No. 17
SUMMER 2014

MERCATUS GRADUATE POLICY ESSAY

COMMUNITY BROADBAND, COMMUNITY BENEFITS? AN ECONOMIC ANALYSIS OF LOCAL GOVERNMENT BROADBAND INITIATIVES

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ABSTRACT

This paper examines the economic impact of local public initiatives to build and operate broadband internet infrastructure. I find that local efforts produce small economic benefits, but they cause a notable increase in the size of local government. Using difference-in-differences estimation on panel data consisting of 23 years of observations from core based statistical areas in the contiguous United States, I find that publicly supported broadband networks lead to over 3 percent more business establishments, while reducing worker income by 1.3 percent, all else being equal. The networks have no discernible effect on private sector employment, but they increase local government employment by around 6 percent.

In light of the financial difficulties some public networks experience and the limited economic benefits they offer, public involvement is more wisely directed toward fostering private sector innovation as opposed to maintaining a more active role. Local initiatives that maintain an active role for local government can lead to a misallocation of resources if they ignore market signals and cause taxpayers to bear the uncertainty of the broadband market as opposed to private shareholders.

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Acknowledgements

I would like to thank Brent Skorup, Thomas Stratmann, and Stefanie Haeffele-Balch for their advice and feedback. I am also grateful for the financial support and access to academic resources provided by the Mercatus Center at George Mason University. All errors are my own.

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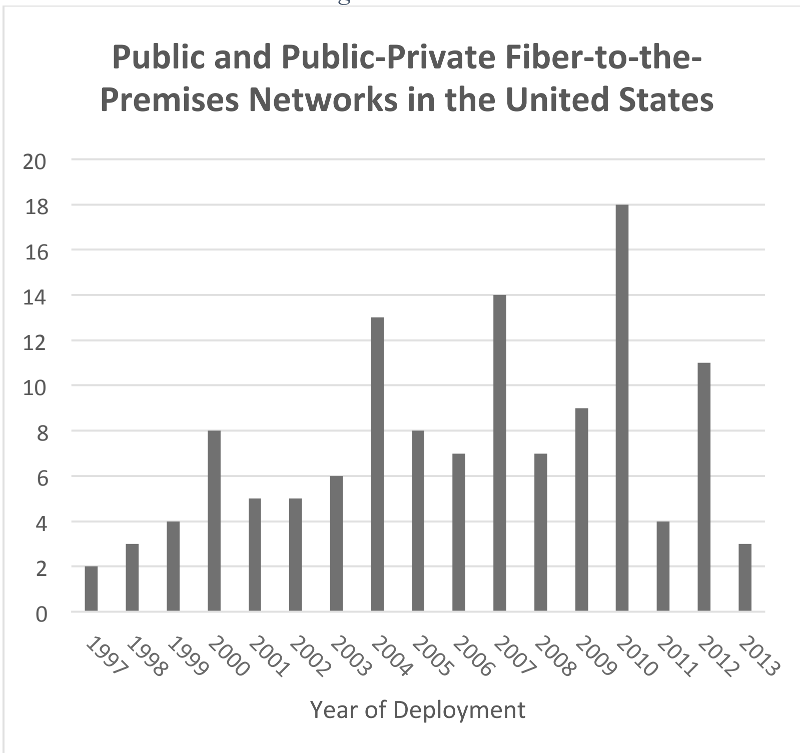
1. Introduction

Internet use among adults is now almost ubiquitous. A Pew Research Center survey shows that in 1995 only 14 percent of adults used the internet, whereas today 87 percent are online (Fox and Rainie 2014). Not only are there more connections to the internet, the connections are also faster. At the turn of the millennium, most people accessed the internet through their telephone lines on a dial-up connection. In 2000, 34 percent of adults accessed the internet using dial-up, while only 3 percent had broadband connections, which typically use coaxial cable lines or digital subscriber lines (DSL) and have faster data transmission capabilities. By 2013, 70 percent of adults used broadband connections, with only 2 percent using dial-up (Pew Internet Project 2013). Further, the use of ultra-high bandwidth fiber-optic connections is now spreading, challenging the older infrastructure owned by telephone and cable companies.

During the technological evolution in internet connections, local public officials have been contributing to innovation on the periphery. Mayors, city councils, and public utilities have brought some of the most advanced technologies to market, including fiber. Figure 1 shows the growing number of publicly supported fiber networks according to the publication Broadband Communities (2013).

Figure 1



Source: Broadband Communities

Inspired by a perceived low quality of internet service, local officials pursue these infrastructure projects with the promise of increased economic development as a result of improved internet access. In a 2012 survey of economic development professionals, 28 percent said internet speeds of 1 gigabit per second (Gbps) were necessary to attract new businesses to an area (Settles 2014). Former Federal Communications Commission (FCC) Chairman Julius Genachowski displayed similar sentiments last year by calling for every state to have at least one city with a gigabit-speed broadband network by 2015 (FCC 2013).

A 1 Gbps connection is 40 times faster than the US average as of June 2014.[1] At gigabit speeds, a customer could download over 60 high-definition movies in about 33 minutes. Some

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[1] US average speed was 24.89 megabits per second according to Ookla's Net Index Explorer, http://explorer.netindex.com/maps.

policymakers maintain that ultrafast internet connections hold the key to economic development, especially for smaller cities and small businesses. For instance, FCC Chairman Genachowski (2012) said, “Broadband allows small businesses to market their products and reach customers in the next neighborhood, the next city, the next state, and even overseas, increasing their revenue. And broadband allows small businesses to lower their costs through cloud-based services. Increased revenue. Lower costs. More profits. More jobs.”

Federal, state, and local policies have addressed certain aspects of the US broadband market. The 2009 American Recovery and Reinvestment Act set aside funds specifically for extending broadband to rural areas, and the law prompted the FCC to create The National Broadband Plan (Wall Street Journal 2009; FCC 2010). The plan created the Connect America Fund, which reformed the extant Universal Service Fund from focusing on subsidizing telecommunications services to expanding broadband access (FCC 2014). The FCC also became involved in local broadband policy when current Chairman Tom Wheeler recently threatened to preempt state laws that put restrictions on municipalities offering internet service (Wheeler 2014). Republicans in the House of Representatives pushed back by passing an amendment to an appropriations bill that would prohibit the FCC from preempting the state municipal broadband laws[2] (Wilson 2014).

The economics profession has produced expansive literature on the impact of the internet, with studies ranging from productivity gains to competition in the term life insurance market. However, economists have not been closely involved with the debate surrounding public support of broadband deployment.

[2] H.R. 5016, 113th Congress (2014), Sec. 920.

Public funding of broadband infrastructure has become a polarizing issue, but there is little rigorous data analysis on the subject. This paper fills that gap by measuring the impact of publicly supported broadband deployment and pushing back against the challenge put forth by fiber network proponent Blair Levin, who said, “The search for statistical validation of these [community broadband] projects is not going to turn up anything meaningful” (Wyatt 2014).

The next section describes community broadband in greater detail, followed by section 3 which outlines my empirical approach to measuring the economic impact of community broadband. Section 4 discusses the data and section 5 presents the estimation results. Section 6 discusses my findings in the context of current public policy issues in the broadband market. Section 7 concludes the paper.

2. Community Broadband

Since the late 1990s, local governments across the United States have been providing internet service and infrastructure for themselves and their citizens. Local governments build and sometimes own and operate high-speed broadband networks, essentially creating a public competitor, or at least a public disrupter, in the local market. The government’s role is premised on some city leaders and organizations making the case that private internet service does not suffice, either in terms of bandwidth or price, or both (Dingwall 2006). Tapia, Maitland, and Stone (2006) put a particular emphasis on price, saying high prices in the United States have slowed broadband adoption relative to other countries.

Local governments control assets that are important to providing communications infrastructure. The most important assets are the rights of way, telephone poles, and existing fiber lines (Settles 2014). But local governments do not always go it alone when providing broadband service. They often collaborate with private entities or public electric utilities. Provo, Utah, built and owned a fiber network while letting private companies provide telecommunications services directly to customers. Provo employed what is called the "wholesale" model. The other model for community broadband is the "retail" model, where the city government also provides internet service operations. Retail models often take advantage of partnerships with local public electric utilities, which already have the back-office operations necessary for customer service.

Federal funding has also supported local community leaders in pursuit of obtaining faster and cheaper internet service. In 2009, the American Recovery and Reinvestment Act set aside $7 billion of federal funds for the "Broadband Technology Opportunities Program." The funds are administered by the National Telecommunications and Information Administration, and are used in part to build broadband network infrastructure that serves community anchors institutions (schools, libraries, and hospitals), households, and businesses (NTIA 2014). In 2009, Chattanooga's public utility received a $111 million federal stimulus grant to hasten the expansion of its fiber network, and Bristol Virginia Utilities received a $22.7 million grant to expand its broadband internet service in rural Virginia in 2010 (Owens 2010; Wyatt 2014).

Next, I highlight specific public networks to paint a clearer picture of how community broadband works and the challenges that face such efforts. In Tennessee, Utah, and Louisiana, public networks share common traits that highlight two key takeaways about the community broadband experience. First, local efforts in Chattanooga, Tennessee, and Lafayette, Louisiana, make it seem plausible that increasing broadband access and bandwidth can boost the local economy, especially by attracting businesses. Second, community broadband projects have experienced financial and implementation problems that slow the deployment of infrastructure and cause some cities to incur large financial losses, especially when a public network competes head-to-head with a private internet service provider.

