THE OHIO STATE UNIVERSITY

C. William Swank Program in Rural-Urban Policy

CONNECTING THE DOTS OF OHIO'S BROADBAND POLICY

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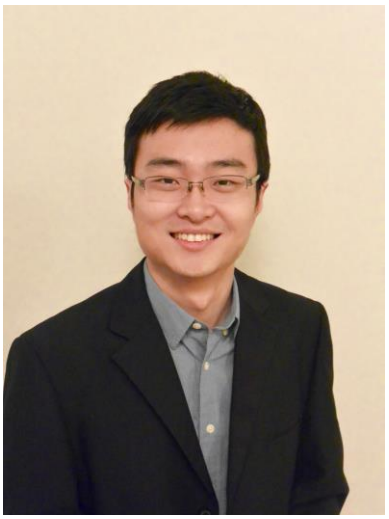

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About the C. William Swank Program on Rural-Urban Policy

The C. William Swank Program in Rural-Urban Policy is a nationally and internationally recognized research and outreach program focused on priority issues related to rural and urban communities and their growth and prosperity.

Led by Professor Mark Partridge, the Swank Program combines innovative approaches in economic theory, planning, advanced statistical research, and geographical information systems to create products that can be used by the academic community, stakeholders, policymakers, students, and the public. In turn, the Swank Program will help inform and facilitate teaching and student research at Ohio State and elsewhere.

The Swank Program conducts and supports research, teaching, and outreach within the College of Food, Agricultural, and Environmental Sciences; the Ohio Agricultural Research and Development Center; and Ohio State University Extension.

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Executive Summary

The internet continues to link itself to nearly every aspect of our daily lives: business, news, entertainment, communication, shopping, and education, just to name a few. The incredible benefits offered by information technologies have led individuals, businesses, and public institutions to become more reliant on the internet. As this transformation in how we communicate and do business has occurred, access to reliable internet has become a necessity for individuals and businesses.

Great progress has been made to achieve near universal access to broadband internet. Ninety percent of the US population and 92 percent of Ohioans already have access to internet services that meet the Federal Communications Commission's (FCC) minimum broadband speeds of 25 Mbps download/3 Mbps upload. Yet, **more than 1 million Ohioans still lack the access to fast, reliable broadband services in their homes. This un-served population largely lives in less populated rural regions of the state where it is prohibitively expensive for internet service providers to extend service.**

Bridging this digital divide and extending access to under-served areas of the state will likely require a focused state effort. Fortunately, Ohio itself offers an excellent model for the effect that public leadership can have on building a high-tech internet backbone. The Ohio Department of High Education's OARnet has built a robust fiber-optic backbone spanning the entire state serving public institutions, research centers, and high tech companies. Expanded in recent years with stimulus funds from the American Recovery and Reinvestment Act, Ohio now has more fiber optic lines per capita than any state in the country.

There is a strong economic case for the state investing in expanding coverage in unserved areas of the state. Significant economic benefits are produced when households are able to access a broader range of products and services at lower prices. Economists have estimated the average consumer benefits of broadband access to be between $1,500 and $2,200 per year. Using these estimates and data on the unserved population in Ohio, **we conservatively estimate that reaching full broadband coverage today would generate between $1 billion and $2 billion in economic benefits over the next 15 years.** This estimate does not include other potential benefits that broadband offers such as reducing the period of unemployment among job seekers.

The public case for investment in broadband expansion often focuses on job creation and economic development benefits. Our review of the economic research finds that broadband's contribution to economic development in rural regions is often overstated. Broadband expansion does produce positive economic effects in certain rural areas, specifically more populated rural counties adjacent to metro areas. Surprisingly, research has found that that broadband expansion can actually result in job loss in low skilled, low population areas. Policymakers should be aware of these effects when creating broadband expansion policies, and couple such policies with broader economic development strategies supporting entrepreneurship and skills development, such as Connect Ohio's Digital Works program.

Broadband policy is complicated. It is composed of a mix of policies, regulations, and programs at the federal, state, and local levels. Effective broadband policy should aim to create a cohesive plan for aligning these various efforts targeted towards expanding broadband access at the lowest possible costs. Ohio has a great opportunity to strengthen its broadband policy to build on its past success.

