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Predictive models to measure the impact of fiber-optic broadband speeds on local towns and communities

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ABSTRACT

Internet availability and speed can impact a local community's education, healthcare, safety, and economic development. Currently, there are few, if any, formal analyses to help communities make informed decisions on investments in internet and bandwidth expansion. This is in spite of the longstanding view posited by economic policy researchers that certain public infrastructure investments must be analyzed on a local government basis. Here, we adopt the local community focus and combine data from local, state and federal sources to develop models that predict the impacts of fiber-optic bandwidth expansion on economic factors for individual towns and communities. Our predictive analysis also demonstrates differing impacts related to town size and yields interesting outcomes related to local geographies. The rankings and comparisons derived from our predictive methodology can be used by town and state planners to holistically plan internet infrastructure development across localities. Our modeling approach can be applied to develop models specific to other towns and communities facing similar decisions regarding investments in internet speed.

1. Introduction

Currently, towns and localities (across the United States and other countries) have very different internet availability and speed. For example, Austin, Texas, enjoys 1 Gigabit/s (Gbps) download speed and Woolcott, Connecticut offers 12 Megabit/s (Mbps). At the same time, Chinle and Fort Defiance in Arizona have only 1.5 Mbps average download speed (Connecticut by the Numbers, 2014). Snyder (2015) and CTC Technology and Energy (2016) found that towns also differ significantly in broadband pricing. AT&T and Google Fiber both charge customers $70/month for 1 Gigabit/s (Gbps) speed in Charlotte, North Carolina, while AT&T charges $110/month for the same 1 Gbps speed in Chicago, where Google Fiber is not present. The same 1 Gbps speed is significantly more costly in Connecticut (around $1000-$2000 per month).

Broadband has become an integral part of today's telecommunication service (Grubesic and Murray, 2004). Faster broadband speed can have a significant impact on the economic growth of a community, and the demand for more advanced, reliable, and affordable broadband is compelling local governments to develop effective strategies for connecting their citizens, businesses, and institutions (Vallee, 2015). Broadband availability is fairly widespread but enhanced connectivity (increased speed and reliability)

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comes with significant upfront costs. Before committing to these expenses, and perhaps signing up for 25–30 year amortized loans, local governments need to understand the net added value (or loss) of their decision.

1.1. Theoretical background

The approach and analysis presented in this paper are grounded in the public choice literature on public infrastructure investment. This includes prior work in this area, such as Haughwout (2002) who emphasized the significant marginal benefits of public capital and drew attention to the importance of local normative elements in infrastructure decision-making. Haughwout and Inman (2001) emphasized local investigation of such issues, using a single city analysis. Other authors including Pereira (2000) emphasized the two-way link between pre-investment tax base/revenue and post infrastructure investment tax base/revenue. Agénor (2010), in his analysis of infrastructure-led development, raised the importance of network effects.

In many jurisdictions, decisions on broadband infrastructure investment are made at the local level (Grubesic, 2006; Blake, 2017). Hence there is a need to identify the benefits to broadband at the local level so that local decision makers (such as town planners) can make informed decisions based on estimated benefits that can be compared to costs determined by broadband providers. Our work, therefore, focuses on the local level infrastructure decision following the general theoretical guidelines provided by prior work in public choice.

1.2. Research questions

In this work, we seek to evaluate economic benefits of possible internet bandwidth expansion decisions at local town level by taking a data-driven predictive modeling approach. The main goals of this study include: i) estimating changes in various economic factors brought about by increased broadband speeds, on a town by town basis; ii) creating an index, for possible policy purposes, to rank towns on likely positive economic impacts; and iii) identifying towns based on the index values that will benefit the most (have the largest positive gains on the economic measures) from increased broadband speed.

Our focus in this study is centered entirely on the economic benefits. Since installation costs can vary significantly by location, we leave it to fiber optic installation vendors to provide the necessary cost estimate information for the towns' analyses (O'Leary, 2015). Traditionally, broadband market has been very non-competitive and monopolies exist there (Brodkin, 2014, 2016). However, there is a continuous push from government for broadband in rural areas, despite the fact that the broadband market is non-competitive, and providing broadband in rural areas may not be profitable for the providers (Perdue, 2018). Rural cooperatives are also working to bring broadband to communities, and it is essential for them to identify potential rural areas for broadband infrastructure development (Trostle, 2017). Therefore, as a first step of broadband expansion process, our model and results will help a town to understand its gains due to speed increases. A better understanding of the benefits to towns may help to inform policymaking on broadband expansion. Our data-driven analysis is the first attempt in the literature that enables towns to quantify the economic benefit.

We demonstrate our approach using towns in the state of Connecticut, USA. We use data on broadband penetration, number of broadband facility providers, download and upload speed, economic, geographic, and demographic variables of all towns in CT from 2008 to 2013. Our data collection utilized the following ten sources: i) Federal Communications Commission (FCC); ii) National Broadband Map (NBM); iii) U.S. Census Bureau; iv) Connecticut Department of Labor; v) Office of Policy and Management, CT; vi) Connecticut Economic Resources Center (CERC); vii) Department of Economic and Community Development, CT; viii) Broadbandnow (Reese, 2016); ix) Missouri Census Data Center; and x) American Community Survey (ACS).

Elements of the data were originally collected by different agencies for their own reporting purposes and were available at different levels of granularity. Some data were reported at a granular census tract level, some at the more aggregated zip code level, and some at the even more highly aggregated town level. On the time dimension, some data are monthly while others are yearly. Integrating and combining data from various sources posed a significant challenge. The resulting data combination, however, increased the richness and information breadth of the data, which is a common feature of Big Data research. Our modeling approach can be applied to develop models specific to other towns and communities facing similar decisions regarding investments in internet connectivity and speed.

2. Literature review

Previous work demonstrated that broadband deployment has a significant impact on employment and the economy. Pociask (2002) showed that broadband deployment yields both employment growth and business benefits. Shideler et al. (2007) showed a positive relationship between broadband deployment and employment in their analysis of industrial sectors in Kentucky. Jayakar and Park (2013) estimated a positive association between broadband deployment and employment utilizing U.S. county-level data.

A few papers considered specific aspects of broadband deployment. Galloway (2007) studied broadband access and the rural economy and showed that broadband investment is of no use unless there is business infrastructure development in the local rural area. Rodrigo et al. (2013) found that broadband had a negative impact on students' exam scores irrespective of gender, subject, or school quality.

Though several papers showed that broadband deployment and access have economic impacts on the society, including employment, there has been very limited research on whether similar effects hold for increased internet speed. Using country-level data, Kongaut and Bohlin (2014) argued that broadband speed had a significant impact on a country's GDP with the impact being greater