"Gig City," USA

The midsize city of Chattanooga, Tennessee, is known as "Gig City" because of its city-owned fiber broadband network that has connection speeds of up to 1 Gbps. For around $70 a month, residents of Chattanooga receive a 1 Gbps internet connection, although when the service was first rolled out the monthly bill was around $350 for that speed tier (Mitchell 2012).

Once a struggling manufacturing economy, Chattanooga has been lauded for promoting high-tech economic development with its "future-proof" fiber network. The network began in 2007 and it is operated under the retail model by the local public electric utility, the Electric Power Board (EPB). Since the network deployed, the city has attracted a small cluster of startups, structured around organizations that help entrepreneurs turn ideas into businesses. Both public and private involvement cultivates Chattanooga's startup business scene. For instance, the local Chamber of Commerce renovated an old ceramic manufacturing facility into office space for startups, and The Company Lab (2014), a private organization, helps potential high-growth companies develop a business plan and get access to investors and strategic partners.

The business incubators in Chattanooga revolve around the gigabit-speed network because it allows small companies to scale their products quickly if they become popular overnight. In addition to trendy startups, the city has also attracted large corporations like Amazon and Volkswagen to set up facilities in the region. However, fiber is not the only reason Amazon and Volkswagen came to Chattanooga, even though Volkswagen did sign up for fiber internet service. Economic development incentives were used to attract the two companies as well (Wotapka 2012).

Chattanooga's fiber network dates back to the late 1990s when a fiber ring was used to connect electric substations. The network's fiber-to-the-home expansion required $162 million in bond-financing at an interest rate of 4.5 percent and a maturity of 25 years, along with support from local government officials, nonprofits, community leaders, and citizens. To build the network, EPB needed approval from the city council and the community at large. EPB even received marketing support from the Lyndhurst Foundation, a local philanthropic organization, which advertised the public network to businesses needing data and voice services (Mitchell 2012). Despite widespread support, community broadband in Chattanooga was slowed by resistance from the Tennessee Cable Telecommunications Association, which filed lawsuits against the network expansion and even created television advertisements advocating against creating a public internet service provider (Mitchell 2012).

Despite legal and media pressure from existing providers, EPB finally launched its network to residences in the fall of 2009 after it already had reached businesses with voice and data services, giving 27,000 homes the option to subscribe to the municipal service. By 2011, EPB had over 25,000 residential subscribers, thanks in part to federal stimulus funding that extended the reach of the network to over 100,000 homes (Mitchell 2012). Since its launch, the fiber network has transformed Chattanooga's economy. A 2013 report from CBS News claimed the network had attracted $400 million in investments and 6,000 jobs (Glor 2013). Edward Wyatt wrote for *The New York Times* that community broadband's positive economic impact on Chattanooga was "unmistakable" (Wyatt 2014).

Utah's Wholesale Networks

While Chattanooga employed a retail model of broadband service, Utah state law requires community broadband to pursue the wholesale network model.[3] The city of Provo built its own fiber network alongside a regional fiber network, called the Utah Telecommunication Open Infrastructure Agency, or UTOPIA, which consists of 16 member cities that grouped together to build a series of wholesale fiber networks that offer high-speed access to voice, video, and data services. Although the network has not been completed, businesses within UTOPIA's current footprint can subscribe to connections as fast as 10 Gbps.

Around the same time that UTOPIA was deploying fiber, Provo launched its own network, called iProvo, which has had a checkered financial history. iProvo has been privatized twice, and most recently sold to Google for $1 at a loss of nearly $40 million.

Provo Mayor Lewis K. Billings advocated for the fiber network that promised to bring businesses and innovation to the city. The network began with three fiber rings that connected community anchor institutions. Due to state law, iProvo's primary internet service provider was HomeNet. After only one year in operation, HomeNet filed for chapter 11 bankruptcy. At the time HomeNet halted its service in 2005, the provider only had around 1,600 subscribers (Titch 2006). The city's network continued running on borrowed city funds, eventually being sold to Broadweave Networks in 2008 for $40.8 million. After Broadweave merged with another company, it defaulted on its purchase of the network in 2011, which left iProvo under city ownership again. The latest effort for the city to leave the troubled network behind was its sale to Google (Davidson and Santorelli 2014).

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[3] Utah Code Ann. § 10-18-201 et seq.

While Provo is just one city, the entire UTOPIA network has had its own set of problems. In 2012, the Utah state legislature conducted an audit of UTOPIA and found that the network had not lived up to its financial or technological expectations, having accumulated operating deficits and construction delays (Schaff 2012). The state auditors concluded that UTOPIA was subject to poor construction planning, mismanagement, and unreliable business and finance partners, on top of experiencing insufficient consumer demand for ultrafast broadband.

Lafayette's "infrastructure of the future"

By not incorporating dynamic considerations into the plans to build local network infrastructure, taxpayers can end up footing the bill for a service they may not even use. The dynamic nature of broadband market competition is best portrayed by the experience of the public network of Lafayette, Louisiana.

Lafayette, in the center of Cajun country, is a town of just over 120,000 residents with a public utility dating back to 1896. Lafayette Utilities System (LUS) offers electricity, water, sewer and, since 2007, internet service to city residents and businesses. Like Chattanooga's network, LUS's $125 million fiber network deployment had to endure a legal battle, but ended up receiving grassroots support and attracting a small cluster of tech startups once it was built (Jervis 2012).

The network dates back to the mid-1990s, when LUS connected its electric substations with strands of fiber. The utility had excess fiber capacity leftover and soon began replacing the city's slow T1 lines, which have around 1.5 Mbps of bandwidth, with the faster fiber-optic lines. LUS Director Terry Huval led the charge for extending the city's fiber network to residences and businesses, much like Mayor Billings did in Provo. Huval met resistance from the incumbent internet service providers (ISPs), which maintained that a community network was unfair competition. Along with Huval's efforts, grassroots organizations in Lafayette garnered support for the network. One group, Lafayette Coming Together, deployed creative strategies, such getting residents to create YouTube videos supporting the network, to counter the incumbent-funded media campaign against the network. In the summer of 2005, the advertising campaigns culminated in a referendum, which saw 62 percent vote in favor of the network, with a 27 percent voter turnout. In 2007, after the battle between LUS and the incumbents had gone from the media to the courts, LUS finally issued an initial $110 million in bonds to start the network (Mitchell 2012).

Since deployment, LUS has experienced several setbacks. At first, LUS had to pay more than it expected for video content because it was not a member of the National Cable Television Coop, a collective bargaining group for small and independent television service providers that negotiates deals with national content companies. On top of content negotiation, LUS endured unanticipated costs in wiring subscribers' homes and training its employees (Mitchell 2012). All these costs put LUS Fiber in the red. Critics of Lafayette's network attributed its financial troubles to being an unfit competitor with the private sector. As of 2013, Lafayette's network was 30 percent short of its revenue projection and $160 million in debt (Titch 2013).

Advocates, including Terry Huval, maintain that the balance sheet issues are worth the trouble because the community receives economic and social benefits from the network. Huval said LUS built the "infrastructure of the future," which has attracted companies to locate in Lafayette, including from California (Jervis 2012). For example, two tech companies, Pixel Magic and Skyscraper Holding, came to Lafayette from California because of the low costs of living and the cheap and reliable bandwidth (Jervis 2012).

Community broadband in Lafayette and Chattanooga attracted internet companies due to cost reductions. Public broadband can be viewed more generally as public infrastructure investment, a broad topic of study in economics, which helps shape expectations regarding the economic impact of these networks. Thus, while a clear answer may not exist for every city as to whether or not a community network is worth its financial burden, it is clear the network's effect will show up.

Public Infrastructure Investment

Much literature exists on how public infrastructure investment affects economic performance. For national and regional governments alike, public infrastructure is held to be an important aspect of attracting business (Romp and De Haan 2007). In one of the first studies on the effects of public infrastructure investment, Eberts (1986) finds that the public capital stock makes a positive and significant increase to manufacturing output, and that public capital and private labor are complements. Aschauer (2000) finds that public infrastructure is associated with increases in overall output per worker.

Firms try to minimize production costs with their location choice (Goetz et al. 2011). Exogenous cost reductions can stem from public capital and greater access to markets. In the United States, infrastructure capital is primarily held by state and local governments (Gramlich 1994), which makes state and local infrastructure policy important to the performance of local economies. Improved local communications infrastructure allows businesses to reach more markets, more easily coordinate activity across many locations, and reduce overall costs,[4]

[4] Some economic theory and evidence also suggests that government intervention can inhibit economic growth. For example, Holcombe (1998) deemphasizes the importance of capital inputs and instead says,"[T]he engine of economic growth is not better inputs, but rather an environment in which entrepreneurial opportunities can be

especially now with the advent of cloud computing which reduces startup costs for businesses (Surdak 2014).

Yet, there has been little research on the impacts of community broadband to date. One study by Ford and Koutsky (2005) finds that municipal broadband investment in Lake County, Florida, leads to greater growth in economic activity relative to similar counties in Florida. However, the authors use sales data as a proxy for economic activity and caveat their results as "preliminary." Lobo, Novobilski and Ghosh (2008) examine Chattanooga's fiber network and estimated that it would lead to 2,600 new jobs and increase local income and tax receipts by more than $352 million over ten years. However, the authors' analysis employs an unusual methodology compared to modern broadband literature by using an input-output model originally developed in the 1970s by the Forest Service. The methodology produces a calculated "best guess" of Chattanooga's network based on assumptions about the number of subscribers, monthly fees, and connection costs. The paper's model produces a tenuous forecast rather than trying to isolate a causal effect in the data, which is more typical of economic research, as Ford's and Koutsky's study attempts to do.