We recommend that the state consider the following policies to accelerate the expansion of broadband services while minimizing public costs:

- Establish a state broadband office to coordinate the many state agencies that contribute to broadband utilization and expansion.
- Adopt a state "dig once" policy to leverage non-broadband infrastructure projects and reduce the costs of broadband expansion.
- Strengthen public-private partnerships so that public infrastructure can be effectively used to expand broadband access without creating anti-competitive conditions.
- Establish a broadband investment fund to finance infrastructure required to reach un-served populations.
- Promote the development of local government policies that facilitate last-mile broadband provision.

Introduction

The internet continues to enmesh itself into nearly all aspects of daily life: business, socializing, education, entertainment, news, art, and government. The list could go on-and-on. It is widely agreed upon that having high-speed internet access is becoming an essential utility for almost all households and businesses to participate in our economic, cultural, and public institutions.

For these reasons, there has been a growing focus on the "haves" and "have nots" of high-speed broadband. While there has been remarkable progress building the infrastructure to provide broadband service to 90 percent of Americans, 10 million people and nearly 1 million Ohioans do not yet have access to high-speed internet. As new internet services are created each day, the digital divide, and the potential costs of not having access continue to grow.

Those who advocate for aggressive public broadband policies often speak to the success of programs aimed at bringing electricity or telephone service to remote and rural parts of the country. There are some similarities between these historical experiences and the challenges of bridging the digital divide, but broadband has some unique features that introduce significant complexities to policymaking. First, broadband is not an entirely new infrastructure, and most service is delivered over existing or modified copper telephone or cable TV wires. As a result, these legacy systems and past investments need to be incorporated into broadband policy. Second, "broadband" is not a single technology, but encompasses a range of existing wired and wireless technologies, and likely technologies that have yet to be invented. This creates a challenge in creating policy which is technology agnostic. Finally, broadband development has largely been driven by market competition, with several providers and technologies competing for customers in an area. This creates a challenge in developing policy that preserves this competitive environment.

Recognizing these complexities, this analysis aims to make three contributions to Ohio's broadband policy. We begin by describing the current broadband environment nationally and in Ohio, focusing on the geographic patterns of broadband access and broadband adoption. Second, we provide an analysis of the existing economics literature on the benefits of broadband. Third, we describe the existing policy infrastructure at the federal and state levels, and finally we offer some concluding remarks and recommendations on ways of strengthening Ohio's broadband access.

Defining Broadband

As the internet has developed, "broadband" has emerged as the marketing terminology used to refer to high-speed internet access. Yet, the term also has a specific technical definition. The official definition of broadband is established the by the Federal Communications Commission (FCC). In the early years of the internet, the FCC defined broadband as a service that was always on and faster than dial-up internet. As the internet has evolved, the requirements for reliable internet service have changed. In 2010, the FCC gave broadband a formal definition as service with download speeds of at least 4Mbps (megabits per second) and upload speeds of at least 1Mbps. In 2015, in recognition of how rapidly the demands of the internet are evolving, the FCC more than quadrupled the definition of broadband to download speeds of 25Mbps and upload speeds of 3Mbps.

Today, many different technologies deliver broadband services. The most common technologies are fixed, wired broadband services that use legacy infrastructure. These services include DSL—delivered over copper wires by

traditional landline telephone companies—and cable—delivered over coaxial cable by cable TV providers. These technologies account for nearly 70 percent of all household internet subscriptions (Table 1). Today, fiber optic connections are the emerging fixed, wired broadband technology. Fiber optic lines transmit data by pulsating light through insulated glass tubes, allowing for superfast data transfers. Given that fiber optic networks require new infrastructure, companies with legacy technologies do not necessarily enjoy the same advantage, and the fiber optic market has presented opportunities for both telephone and cable companies, as well as new entrants such as Google, small providers, and even municipalities. Fiber optic technology provides the ability to transmit massive amounts of data at superfast speeds, and it is future-proof in regards to growing demands for higher speed internet connections. Demand for fiber optic connections are growing among businesses and consumers, and in 2015 accounted for 8 percent of household internet connections.

