 47* (3), 17-19.

Foster, C.S. (2004, January). Right to Know vs. Need to Know. *State Government News, 47* (1), 16-18.

Foster, C.S. (2003, September). Color-Coding Security. *State Government News*, *46* (8), 25-26.

Foster, C.S. (2003, May). Bridging the Public/Private Security Gap. *State Government News, 46* (5), 26-28.

Foster, C.S. (2003, April). The Impact of War on the States. *State Government News, 46* (4), 16-18.

Foster, C.S. (2003, January). Homeland Security: Who Pays? *State Government News, 46* (1), 23-24, 28.

Mountjoy, J.J. & Foster, C.S. (2003, January). New Juvenile Compact. *State Government News*, *46* (1), 26-28.

Foster, C. (2002, August). Plugging the Holes: States Play Large Role in Border Security. *State Government News, 45* (7), 8-10.

Foster, C.S. (2002, Summer). How Safe are Hydroelectric Dams? *Ecos, 9* (3), 4, 8.

Foster, C.S. (2002, May). Biometric Border Solutions. *State Government News, 45* (5), 8-11.

Foster, C.S. (2002, April). Biometrics: The Future of Identification, *State Government News, 45* (4), 19, 22.

Mountjoy, J.J. & Foster, C.S. (2002, March). Budgets in Crisis: Public Safety Under the Gun. *State Government News, 45* (3), 22-23.

Select Technical Projects and Reports (Project Manager, Oversight, Contributor)

Publications, Job Aids and Guides

- National Incident Management System (NIMS) Incident Command System (ICS) Field Operations Guide
- NIMS ICS Forms Booklet
- NIMS Basic Guidance for Public Information Officers (PIOs)
- Multiagency Coordination (MAC) System Guide
- NIMS Standards Quarterly Briefs and Case Studies

Software Tools

- Emergency Management Institute (EMI) Model Community and Exercise Simulation System (ESS)
- Incident Resource Inventory System (IRIS)
- NIMS Compliance Assistance Support Tool (NIMSCAST)

Conformity Assessment Programs

- Integrated Public Alert and Warning System (IPAWS) Conformity Assessment Program
- NIMS Supporting Technology Evaluation Program (NIMS STEP)

Grant Support Activities and Funding

2012–Present Federal Emergency Management Agency, U.S. Department of Homeland Security – Support for the implementation of the Rural Domestic Preparedness Consortium (RDPC) (more than $37 million)

2009–2011 Federal Emergency Management Agency, U.S. Department of Homeland Security – Support for the implementation of the Integrated Public Alert and Warning System (IPAWS) Conformity Assessment Program ($1,536,462)

2006–2012 Federal Emergency Management Agency, U.S. Department of Homeland Security – Support for the implementation of the National Incident Management System (NIMS) Support Center Program ($31,500,000)

2005–2006 The District of Columbia – Support for an assessment of the National Capital Region's emergency management capabilities ($1,395,816)

2004 Citigroup, Inc. – Support for a policy session and publication on identity theft ($5,000)

2003–2005 National Institute of Justice, U.S. Department of Justice – Principal Investigator for research on state law enforcement agencies in the post-9/11 era ($386,000)

2003 Office of Juvenile Justice and Delinquency Prevention, U.S. Department of Justice – Continued funding for the Interstate Compact for Juveniles project ($250,000)

2003 Chlorine Chemistry Council – Continued support for the 2004 Homeland Security Briefing Series ($7,500)

2002 Chlorine Chemistry Council – Support for the 2003 Homeland Security Briefing Series ($7,500)

2002 21st Century Foundation (CSG) – Funding for the 2003 Homeland Security Briefing Series and State Official's Guide to Homeland Security ($45,000)

Special Meetings and Presentations

June 2008 Presenter, Office for Interoperability and Compatibility Industry Roundtable, Plenary II: Industry Participation in Compliance Assessment Programs, Washington, DC

Oct. 2007 Presenter, NIMS Point of Contact Workshop (B975), Noble Training Center, Anniston, Alabama

May 2006 Moderator/Presenter, Understanding and Assessing Regional Preparedness, 20th Annual Governor's Hurricane Conference, Fort Lauderdale, Florida

July 2005 Presenter, Annual Conference on Criminal Justice Research and Evaluation, The National Institute of Justice, Washington, DC (Preventing Terrorism at the State and Local Level)

May 2005 Presenter, The Impact of Terrorism on State Law Enforcement, Federal Bureau of Investigation – Office of Law Enforcement Coordination, Washington, DC

April 2005 Presenter, The Impact of Terrorism on State Law Enforcement, Spring Conference of the Association of State Criminal Investigative Agencies, Atlantic Beach, North Carolina

July 2004 Presenter, Annual Conference on Criminal Justice Research and Evaluation, The National Institute of Justice, Washington, DC (Preventing Terrorism at the State and Local Level)

June 2004 The Council of State Governments Staff Point of Contact, U.S. Department of Homeland Security Task Force on State and Local Homeland Security Funding

May 2004 Moderator, Order the Quarantine! Assessing State Health Powers and Readiness, Audio Teleconference, Homeland Security Briefing Series

Oct. 2002 Presenter, Homeland Security Policy Debate, Leadership Kentucky, University of Kentucky

Professional Courses Completed

- IS-860.A Introduction to the National Infrastructure Protection Plan (NIPP), 2013
- IS-100 Introduction to the Incident Command System (ICS 100), 2008
- IS-200 ICS for Single Resources and Initial Action Incidents, 2008
- IS-700 National Incident Management System (NIMS) an Introduction, 2008
- IS-701 NIMS Multi-Agency Coordination System, 2008
- IS-800.B National Response Framework, An Introduction, 2008
- Combined Arms and Services Staff School (CAS3), 2000
- Armor Officer Advanced Course, 2000
- Strategic Deployment/Unit Movement Officer Course, 1997
- Armor Officer Basic Course, 1996

Memberships and Select Honors and Awards

- The Association of Public-Safety Communications Officials (APCO) (2009-Present)
- Pi Alpha Alpha – The National Honor Society for Public Affairs and Administration (2006)
- The Honor Society of Phi Kappa Phi (2006)
- Military Decorations, Medals, Citations, and Campaign Ribbons (1996-2001): Army Commendation Medal, Army Superior Unit Award, Armed Forces Service Medal, National Defense Service Medal, Kosovo Campaign Medal, Armed Forced Expeditionary Medal, Army Service Ribbon, Overseas Service Ribbon, North Atlantic Treaty Organization Medal