Besides these two articles, academic literature does not contain much rigorous analysis of municipal broadband. Many case studies of merit exist for and against municipal broadband conducted by research centers, but it is difficult to generalize about the networks' economic impact using this evidence. I fill this gap in analysis by combining information on community broadband with economic data from cities across the United States. Many claims surround the benefits of publicly funded networks. In this paper I examine three questions, with one larger question in mind: what is the economic impact of publicly funded broadband infrastructure? In

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capitalized upon." Furthermore, Higgins et al. (2006; 2009) find a negative relationship between the size of government and economic growth.

order to be specific about how I measure community broadband's impact, I examine three main empirical questions: what is the effect of network deployment on the quantity of businesses in a community? What are the networks' effects on wages? And what are the networks' effects on community-level employment? Because community network deployment is supposed to be a boon to economic activity, reducing costs and boosting productivity, I expect to find a positive effect with regards to all three questions. Furthermore, some of these broadband projects are the product of hundreds of millions of dollars of local and federal government spending, and conventional wisdom of public infrastructure literature would expect an increase in employment to construct and run the networks.

3. Empirical Approach

One way to isolate the effect of publicly funded broadband is to compare changes in cities that deployed broadband to the changes in cities that did not. If a direct comparison is made between cities with and without networks, then any relationship between networks and economic activity could be partially explained by unobserved differences in a city's economic, political, cultural, or geographic characteristics. One way to get around this problem is to look at the variation in economic activity within a city before and after it deploys a network. This strategy is called difference-in-differences, which exploits the policy intervention of network deployment. If network deployment is modeled as a "treatment" variable, then difference-in-differences uses sample data to isolate the causal effect of the network on a given outcome of interest Y in the following way:

$$\text{Effect} = [E(Y_{it}|i = 1, t = 1) - E(Y_{it}|i = 1, t = 0)] - [E(Y_{it}|i = 0, t = 1) - E(Y_{it}|i = 0, t = 0)]$$

where *i* indexes a community and *t* indexes time, specifically *i*=1 for the communities with networks, the "treated" group, and *i*=0 for the untreated group, while *t*=0 before the network is deployed and *t*=1 after deployment.

The regression model can incorporate multiple communities and periods of observation while controlling for confounding factors as well. The following two-way fixed effects model measures the treatment effect, denoted as β_1, assuming there is no time-varying unobservable factor related to both the treatment and the outcome of interest:

$$Y_{it} = \beta_1 Network_{it} + X_{it}\beta_k + \mu_i + \gamma_t + \varepsilon_{it}$$

Where i indexes the city and t indexes the year. Y_{it} is the outcome of interest related to economic activity, $Network_{it}$ is a variable that indicates in which city and year a network is deployed, X_{it} is a vector of k city- and state-level demographic and economic characteristics, μ_i and γ_t are the city and year fixed effects, respectively, and ε_{it} is the stochastic error term. The city fixed effect controls for any time-constant unobserved heterogeneity across cities. The year fixed effect controls for temporal shocks that affect the entire country, such as a recession.

4. Data

This analysis uses nationwide panel data from several sources covering core based statistical areas (CBSA) in the contiguous United States from 1990 to 2012. Based on Census Bureau information, the Office of Management and Budget defines one or more counties as either a metropolitan statistical area or a micropolitan statistical area, both of which are core areas. The Census Bureau explains that "[t]he general concept of a metropolitan or micropolitan statistical area is that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core"[5] (Census Bureau 2014).

Difference-in-differences analysis requires a treatment group and control group. The treatment group consists of CBSAs that deploy a publicly supported network. For my analysis, the CBSA definition ensures that comparisons are being made among clusters of economic activity, small or large, and throughout the rest of the paper I use the term "city" and CBSA interchangeably.

The "treatment" is a dummy variable that indicates which city deployed a publicly funded Fiber-to-the-Premises (FTTP) network and when it was deployed. The information on publicly funded networks comes from the Broadband Communities' municipal network census (Broadband Communities 2013). As of 2012, there were 107 CBSAs with community FTTP broadband networks. Broadband Communities has three criteria for including a network on its list. First, the network must be deployed by public entities, public-private partnerships, or private entities that received significant investment from local government. Second, the network must connect local homes and businesses to the internet using all-fiber networks, or be in the process of doing so. Third, the networks must have services such as voice, data, and video available directly to end users, through either the wholesale or retail model (Broadband Communities 2013). This last criterion is important, since many cities have excess fiber capacity, "dark fiber," that goes unused. Therefore, the project start date marks when internet service is provided, not just the laying of dark fiber.

[5] Each CBSA has at least one urban area of 10,000 people or more. Metropolitan areas have at least one urbanized area with a population of at least 50,000, while micropolitan areas must have at least one urban cluster of a population between 10,000 and 50,000 people.

Broadband Communities lists the years in which the networks began. Fiber networks are labor-intensive and take many years to complete. While network deployments are heterogeneous, many community broadband projects begin because local government institutions already have fiber lines in place, and often businesses are the first nongovernmental users connected to the networks. Residential users, who are more geographically dispersed, are usually the last users connected to the FTTP networks. The fact that businesses connect first facilitates the analysis because I examine the effect of community broadband on business activity, not household outcomes.

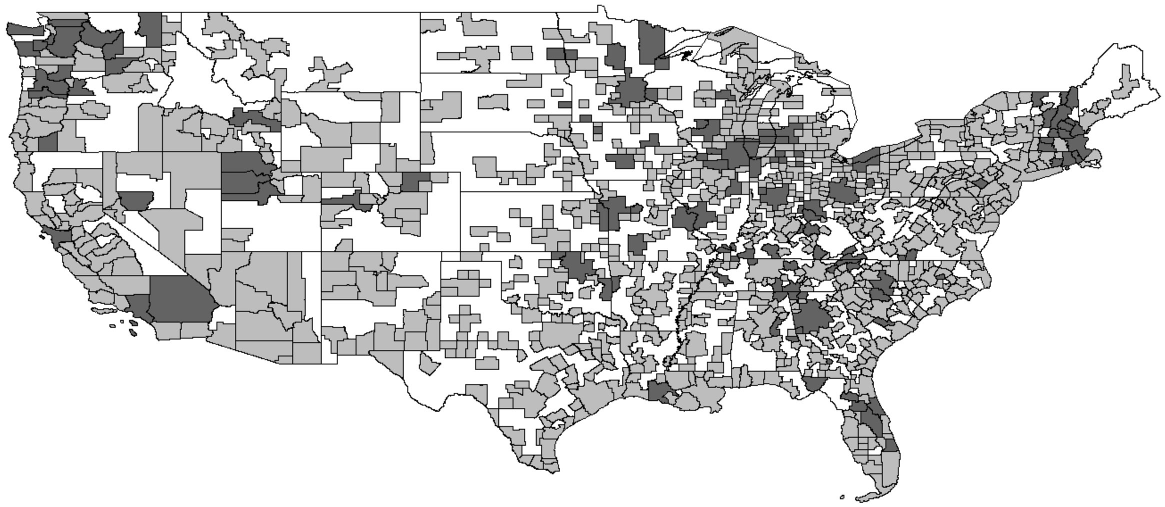
The information from Broadband Communities and the CBSA definitions present two challenges that lead me to limit the sample of cities. First, looking at the map of community broadband in 2012 in Figure 2, the question arises whether or not a network inside of a CBSA is deployed widely enough to make an impact. For example, there is a community network in Vernon, California, which is located inside the Los Angeles Metropolitan Statistical Area. Vernon's businesses account for less than 1 percent of Los Angeles' total number of businesses and around 1 percent of its total level of employment.[6] Because of the small reach of the network, it is not very plausible that changes in economic activity at the metropolitan level would be due to Vernon's public network. Second, after inspection, many other implausible cities in the treatment group are highly populated. Large metropolitan areas are not the types of cities where community broadband is likely to occur because they are large markets that have long received internet service from the private sector. Therefore, including large metropolitan areas in the control group does not provide the relevant counterfactual to Chattanooga's network deployment, to name one example.

[6] Author's calculation based on the City of Vernon's official website, www.cityofvernon.org/about-vernon, and preliminary 2013 annual estimates from the Bureau of Labor Statistics.

Figure 2

US Metropolitan and Micropolitan Areas with Community Broadband, 2012

Office of Management and Budget 2013 Area Delineations



Dark grey areas have community broadband, light grey do not. The white portions of the map are outside the Core Based Statistical Areas.

Source: Broadband Communities and the Census Bureau

I restrict the sample of cities to those with populations below 600,000 in 2010. The resulting panel data consists of 23 years of observations from a total of 818 CBSAs in my sample, 80 of which have community broadband in 2012. See Table 7 in the appendix for a complete list of the 80 cities with community broadband and their start dates.

As noted earlier, I examine three questions of interest in this paper: what is the effect of network deployment on the number of businesses in a community? What are the networks' effects on wages? And what are the networks' effects on community-level employment?