The next most common form of broadband connection is mobile broadband, delivered via cell phone towers to smart phones and other mobile devices. The rapid rise of smart phone use in recent years has led 50 percent of US households to purchase a mobile broadband subscription (Table 1). The fastest mobile broadband service—4G—averages 15 mbps to 20 mbps. While the current 4G mobile broadband technology does not technically qualify as broadband under the FCC's most recent definition, it is sometimes faster than the fastest fixed internet options in rural areas, and at least currently, provides suitable speeds for browsing the internet and streaming online media. A significant difference between fixed and mobile broadband systems is that mobile broadband is limited by the capacity of the system, which can cause performance issues for users that are much less common with fixed broadband technologies. As a result, mobile broadband plans tend to utilize a pricing structure that places a cap on usage or charge a high premium above a defined usage level. Fixed broadband technologies are not as sensitive to capacity issues, and fixed broadband plans typically allow for unlimited usage.

Between fixed broadband and mobile broadband sits fixed-wireless broadband technology. Fixed wireless systems broadcast high-speed internet using radio frequencies to users in a defined area. Customers receive the broadband service using a fixed antenna connected to a router similar to those found in DSL or cable connections. Fixed wireless systems are able to broadcast super-high speed internet connections as fast as fiber optic connections. Recently, fixed wireless has been recognized for its potential to bridge the "last mile" in areas that lack fixed broadband infrastructure. Yet, fixed wireless has its own limitations. Fixed wireless systems require a line-of-sight connection between the broadcast radio and the customer's receiver. This line-of-sight connection can be difficult in hilly areas, and anything in the air like rain or haze can create interference.

For the remainder of this analysis, we will refer to fixed, wired broadband technologies as fixed broadband, mobile broadband as mobile broadband, and fixed wireless broadband as fixed wireless broadband.

Table 1. Presence and Types of Household Internet Subscription, US - 2015

	Households	Percent
With an Internet subscription	91,313,308	100%
Dial-up alone	667,676	1%
DSL	14,786,484	16%
Cable modem	48,444,157	53%
Fiber-optic	7,515,585	8%
Satellite Internet service	3,356,018	4%
Two or more fixed broadband types, or other	9,329,597	10%
Mobile broadband alone or with dialup	7,213,791	8%
Total Mobile Broadband	45,031,832	50%
Total Fixed Broadband	45,613,800	50%

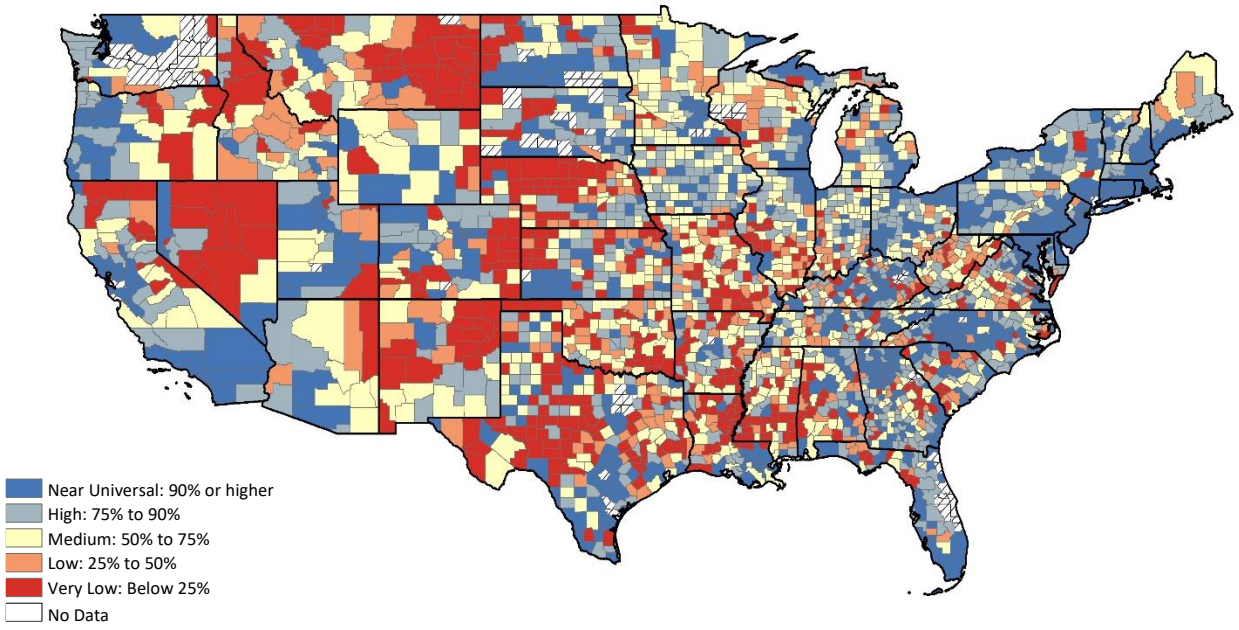
Source: American Community Survey 2015, 1-Year Estimates.