For the first question, I have data for the number of establishments from the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages. The BLS defines an establishment as "a single economic unit, such as a farm, a mine, a factory, or a store, that produces goods or services" (BLS 2014). An establishment is not the same as a company or firm, which may have several establishments in one city. The establishment definition is ideal for my analysis because I am not concerned whether or not a company is headquartered in an area, just if it has a presence. For the second and third questions, I have data on the real annual compensation per job and the level of employment, in total and for specific industries. Compensation and employment data are available at the CBSA level from the Bureau of Economic Analysis. Table 1 presents summary statistics of the data.

The Internet era did not begin until the mid-1990s, but having data that dates back to 1990 provides a pre-treatment period. However, the length of my panel has drawbacks. It is difficult to obtain a completely satisfactory set of control variables at the CBSA-level dating back to the 1990s. Specifically, educational attainment has poor coverage, which I proxy with the proportion of the population, aged 25 years or more, with a bachelor's degree or higher level of education. I have educational attainment from the Census Bureau data for the years 1990, 2000, and 2009 through 2012. Note that some controls are aggregated at the state level, located at the bottom of the table. The data contains controls for the economic, demographic, and political characteristics of cities. See Table 8 in the appendix for a complete list of the controls, their sources, and years of observations.

Table 1 – Summary Statistics

	Minimum	Maximum	Mean	Standard Deviation	Observations
Community Broadband Treatment Dummy	0	1	0.031	0.175	18814
Total Establishments	133	20180	2591.358	2676.33	18814
Real Compensation per Job	$15,537.17	$94,806.58	$35,855.58	$10,206.97	12270
Real Compensation per Job, Information Industry	$8,239.09	$247,806.70	$35,020.16	$10,762.60	9375
Real Compensation per Job, Health and Social Assistance Industry	8012.90	82747.05	33737.18	9500.18	7125
Real Compensation per Job, Finance and Insurance Industry	$8,012.90	$82,747.05	$33,737.18	$9,500.18	9580
Real Compensation per Job, Manufacturing Industry	4572.626	137762.6	46720.21	14833.76	9614
Real Compensation per Job,	5953.315	40556.7	13734.83	3902.403	9391

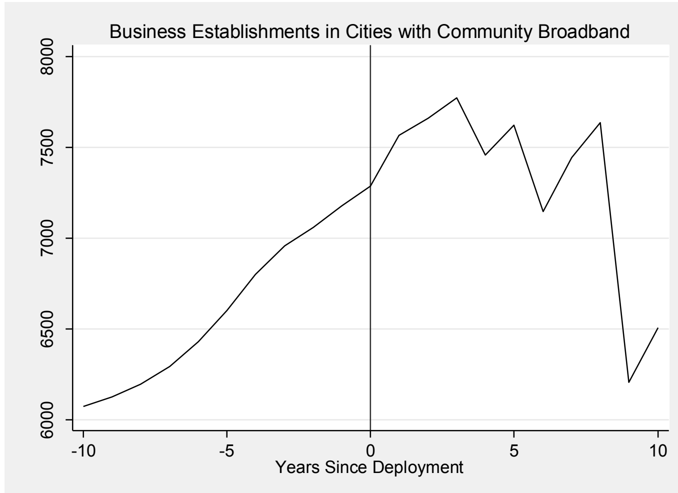
Food and Accommodation Services Industry					
Real Compensation per Job, Local Government	$1,214.25	$296,862.60	$29,141.79	$9,662.67	8715
Private Nonfarm Employment	1373	325256	45116.42	49748.31	18814
Local Government Employment	453	33560	4763.208	4592.196	17397
Unemployment Rate	0.7	40.8	6.394	2.967	18814
Proportion of Population, Race is White Alone	0.02	0.993	0.804	0.182	18814
Proportion of Population, Aged 25 to 64 years	0.322	0.803	0.536	0.05	18814
Real per Capita Personal Income	3270.42	123167.90	21607.24	9978.968	18814
Proportion of Population 25 Years or Older, with Bachelor's Degree or Higher	5.5	64	19.171	7.816	4908
Proportion of State Tax Revenue from Property Taxes	0	0.375	0.019	0.039	18814
Proportion of State Tax Revenue from Individual Income Taxes	0	0.744	0.304	0.168	18814
State Average Total Energy Price, Dollars per Million BTU	$5.07	$28.85	$11.96	$4.67	17996

5. Estimation Results

Business Establishments

Looking at the raw data, the number of establishments increases noticeably after network deployment occurs, followed by dips in the data that may suggest a long-run decrease. Figure 3 below shows the average number of establishments for the treatment group of cities, with the vertical line marking when a network deployed. However, Figure 3 does not show what the counterfactual may have been for areas that did not deploy fiber. A more compelling story is told by focusing on a case study of two cities in southern Virginia. Danville and Bluefield are both micropolitan areas, and in 2007, Danville deployed a high-speed municipal network. Bluefield recently received stimulus funding to also build a network, but in the sample Bluefield remains in the control group since their network was not active in 2012. It is also important to note that both cities have similar population counts, making a comparison between the two a quasi-experiment for community broadband.

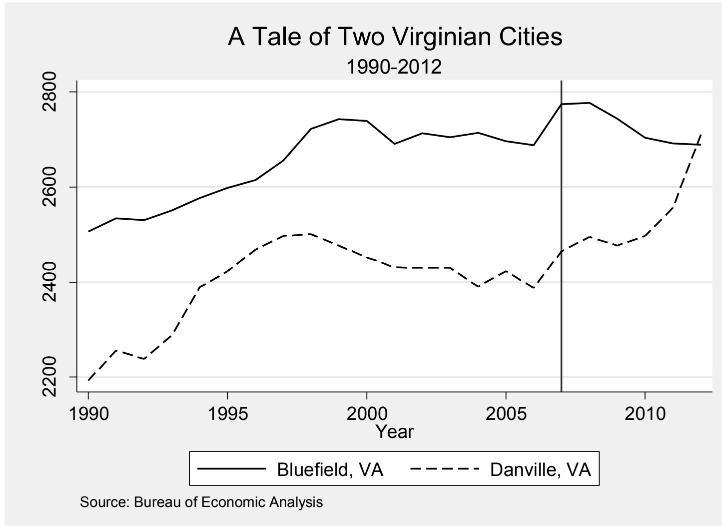
Figure 3



Source: Bureau of Labor Statistics and author's calculation

Figure 4 shows that Danville experienced a large increase in business establishments after deploying an FTTP network, while the number of establishments in Bluefield remained stagnant. It is important to note that, while the two cities' levels of establishments are not the same, they share similar trends during the pre-treatment period. By 2012, Danville has more establishments than Bluefield, which did not occur during any other year in the sample. Regression analysis can generalize the many quasi-experiments that occur throughout the data and control for potential confounding factors in order to measure the effect of community broadband.

Figure 4



Moving from two cities to the entire sample of 818, I use Ordinary Least Squares (OLS) and difference-in-differences estimation to measure the statistical relationship between the networks and establishments. The following is the difference-in-differences econometric model:

$$\ln(Establishments_{it}) = \beta_0 + \beta_1 Network_{it} + X_{it}\beta_k + \mu_i + \gamma_t + \varepsilon_{it}$$

Where $Network_{it}$ is a dummy variable that indicates in what city and year a network is deployed, X_{it} is a vector of city- and state-level covariates, and there is a 3-part error term that includes city and time fixed effects and the usual error term. Measuring β_1 will indicate how large an impact community broadband has on the number of establishments.

Table 2 presents OLS estimation results in column 1, and difference-in-differences estimation results in columns 2-5. OLS does not control for any CBSA and year fixed effects, which means estimation uses the variation between cities with and without community broadband to measure the effect. The OLS results indicate a strong positive relationship between community broadband and the number of business establishments. After eliminating time-constant unobserved heterogeneity with CBSA fixed effects and controlling for national annual shocks, the coefficient becomes smaller, but still remains positive and statistically significant beyond the 5 percent level. The result suggests that network deployment leads to over 3 percent more establishments in a community, all else equal, and the effect is robust to controlling for covariates.

Table 2

Effect of Community Broadband Deployment on Business Establishments

	(1) Total Sample	(2) Total Sample	(3) Total Sample	(4) Above Median Income	(5) Below Median Income
Network	0.393***	0.032**	0.032**	0.0398**	0.025
	(0.038)	(0.015)	(0.014)	(0.019)	(0.022)
Unemployment Rate	-0.0157***		0.0017	0.00757***	-0.0001
	(0.002)		(0.0012)	(0.002)	(0.002)
White Population	-0.0871**		0.081	0.113	0.064
	(0.038)		(0.124)	(0.158)	(0.182)
Working Age Population	1.565***		0.717**	1.391***	0.164
	(0.169)		(0.296)	(0.316)	(0.433)
Real per Capita Personal Income	2.84e-05***		8.41e-06***	1.10e-05***	8.58e-06***
	(1.58e-06)		(1.20e-06)	(1.64e-06)	(3.28e-06)
Property Tax Revenue Ratio	2.315***		-0.303***	-0.305***	-0.155
	(0.137)		(0.079)	(0.082)	(0.185)
Cost of Energy	-0.0364***		0.0142***	0.0118***	0.0213***
	(0.003)		(0.003)	(0.004)	(0.007)
Constant	6.588***	7.301***	6.682***	6.570***	6.630***
	(0.084)	(0.005)	(0.165)	(0.206)	(0.225)
Observations	17,996	18,814	17,996	8,998	8,998
R^2	0.094	0.488	0.534	0.617	0.463
CBSA FE	No	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Number of CBSA		818	818	409	409

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Dependent variable is the natural log of the number of establishments in a city. Column 4 estimates the model using only a subsample of cities with per capita personal income above the median, while column 5 uses a subsample of cities with below median per capita personal income. The covariates Property Tax Ratio and Cost of Energy are measures aggregated at the state level.

I split the data according to levels of income to find any measureable difference in the effect between cities with higher and lower income levels. Columns 4 and 5 in Table 2 estimate the difference-in-differences model on two subsets of the data. Column 4 uses only cities with real per capita personal income in 2010 that is above the median, and column 5 uses only the cities below the median level. The results indicate that the richer half of cities, with population around or below 600,000, benefit from community broadband while less well-off cities do not experience a statistically significant increase in businesses.

Compensation

My results show that community broadband attracts businesses, although mostly for higher income cities in the sample. Since public capital and private labor are found to be complements, network deployment is expected to increase worker pay along with business establishments (Eberts 1986). To test the effect of community broadband on worker pay, I use a wage model that is similar to the two-way-fixed effects model for business establishments, except that it contains different covariates and the dependent variable is a natural logarithmic transformation of the average level of real annual compensation per job, which is a proxy for wages. Here is the model, with the focus on measuring the coefficient β_1:

$$\ln(Compensation_{it}) = \beta_0 + \beta_1 Network_{it} + X_{it}\beta_k + \mu_i + \gamma_t + \varepsilon_{it}$$

Table 3 presents OLS estimation results in column 1 and the difference-in-differences results in columns 2-9. OLS estimation shows a statistically significant positive relationship between community broadband and real compensation. However, the measured coefficient becomes statistically significant and *negative* with difference-in-differences estimation, as seen in columns 2 and 3. This suggests that community broadband reduces worker pay by almost 1.3 percent, all else being equal. A negative wage effect is not unheard of in the economics of broadband literature. Forman, Goldfarb, and Greenstein (2012) find that the spread of the internet could actually exacerbate regional wage inequality, leading to growth in high-skilled areas without a reciprocal effect in rural, less-skilled areas. To see if Forman et al.'s findings hold for community broadband, I estimate the difference-in-differences model on six subsets of the data, which consist of cities in the top and bottom quartiles of income, population, and education. I use levels of real per capita income, population, and educational attainment in 2010 to separate the cities into the highest and lowest quartiles.

The estimation results are presented in columns 4-9 of Table 3, and Figure 5 plots the estimated coefficients. Unlike Forman et al.'s findings, my results suggest that community broadband has a negative impact in higher income, more populated, and more educated cities. However, these quartiles come from a sample of cities with population levels below 600,000 in 2010, whereas Forman et al. examines a wider range of counties in the United States which includes large metropolitan areas that are not in my sample. Nevertheless, the data clearly does not show large pecuniary benefits to community broadband deployment via worker pay.

Figure 5

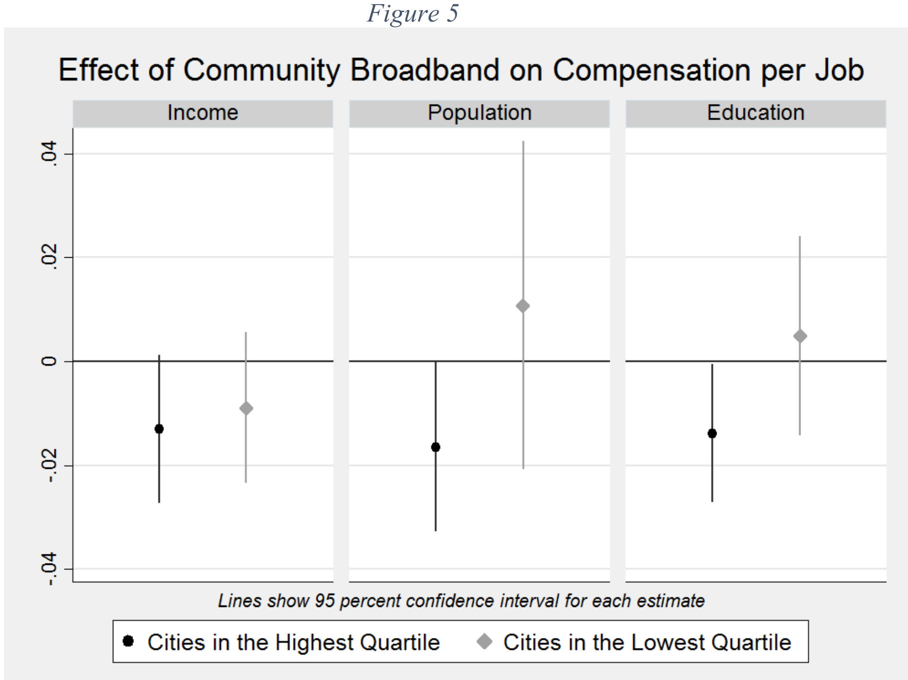


Table 3

Effect of Community Broadband Deployment on Compensation

	(1) Total Sample	(2) Total Sample	(3) Total Sample	(4) Top Income Quartile	(5) Bottom Income Quartile	(6) Top Population Quartile	(7) Bottom Population Quartile	(8) Top Education Quartile	(9) Bottom Education Quartile
Network	0.067***	-0.0145***	-0.0127***	-0.013*	-0.009	-0.017**	0.011	-0.014**	0.005
	(0.010)	(0.004)	(0.005)	(0.007)	(0.007)	(0.008)	(0.016)	(0.007)	(0.010)
Unemployment	0.040***		-0.008***	-0.009***	-0.006***	-0.009***	-0.0107***	-0.009***	-0.007***
Rate	(0.001)		(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Bachelor's	0.012***		7.64e-05	-0.004	-0.0001	-0.0005	-0.001	0.003	-0.001
Degree	(0.001)		(0.001)	(0.0025)	(0.0017)	(0.0029)	(0.002)	(0.002)	(0.002)
White	-0.023		-0.285***	0.071	-0.355	-0.725***	0.028	-0.124	-0.528***
Population	(0.023)		(0.105)	(0.215)	(0.244)	(0.194)	(0.193)	(0.211)	(0.199)
Working Age	1.874***		1.457***	2.007***	1.198***	1.098***	1.965***	0.794***	1.873***
Population	(0.152)		(0.217)	(0.557)	(0.284)	(0.295)	(0.488)	(0.241)	(0.322)
Observations	4,090	12,270	4,090	1,025	1,025	615	1,020	1,025	1,010
R^2	0.342	0.979	0.983	0.980	0.982	0.989	0.975	0.990	0.980
CBSA FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of CBSA		818	818	205	205	205	204	205	202

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Dependent variable the natural log of the average compensation per job. Columns 4 and 5 estimate the model using a subsample of cities whose level of real per capita personal income in 2010 was in the top and bottom quartiles, respectively. Columns 6 and 7 estimate the model using cities whose population in 2010 was in the top and bottom quartiles, respectively. Columns 8 and 9 estimate the model using a subsample of cities whose level of educational attainment in 2010 was in the top and bottom quartiles, respectively. When controlling for Bachelor's Degree, the sample size is reduced due to limited data availability, although the results hold when not including educational attainment as a control.

To find out in which sectors the negative compensation effect shows up, I estimate the difference-in-differences model on levels of compensation per job in various subsectors of the local economy. Table 4 presents the regression results for the effect of community broadband on compensation in the information industry, healthcare industry, finance and insurance industry, as well as in other industries where there is not expected to be an effect, such as the manufacturing sector, food and accommodation services, and local government.