Broadband Accessibility & Adoption

Broadband in the US

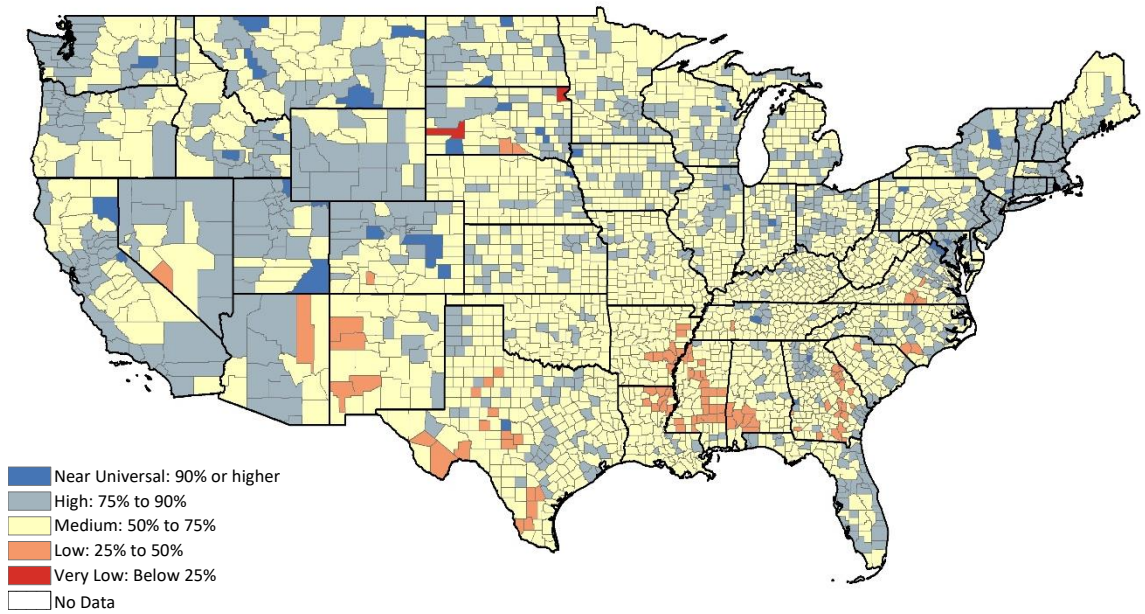
The growing demand for broadband internet has led to a rapid expansion of broadband services in the US. In 2015, 90 percent of the US population had access to broadband service of at least 25Mbps/3Mbps. Yet, there are still more than 10 million Americans that do not have any access to fixed broadband services. The digital divide between those with and without broadband access is drawn along urban and rural lines (Figure 1). Only 61 percent of the population living in rural areas has access to fixed broadband services, compared to 96 percent in urban areas, putting many rural areas at risk for lacking what is increasingly a necessity.

Figure 1. Share of the Population with Access to Fixed Broadband, 2015



Source: Federal Communications Commission (Americans Without Access to Fixed Advanced Telecommunications Capability by County)

Figure 2. Share of Households with a Broadband Internet Subscription, 2015



Source: American Community Survey 2015, 1-Year Estimates. County data converted from American Community Survey PUMAs data using Geographic Correspondence Engine.

According to the American Community Survey, more than 77 percent of US households subscribed to broadband service in 2015. Figure 2 shows the share of households with a broadband subscription. The map shows that the subscription rates in the majority of the country are between 50 percent and 75 percent. While fixed broadband service access has reached 90 percent of the population or greater in many areas of the country, only a handful of counties in the US have a subscription rate at that level.

Several factors have been identified as driving current broadband adoption rates. Senior citizens 65 years and older only have a 67 percent broadband adoption rate, compared with an 83 percent rate among people aged 18 to 64 in 2015. Education is also associated with higher rates of broadband adoption. In 2015, people with at least a college degree have a 92 percent adoption rate, while only 56 percent of those with less than a high school degree purchased broadband service. Different ethnic groups also show different broadband adoption rates. Asians recorded the highest subscription rate of 91 percent, compared with whites at 82 percent, Hispanics at 75 percent, and African Americans at 70 percent. Additionally, household income is an important factor in determining broadband adoption. As shown in Table 2, households with annual income of more than $75,000 are almost twice as likely to have a broadband internet subscription than households with income lower than $10,000

Table 2. Percentage of Households with Broadband Internet by Income Level, 2015

Household Income	Percentage of Household w/ Broadband
All Households	77%
Less than $10,000:	48%
$10,000 to $19,999:	49%
$20,000 to $34,999:	63%
$35,000 to $49,999:	75%
$50,000 to $74,999:	83%
$75,000 or more:	92%

Source: American Community Survey 2015, 1-Year Estimates.