Table 4

Effect of Community Broadband Deployment on Compensation by Industry

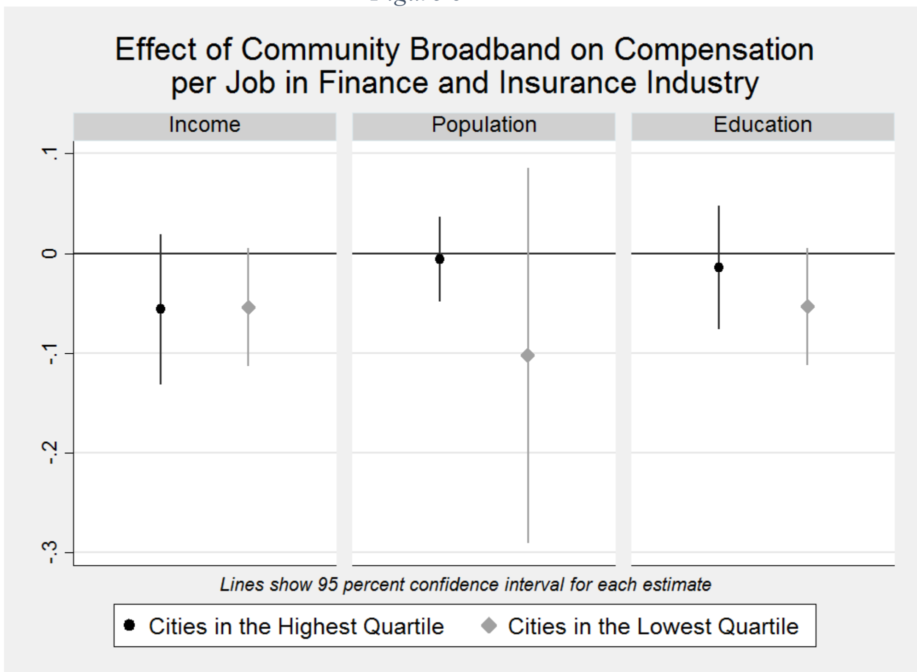
Industry:	(1) Information	(2) Healthcare	(3) Finance and Insurance	(4) Manufacturing	(5) Food Services	(6) Local Government
Network	-0.005	-0.020**	-0.0369**	-0.005	-0.012***	-0.018
	(0.013)	(0.010)	(0.0181)	(0.010)	(0.005)	(0.015)
Unemployment Rate	0.003	0.001	0.0001	-0.001	-0.001	0.001
	(0.003)	(0.001)	(0.0025)	(0.002)	(0.001)	(0.001)
Bachelor's Degree	-0.002	-0.0004	4.09e-05	-0.006	0.001	-0.001
	(0.005)	(0.002)	(0.00305)	(0.006)	(0.002)	(0.001)
White Population	1.236	-0.416	-0.0197	-0.651	-1.037**	-0.621***
	(0.845)	(0.339)	(0.571)	(0.581)	(0.489)	(0.194)
Working Age Population	0.554	0.754**	1.493**	0.679	0.989**	0.355*
	(0.773)	(0.319)	(0.737)	(0.494)	(0.494)	(0.193)
Constant	9.289***	10.43***	9.410***	11.06***	9.844***	11.07***
	(0.80)	(0.33)	(0.66)	(0.64)	(0.44)	(0.20)
Observations	3,095	2,416	3,169	3,191	3,135	2,916
R^2	0.169	0.770	0.403	0.555	0.851	0.876
Number of CBSA	798	675	805	809	797	744

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Regressions include CBSA and year fixed effects. Dependent variables are as follows: column 1 is real compensation per job in the Information sector (NAICS code 51), column 2 is real compensation per job in the Healthcare and Social Assistance sector (NAICS code 62), column 3 is real compensation per job in the Finance and Insurance sector (NAICS code 52), column 4 is real compensation per job in the Manufacturing sector (NAICS codes 31-33), column 5 is real compensation per job in the Accommodation and Food Services sector (NAICS code 72), column 6 is real compensation per job in local government.

The results in columns 2 and 3 suggest that worker pay is lower due to network deployment in industries where fast internet connections could be used to open labor markets to more competition, such as healthcare with electronic filing systems and telemedicine practices, and in finance and insurance, where the internet increases competition (Brown and Goolsbee 2002). Industry compensation analysis also leads to the interesting result that compensation in the food service industry is affected negatively by network deployment. Overall, the finance and insurance industry experiences the largest decrease in compensation, around 3.7 percent, all else being equal.

I further analyze compensation and community broadband by examining the effect in the finance and insurance industry. Figure 6 presents the measured treatment effects on finance industry compensation across the highest and lowest quartiles of income, population, and education, similar to Figure 5 above. The results indicate that community broadband reduces compensation per job in the finance industry in cities from the lowest quartiles of income and educational attainment. See Table 9 in the appendix for a complete presentation of results. Similar results hold for the healthcare industry, in which the lowest quartiles of income and education also experience a negative treatment effect.

Figure 6



The analysis of finance and insurance industry compensation does not concur with the results from compensation across all industries. Overall compensation per job is negatively affected by community broadband, especially in the highest income, most populated, and most educated cities. However, in the finance, insurance, and healthcare industries, it appears as if the opposite holds: the subset of less educated and lower income cities experience larger reductions in compensation.

While slicing up the data by industry and demographic characteristics paints a fuzzier picture than simply looking at the average effect across all cities and industries, the clear result is that worker pay is not enhanced by the arrival of community broadband.

Employment

Lastly, I examine the effect of community network deployment on the level of employment in a city. Goetz et al. (2011) find that increases in computing at work and at home positively influences employment. Therefore, community broadband should increase opportunities for employment in a city. The model is similar to the analysis of establishments and wages except that the covariates differ:

$$\ln(Employment_{it}) = \beta_0 + \beta_1 Network_{it} + X_{it}\beta_k + \mu_i + \gamma_t + \varepsilon_{it}$$

Before estimating the relationship, which in the equation is represented by β_1, I return to the previous comparison between Danville and Bluefield in Virginia. Figure 7 compares the trends in private nonfarm employment in both cities, with the dashed line representing Danville, which deployed community broadband in 2007. The figure shows that during the recession from 2007 to 2010, both cities experienced decreases in employment. But Danville begins to recover lost employment in 2011 and 2012, while Bluefield remains stagnant. Many possibilities exist as to why the two cities have had different post-recession labor market outcomes; however, regression analysis can illuminate whether or not community broadband increases the level of employment across the sample of CBSAs.

Figure 7

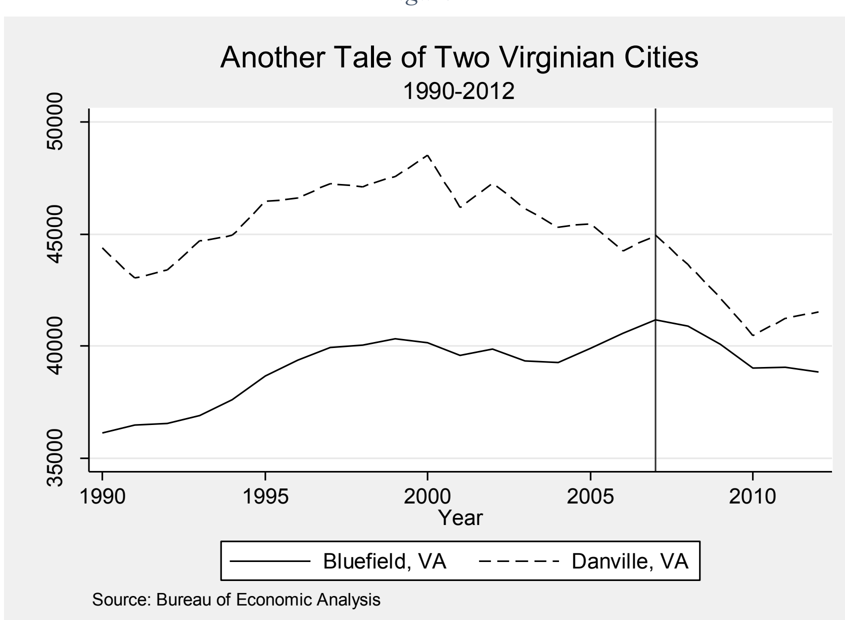


Table 5 presents the regression results, with column 1 containing OLS results and columns 2-5 containing the difference-in-differences results. OLS indicates a strong positive relationship between community broadband and employment. The results could mean that Danville's recovery in Figure 7 is experienced broadly by communities which pursue the public provision of speedy internet. However, column 2 shows that after ridding the data of time-constant unobserved heterogeneity and temporal shocks, the effect of community broadband on private nonfarm employment is statistically insignificant. Also, the effects in specific private industries are statistically insignificant.

Columns 3-5 in Table 5 present estimation results for network deployment on local government employment. When local government performs a new function, like building or running a network, it is expected that more government workers will be employed. For example, a community network may need to hire web developers, customer service representatives, and network technicians, to name just a few jobs, in addition to workers that initially lay fiber in the ground. The results show that networks increase local government employment by around 6 percent, all else being equal, and the effect is robust even when using a smaller sample in order to control for educational attainment.

Table 5

Effect of Community Broadband Deployment on Private Nonfarm Employment and Local Government Employment

	(1)	(2)	(3)	(4)	(5)
	Private Nonfarm Employment		Local Government Employment		
Network	0.415*** (0.037)	0.017 (0.018)	0.068*** (0.016)	0.063*** (0.015)	0.064*** (0.019)
Real per Capita Personal Income	1.17e-05*** (9.17e-07)			2.42e-06** (1.08e-06)	-6.97e-07 (1.11e-06)
White Population	0.233*** (0.038)			-0.435*** (0.127)	-0.786*** (0.152)

Working Age Population	1.941***			-0.243	-0.419
	(0.181)			(0.277)	(0.307)
Bachelor's Degree					0.0211***
					(0.003)
Individual Income Tax Revenue Ration	0.454***			0.39***	0.469***
	(0.040)			(0.01)	(0.132)
Constant	8.647***	10.10***	7.937***	8.285***	8.363***
	(0.09)	(0.01)	(0.004)	(0.168)	(0.202)
Observations	18,814	18,814	17,397	17,397	4,393
R-squared	0.074	0.496	0.520	0.533	0.588
CBSA FE	No	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Dependent variable for columns 1 and 2 is the natural log of private nonfarm employment. Dependent variable for columns 3-5 is the natural log of local government employment. There are 818 CBSAs in the sample in each regression.

Long-run Effect of Community Broadband

As a network expands, more businesses are connected and more residences can sign up for publicly supported internet service, sometimes receiving vastly improved bandwidth capabilities, as in Chattanooga. Therefore, it is useful to examine the long-run effects of the networks.

The possibility for long-term effects of network deployment gives rise to an alternative model specification. In the spirit of Wolfers' (2006) analysis of the dynamic response of the US divorce rate to changes in law, I examine the long-run response of establishments to network deployment because it is informative to explore which years the network deployment effect shows up in the data. The regression model has the following specification:

$$Y_{it} = \beta_0 + \beta_k Network\ has\ been\ in\ effect\ for\ k\ periods_{it} + X_{it}'\beta_m + \mu_i + \gamma_t + \varepsilon_{it}$$

The model is similar to the other difference-in-differences models except that the single dummy treatment variable becomes multiple dummy variables for each of the two years since a network deployed, top-coded at 15 years.

Table 6 presents the long-run difference-in-differences estimation results. Column 1 indicates that community broadband immediately attracts more businesses and the effect persists for around 12 years. But the long-run coefficient is negative and statistically significant which indicates that, over time, the networks lure fewer businesses. Column 2 shows that the statistically significant negative effect of community broadband on compensation is present for the first six years after network deployment. Lastly, community broadband increases the level of local government employment persistently, with a positive effect present for up to 12 years after deployment. The results make sense because as a broadband project reaches more end users, its economic impact is likely to persist.

Table 6

Long Run Effects of Community Broadband Deployment

	(1) Establishments	(2) Compensation	(3) Local Government Employment
Network deployed for:			
First Two Years	0.0231*	-0.00915***	0.0476***
	(0.0122)	(0.00333)	(0.0132)
Years 3 to 4	0.0380***	-0.0109***	0.0630***
	(0.0147)	(0.00377)	(0.0137)
Years 5 to 6	0.0337**	-0.0115**	0.0806***
	(0.0171)	(0.00457)	(0.0152)
Years 7 to 8	0.0386*	-0.0106	0.0747***
	(0.0211)	(0.00664)	(0.0219)
Years 9 to 10	0.0343*	-0.00592	0.0667**
	(0.0201)	(0.00819)	(0.0291)
Years 11 to 12	0.0501**	-0.00919	0.0731**
	(0.0215)	(0.0120)	(0.0370)
Years 13 to 14	0.00555	-0.00616	0.0480
	(0.0303)	(0.0169)	(0.0418)
Years 15+	-0.0447***	-0.0221	-0.0358
	(0.0127)	(0.0167)	(0.0665)
Unemployment Rate	0.00176	-0.00730***	
	(0.00122)	(0.000756)	
White Population	0.0826	-0.170***	-0.432***
	(0.124)	(0.0605)	(0.127)
Working Age Population	0.718**	1.143***	-0.241

	(0.296)	(0.126)	(0.277)
Real per Capita Personal Income	8.41e-06***		2.41e-06**
	(1.20e-06)		(1.08e-06)
Property Tax Revenue Ratio	-0.300***		
	(0.0790)		
Cost of Energy	0.0142***		
	(0.00333)		
Individual Income Tax Ratio			0.393***
			(0.0991)
Constant	6.680***	9.674***	8.282***
	(0.165)	(0.0929)	(0.168)
Observations	17,996	12,270	17,397
R-squared	0.535	0.983	0.534

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Dependent variable for column 1 is the natural log of business establishments. Dependent variable in column 2 is the natural log of the real average wage per job. Dependent variable for column 3 is the natural log of the number of local government employees. Regressions include fixed effects for the 818 CBSAs and year fixed effects.

6. Local Broadband Policy

The policy question remains as to whether or not government should play an active role in the local broadband market. Overall, public officials may be correct in that some cities could use fiber networks. For example, Google is building all-fiber networks in several cities across the United States. However, advocates for government involvement are suggesting that taxpayers and not shareholders, say of Google stock, should bear the uncertainty of fiber network build-outs. Some proponents go as far as to recommend that broadband should be treated as a public utility (Gustin 2013). This paper evaluates networks that already operate under the utility model, along with other forms of substantial government involvement, and shows that the economic benefits of local government expanding the internet infrastructure with fiber-optic connections is limited. Networks attract businesses, but mostly in richer small- to medium-size cities. Community network deployment also reduces compensation per job and has no effect on private sector employment, only a positive effect on local government employment.

The results do not conform to the expectations of the conventional wisdom of the literature on public infrastructure, which holds that public infrastructure investment lowers costs for businesses and spurs economic development. Instead, the limited economic benefits of community broadband would be unsurprising to scholars who maintain that an institutional environment that encourages entrepreneurship creates the positive relationship between infrastructure investment and economic growth, e.g. Holcombe (1998). In this view, physical capital is an important input into the production process, but it does not create economic growth by itself. Therefore, public investment plans that focus on end-states, such as attracting a certain business or building a fiber network, are focusing on the inputs of economic growth rather than a root cause, which could end up misallocating resources and encouraging rent-seeking[7] (Coyne and Moberg 2014). In fact, my findings that local government expands while worker pay is reduced and private nonfarm employment does not increase align with previous research by Higgins et al. (2006; 2009), which finds that the size of local government, measured by the level of government employment, is negatively correlated with economic growth. Higgins et al. suggest rolling back government's role may actually increase growth. Therefore, more private sector involvement in the provision of broadband should be fostered, especially given the dynamic nature of the broadband market, because the more radical an innovation is, the riskier it is. So while Chattanooga's network has been relatively successful, Lafayette's experience shows how costly competing with the private sector can be. Public officials had to endure political costs to launch the network in Lafayette, and the economic costs are still uncertain since they are competing directly with the private sector.

[7] Rent-seeking occurs when companies spend resources on political activities in order to obtain special privileges from government.

Market competition uses both profit and loss signals, which determine the allocation of resources. For example, when Charter Communications, a private cable provider, cut its internet service prices in Monticello, Minnesota, to attract customers from the local public competitor, FiberNet, local officials and advocates of community broadband worried about FiberNet's financial stability due to the loss of subscribers (Lasar 2012). This worry is typical of a dynamic market and private companies must deal with the consequences of not being able to satisfy customers. If a private broadband provider experiences losses and is in the red, it is a signal that sinking more money into upgrading or building-out a network is not the best use of resources. However, local governments often continue their network expansion despite the loss signals.

As seen in Utah's experience, networks are financially risky and when projects do not pan out, there may be few alternatives for the local government to sell or find a use for their network. For example, this year Macquarie Capital, part of a global investment bank, proposed to complete the UTOPIA network in Utah, but part of the plan included a fee to be added onto residents' monthly utility bills, regardless of whether or not they use the network (Macquarie Capital 2014). Five cities in the UTOPIA network already reject Macquarie's terms (Semerad 2014). These cities are still seeking other options, and meanwhile UTOPIA's fiber network remains incomplete.

For community broadband networks, taxpayers bear the uncertainty that public officials take on. On the dynamic considerations of community broadband, Ellig (2006) lays out key questions regarding pricing, identifying competitors, and dealing with rapid technological change, which are all difficult for a private ISP to answer, let alone a local government agency. Greater private involvement is the ideal way to harness the information from the profit and loss signals in a highly uncertain market. Broadband Internet has seen more technological change in a shorter amount of time than the other traditional local government services, such as gas, water, and heat. Therefore, it is misleading to classify broadband service as just another government utility (Titch 2013).

When advocates for community broadband ask critics not to judge a public network using its balance sheet figures, they are implying that another signal besides profit and loss should guide the provision of high speed internet. The broadband market may be able to use more competition and innovation, perhaps from a public competitor. But the dynamic considerations of competing in the broadband market makes the financial viability of fiber networks vital to making sure that scarce community resources are not wasted and taxpayers are not left receiving one dollar for $40 million worth of investment, as happened in Provo.

Recent private sector efforts show that worthwhile investment can be made in the nation's information infrastructure. But instead of being competed against, private sector efforts should be fostered by local government policy. Local governments can encourage broadband innovation by providing private companies with easy access to local public assets without costly regulatory hurdles and by allowing companies to pursue plans that meet demand expectations. Private network build-out requires access to publicly owned assets. When Google Fiber works with city governments, it must access the local utility poles or underground conduits to place fiber lines. It also needs to know the location of local infrastructure, such as gas lines, so that it is not damaged during network construction (Slater 2013). Also, cities often require building permits, and so the easier that process is the more resources will be spent on the network rather than trying to navigate the local regulatory requirements. The success of Google's model, which is now being implemented by AT&T and CenturyLink, has been partly due to city governments not requiring universal access to broadband, i.e. every resident must be able to connect to the network (Barr 2014). Instead, Google gauges local demand through surveys and then lays fiber in neighborhoods where sufficient demand exists.

Cities that foster private sector innovation are already experiencing the benefits of market competition. AT&T and Google have gone head-to-head in Texas and North Carolina to sign up subscribers to all-fiber networks. Their competition started in Austin, Texas, where AT&T was an incumbent ISP but Google Fiber disrupted the local market by solidifying plans to build a gigabit-speed network (Brodkin 2013). Recently, AT&T beat Google in planning a fiber network in several cities in North Carolina, beginning with Winston-Salem (Gryta 2014). Overall, AT&T says it is considering bringing gigabit networks to 21 major metropolitan areas, while Google is working on plans to roll out fiber in nine (Brodkin 2014). The biggest role for local governments is leveraging their control over key assets to help private providers lay fiber, without having to compete in a dynamic market and exposing the community to unnecessary financial risks.