Of those who do not subscribe to broadband service, fundamental disinterest in using the internet is a major driver of choosing to forgo broadband. A 2011 survey of more than 15,000 households found that nearly two-thirds reported that they would not purchase broadband service at any price (Carare, 2015). These households reported non-price barriers to utilization like lack of computer equipment, computer literacy, or fear of internet crime.

A close comparison of Figure 1 and Figure 2 sheds light on some of the issues that can arise when comparing broadband data from different sources. Focusing on Figure 2 gives the impression that the divide between urban and rural broadband adoption is much less severe than the sharp divide in broadband access in Figure 1. Furthermore, there are areas in Figure 2 that have significantly higher levels of broadband adoption than the level of broadband access in Figure 1, a seemingly confusing result. These differences result from the methodologies used by the FCC and the American Community Survey (ACS) to measure broadband. The FCC

data used in Figure 1 measures actual fixed broadband speeds in an area based on reports from broadband providers. The ACS data used in Figure 2 is based on surveys of households which ask about fixed and mobile internet subscriptions.

The ACS potentially over-counts broadband adoption in rural areas in two ways. When reporting the household broadband subscription rate, both fixed and mobile subscriptions are included. As we noted in the previous section, mobile broadband and fixed broadband services are not perfect substitutes. While mobile broadband is suitable for many internet activities such as checking social media, reading the news, or streaming videos, it does not offer the speed and reliability of fixed broadband. Most mobile broadband subscribers access the internet through mobile phone devices, which can limit usability. Thus, one should be careful about equating a household that only has access to mobile broadband to a household with fixed broadband.

The second way the ACS potentially over-counts adoption in rural areas arises from its survey process. Households are asked about the type of internet connection in the house. When DSL, cable, or fiber are reported, the household is considered to have fixed broadband. Yet, 20 percent of the rural population has access to DSL or cable services that greatly lag the FCC definition of broadband (FCC). Equating subscribers with DSL speeds of 4Mbps to subscribers with speeds of 25Mbps can lead to understating the broadband divide. Given that broadband can have a general meaning—internet that is always on and faster than dial-up—and a technical meaning—25Mbps/3Mbps—it is critical to consider how broadband is measured when making comparisons across data sources.

Broadband in Ohio

In several key ways, Ohio has distinguished itself as a regional leader in broadband. Ninety-two percent of Ohio's population has access to fixed broadband service, slightly higher than the national rate, and the second highest rate among its neighboring states. (Table 3).

Table 3. Broadband Access by State

	All Areas		Urban Areas		Rural Areas	
	% Pop with Access	Pop/Sq. Mile	% Pop With Access	Pop/Sq. Mile	% Pop With Access	Pop/Sq. Mile
Ohio	**92%**	**284**	**98%**	**2,060**	**69%**	**68**
Pennsylvania	94%	288	97%	2,162	80%	67
Kentucky	84%	113	97%	1,877	66%	47
Michigan	88%	174	97%	2,037	63%	46
Indiana	83%	185	95%	1,933	48%	52
United States	90%	92	96%	2,437	61%	17

Source: FCC

One reason for Ohio's high broadband accessibility in urban areas is OARnet, one of the most advanced broadband backbone systems in the country. Led by the Ohio Department of Higher Education, the OARnet project was established in the 1990s as an effort to link Ohio's colleges and libraries to the internet. Over time,

the effort has expanded, and it now provides services to other anchor institutions like public schools, local government, and hospitals. The state has made significant investments in the OARnet system, replacing copper wire with an advanced fiber optic network. Today, OARnet offers speeds up to 100Gbps (Gigabits per second). The American Reinvestment and Recovery Act (ARRA) further expanded OARnet by providing grant money to support the public-private Ohio Middle Mile Consortium (OMMC) to extend the existing OARnet infrastructure. This project helped to build an open-access middle-mile fiber network throughout unserved and underserved areas of the state, focusing on connecting community anchor institutions like hospitals schools, public safety, and local governments. Ohio now has more fiber optic lines per capita than any other state (OARnet).

Still, there are significant gaps that remain in Ohio's broadband network. Nearly 1 million Ohioans still lack access to fixed broadband service. Like the rest of the nation, these unserved or underserved areas tend to be rural, where 24 percent of the population do not have access to fixed broadband (Figure 3). Table 3 compares Ohio's rural broadband access and population density with neighboring states. This comparison clearly shows the expected relationship between population density and broadband access, with lower density rural areas having less access. Using population density as a point of comparison, Ohio appears to be significantly lagging in rural broadband access, with rates similar to states with much lower rural density. Pennsylvania and Ohio have almost identical population densities in rural areas, yet, Ohio lags Pennsylvania rural broadband access rates by 11 percentage points.

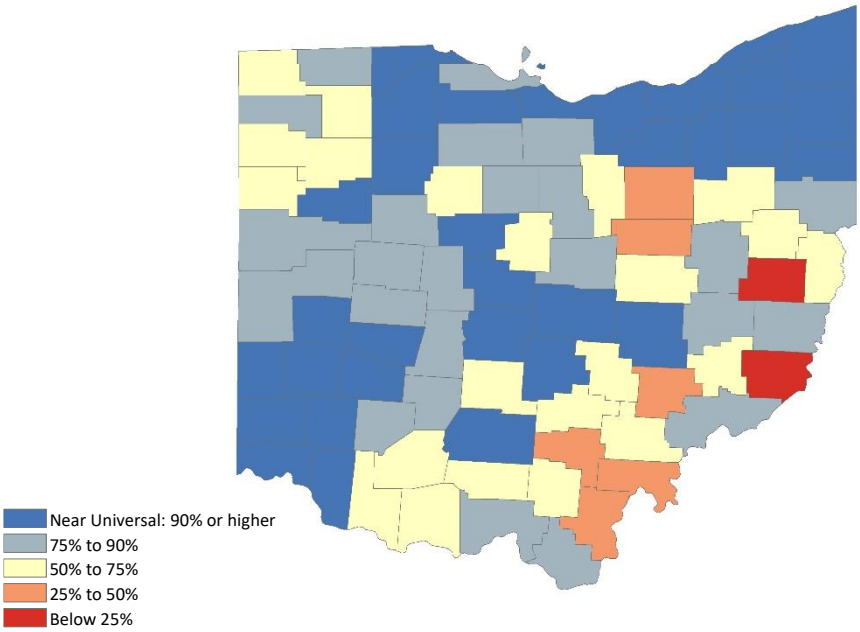
Ohio lags the rest of the country but leads its neighbors in broadband adoption (Table 4). Ohio reflects the rest of the nation with a clear divide in urban and rural broadband adoption depicted in Figure 4. Yet, a closer look at subscription rates using data at the PUMAs level (Public Use Microdata Areas) in Figure 4 shows significant heterogeneity within major metropolitan areas. In Ohio's metropolitan areas where fixed broadband access is near universal, broadband adoption within the metro area ranges from over 90 percent to less than 60 percent.

Table 4. Share of Households with a Broadband Subscription, 2015

Ohio	**76%**
Pennsylvania	76%
Michigan	74%
Indiana	73%
Kentucky	72%
United States	77%