7. Conclusions

This paper examines the economic impact of community broadband, and the results show that public broadband initiatives have not had a large economic impact apart from expanding the size of local government. I find that networks increase business establishments by more than 3 percent, while reducing worker income and having no effect on private employment, all else being equal. Instead of increasing private employment, networks increase local government employment by around 6 percent. Further research is needed to make sense of the employment effect in light of the increase in business establishments. Research into the size of establishments that are attracted by fiber networks could help reconcile these findings because presumably the establishments are small like startup software companies. Also, further research is needed to understand the political economy of public intervention in the broadband market. For example, local officials' political party affiliations or local governance structures could help explain where these networks occur as well as their comparative success.[8]

I do not examine a comprehensive list of economic benefits, but the private sector impact of this form of public infrastructure investment is not large enough to ignore the growth in local government and the financial stress that publicly supported broadband puts on a community. In the end, the difference between private and public sector involvement concerns who is best equipped to innovate in the broadband market and who bears the uncertainty inherent of innovation: the taxpayer or the shareholder. While some cities could use better broadband service, deploying FTTP networks without regard to the profit and loss discipline has not caused large robust economic benefits in terms of luring businesses, worker income, and employment.

[8] For example, Bradbury and Stephenson (2003) find that the number of county commissioners is positively correlated with county government expenditures.

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Appendix

Table 7 – Community Broadband Deployment Cities and Years

Core Based Statistical Area	Deployment Year
Aberdeen, WA (Micropolitan Statistical Area)	1998
Auburn, IN (Micropolitan Statistical Area)	2006
Auburn-Opelika, AL (Metropolitan Statistical Area)	2010
Baraboo, WI (Micropolitan Statistical Area)	2003
Berlin, NH-VT (Micropolitan Statistical Area)	2011
Big Stone Gap, VA (Micropolitan Statistical Area)	2004
Bowling Green, KY (Metropolitan Statistical Area)	2007
Brainerd, MN (Micropolitan Statistical Area)	2005
Bremerton-Silverdale, WA (Metropolitan Statistical Area)	2000
Brookings, SD (Micropolitan Statistical Area)	2006
Burlington-South Burlington, VT (Metropolitan Statistical Area)	2006
Champaign-Urbana, IL (Metropolitan Statistical Area)	2010
Chattanooga, TN-GA (Metropolitan Statistical Area)	2007
Claremont-Lebanon, NH-VT (Micropolitan Statistical Area)	2010
Clarksville, TN-KY (Metropolitan Statistical Area)	1999
Coldwater, MI (Micropolitan Statistical Area)	2010
Concord, NH (Micropolitan Statistical Area)	2011
Cookeville, TN (Micropolitan Statistical Area)	2004
Crawfordsville, IN (Micropolitan Statistical Area)	2006
Dalton, GA (Metropolitan Statistical Area)	2003
Danville, VA (Micropolitan Statistical Area)	2007
Deltona-Daytona Beach-Ormond Beach, FL (Metropolitan Statistical Area)	2009
Duluth, MN-WI (Metropolitan Statistical Area)	2010
Elkhart-Goshen, IN (Metropolitan Statistical Area)	2008
Fallon, NV (Micropolitan Statistical Area)	2004
Fargo, ND-MN (Metropolitan Statistical Area)	2009
Fort Smith, AR-OK (Metropolitan Statistical Area)	2004
Frankfort, KY (Micropolitan Statistical Area)	2009
Gainesville, FL (Metropolitan Statistical Area)	2001
Glenwood Springs, CO (Micropolitan Statistical Area)	2002
Greeley, CO (Metropolitan Statistical Area)	2012
Greenfield Town, MA (Micropolitan Statistical Area)	2012
Holland, MI (Micropolitan Statistical Area)	2012
Idaho Falls, ID (Metropolitan Statistical Area)	2007
Jackson, TN (Metropolitan Statistical Area)	2004
Johnson City, TN (Metropolitan Statistical Area)	2012
Keene, NH (Micropolitan Statistical Area)	2011
Kennewick-Richland, WA (Metropolitan Statistical Area)	2001
Kingsport-Bristol-Bristol, TN-VA (Metropolitan Statistical Area)	2003
Laconia, NH (Micropolitan Statistical Area)	2011
Lafayette, LA (Metropolitan Statistical Area)	2007

LaGrange, GA (Micropolitan Statistical Area)	2000
Lexington-Fayette, KY (Metropolitan Statistical Area)	2010
London, KY (Micropolitan Statistical Area)	2010
Manchester-Nashua, NH (Metropolitan Statistical Area)	2011
Marshall, MO (Micropolitan Statistical Area)	2005
Martinsville, VA (Micropolitan Statistical Area)	2009
Medford, OR (Metropolitan Statistical Area)	2000
Morristown, TN (Metropolitan Statistical Area)	2006
Moses Lake, WA (Micropolitan Statistical Area)	2000
Mount Vernon-Anacortes, WA (Metropolitan Statistical Area)	2007
Murray, KY (Micropolitan Statistical Area)	2000
New Philadelphia-Dover, OH (Micropolitan Statistical Area)	2004
Norwich-New London, CT (Metropolitan Statistical Area)	2002
Ocala, FL (Metropolitan Statistical Area)	2010
Ogden-Clearfield, UT (Metropolitan Statistical Area)	2004
Orangeburg, SC (Micropolitan Statistical Area)	2010
Ottawa-Peru, IL (Micropolitan Statistical Area)	2003
Paducah, KY-IL (Micropolitan Statistical Area)	2004
Ponca City, OK (Micropolitan Statistical Area)	2009
Port Angeles, WA (Micropolitan Statistical Area)	2002
Port St. Lucie, FL (Metropolitan Statistical Area)	2004
Provo-Orem, UT (Metropolitan Statistical Area)	2004
Reading, PA (Metropolitan Statistical Area)	2002
Rochelle, IL (Micropolitan Statistical Area)	1998
Salem, OR (Metropolitan Statistical Area)	2007
Scottsboro, AL (Micropolitan Statistical Area)	1998
Shawano, WI (Micropolitan Statistical Area)	2008
Shelton, WA (Micropolitan Statistical Area)	2000
South Bend-Mishawaka, IN-MI (Metropolitan Statistical Area)	2005
Spencer, IA (Micropolitan Statistical Area)	2007
Springfield, MO (Metropolitan Statistical Area)	2000
Sterling, IL (Micropolitan Statistical Area)	2004
Talladega-Sylacauga, AL (Micropolitan Statistical Area)	1997
Tifton, GA (Micropolitan Statistical Area)	2007
Tullahoma-Manchester, TN (Micropolitan Statistical Area)	2007
Waterloo-Cedar Falls, IA (Metropolitan Statistical Area)	2006
Wenatchee, WA (Metropolitan Statistical Area)	1999
Wilson, NC (Micropolitan Statistical Area)	2008
Worthington, MN (Micropolitan Statistical Area)	2010

Table 8 – Data and Sources

Variable and Coverage Years if not 1990-2012	Source
Network Indicator	Broadband Communities
Total Establishments	Bureau of Labor Statistics, Quarterly Census of Employment and Wages
Real Compensation per Job, 1998-2012	Bureau of Economic Analysis
Real Compensation per Job, Information Industry, 2001-2012	
Real Compensation per Job, Health and Social Assistance Industry, 2001-2012	
Real Compensation per Job, Finance and Insurance Industry, 2001-2012	
Real Compensation per Job, Manufacturing Industry, 2001-2012	
Real Compensation per Job, Food and Accommodation Services Industry, 2001-2012	
Real Compensation per Job, Local Government, 2001-2012	
Private Nonfarm Employment	
Local Government Employment	
Unemployment Rate	Bureau of Labor Statistics, Local Area Unemployment Statistics
Proportion of Population, Race is White Alone	Census Bureau, American Community Survey
Proportion of Population, Aged 25 to 64 years	Bureau of Economic Analysis
Real per Capita Personal Income	
Proportion of Population 25 Years or Older, with Bachelor's Degree or Higher, 1990, 2000, 2009-2012	Census Bureau, American Community Survey
Proportion of State Tax Revenue from Property Taxes	Census Bureau
Proportion of State Tax Revenue from Individual Income Taxes	
State Average Total Energy Price, Dollars per Million BTU, 1990-2011	US Energy Information Administration

Table 9

Effect of Community Broadband Deployment on Compensation in the Finance and Insurance Industry

	(1) Top Income Quartile	(2) Bottom Income Quartile	(3) Top Education Quartile	(4) Bottom Education Quartile
Network	-0.056	-0.054*	-0.014	-0.053*
	(0.038)	(0 .030)	(0.032)	(0.030)
Unemployment Rate	-0.030***	-0.010***	-0.022***	-0.011***
	(0.007)	(0.003)	(0.005)	(0.003)
White Population	1.164**	0.725	1.433*	0.516
	(0.532)	(0.601)	(0.727)	(0.530)
Working Age Population	3.286***	0.237	2.10***	0.927
	(0.632)	(0.657)	(0.67)	(0.774)
Constant	7.35***	9.277***	7.82***	9.040***
	(0.50)	(0.642)	(0.70)	(0.644)
Observations	2,415	2,356	2,446	2,370
R^2	0.667	0.621	0.691	0.634
Number of CBSA	205	204	205	201

Notes. Robust Standard Errors are in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10%, respectively. Regressions include CBSA and year fixed effects. Dependent variable is real compensation per job in the Finance and Insurance sector (NAICS code 52). Columns 1 and 2 estimate the model using a subsample of cities whose level of real per capita personal income in 2010 was in the top and bottom quartiles, respectively. Columns 3 and 4 estimate the model using a subsample of cities whose level of educational attainment in 2010 was in the top and bottom quartiles, respectively.