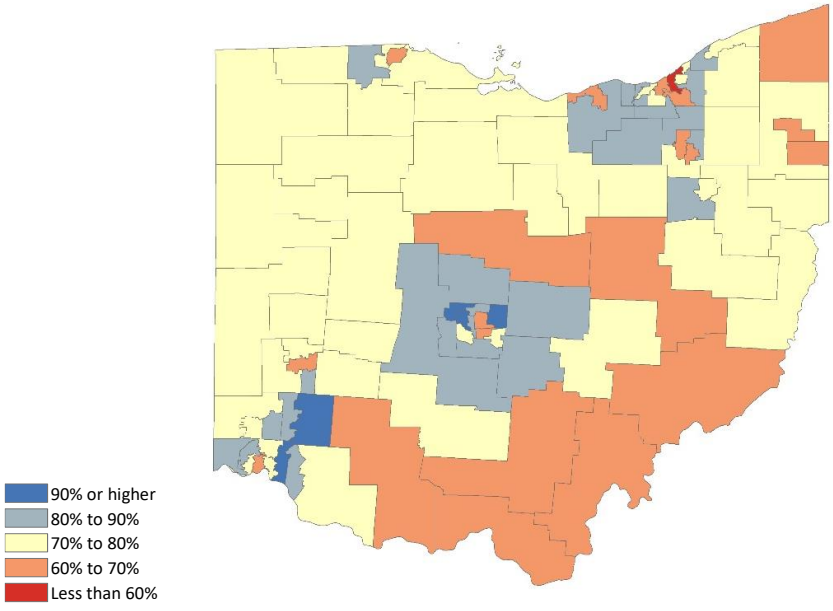
Source: American Community Survey

Figure 3. Percentage of Population with Access to Fixed Broadband, Ohio Counties - 2015



Source: Federal Communications Commission (Americans Without Access to Fixed Advanced Telecommunications Capability by County)

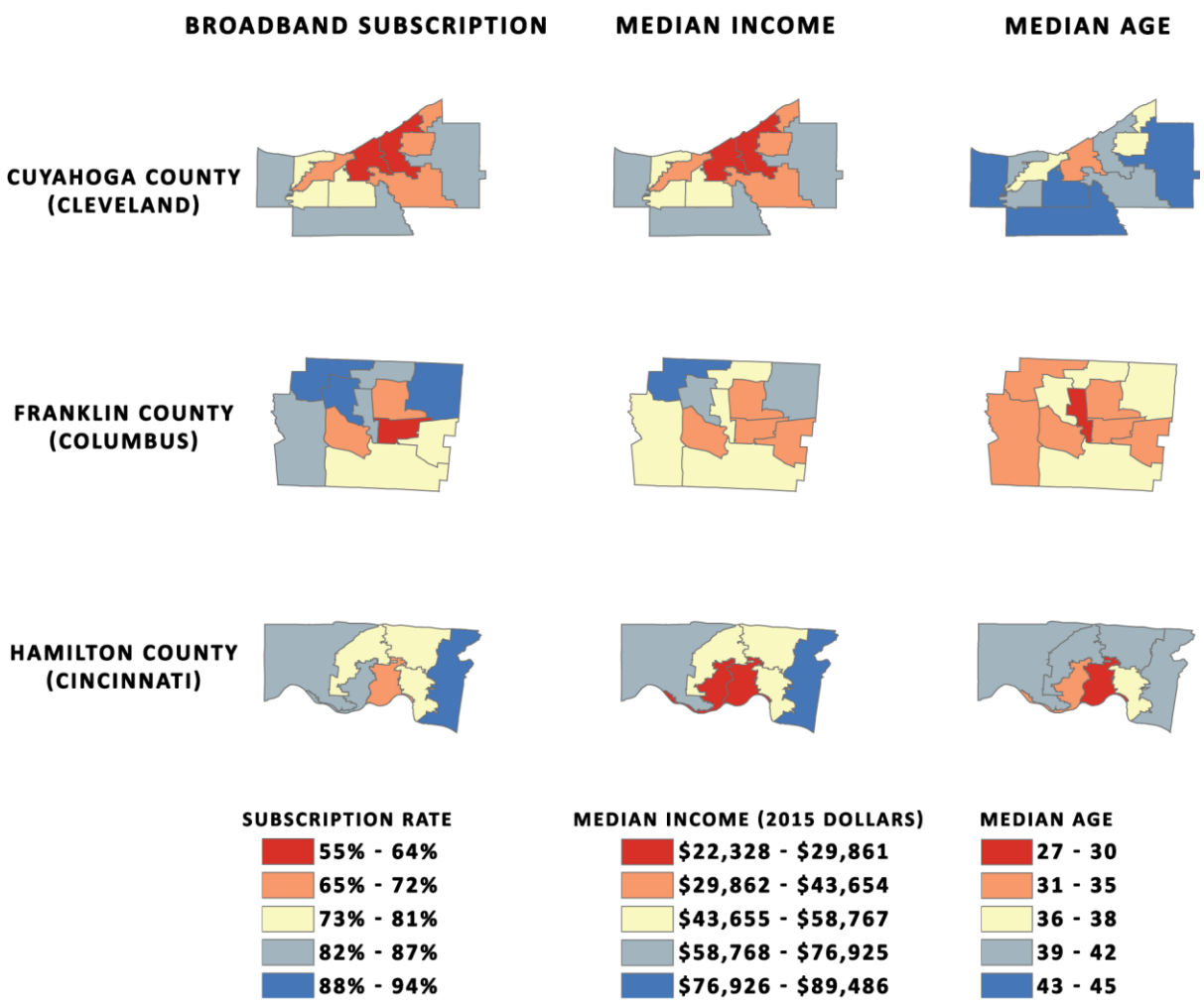
Figure 4. Share of Households with a Broadband Internet Subscription, Ohio PUMAs - 2015



Source: American Community Survey 2015, 1-Year Estimates.

Figure 5 compares broadband subscription rates within the PUMAs of Ohio's three largest cities with median income and median age. These maps show the range of broadband adoption across neighborhoods in each city. The maps suggest that broadband adoption is highest in Cincinnati, followed by Columbus, with the lowest level of adoption in Cleveland. A clear pattern emerges which suggests a close relationship between income and broadband adoption. The same pattern does not appear when comparing broadband adoption and median age, suggesting that income is a much stronger determinant of broadband adoption than age. While broadband expansion should be a priority for the state, these maps of areas with near universal broadband coverage show that there are significant opportunities to grow broadband adoption.

Figure 5. Broadband Subscription Rate, Median Income and Median Age by PUMA, 2015



Source: American Community Survey 2015, 1-Year Estimates.

The Economic Benefits of Broadband

Taking stock of the economic gains from broadband expansion is critical to developing policies that maximize benefits and minimize costs. While broadband expansion policies are often couched in the context of job creation and economic development in rural areas, there are other mechanisms through which broadband affects consumers, businesses, and workers. Looking to the economics literature, we offer an analysis of the potential economic gains that can be achieved through broadband expansion, and the sources that are likely to produce these gains.

Consumer Benefits

The internet has unlocked countless new benefits for consumers. The internet has dramatically increased the variety of products and services, and promoted competition among businesses. From shopping, to entertainment, to building community, the internet has helped consumers connect with innovative goods and services, and familiar goods and services at a lower cost. Access to quality internet is increasingly a necessity for a family or business.

The growth of broadband has generated significant consumer benefits. One way to consider these benefits is to look at the savings consumers receive through increased information and competition among sellers online. While estimating this amount is challenging, a few attempts have been made. The Internet Innovation Alliance—a broadband advocacy organization—estimated that in 2015, an average consumer could have realized more than $9,000 in savings from groceries ($508), housing ($3,574), apparel ($828), news ($130), entertainment ($3,629), and health insurance ($447) by maximizing the discounts and low cost services available only online (IIA, 2016). While these estimates represent extreme cases, they suggest that households can achieve significant savings using the internet that may not be available to non-internet users. Using a more conservative approach, the UK government estimated in 2014 that the average household saved £560 per year from shopping and paying bills online (Government Digital Inclusion Strategy, 2014).

While the internet can offer consumers greater convenience and more opportunities to save money when shopping online, these savings are less likely to benefit low-income people who need them most. As noted in Table 5, low-income households in Ohio are less likely to have the internet at home, and research has found that low-income shoppers are much more likely to weigh the risks of online shopping (identity and credit card theft), and much less likely to see the benefits. The trend is reversed for high-income shoppers who are much more likely to focus on the benefits of online shopping, and express fewer concerns about risks (Horrigan, 2008).

Table 5. Share of Ohio Households with a Broadband Subscription by Income - 2015

	Share of households with broadband
All Households	76%
Less than $20,000:	49%
$20,000 to $74,999:	75%
$75,000 or more:	93%

Source: American Community Survey

A second approach to measuring the benefits to consumers is to determine the implied value of broadband by considering what a consumer would be willing to pay for service compared to what they are actually paying, often referred to by economists as consumer surplus. As the price of internet service has fallen, and the value to consumers has risen, consumer surplus has grown. Dutz et al. (2009) estimated consumer surplus from home broadband use to be about $500 per subscriber in 2008. Using a similar approach but adjusting for the increase in broadband quality and speed over time, Greenstein and McDevitt (2012) estimate a consumer surplus of $1,500 per US broadband subscriber.

These values help to provide an estimate for the economic value generated by providing broadband access to those who do not already have it, and while they are non-trivial, the US actually lags many other developed countries. It is estimated that the quality adjusted consumer surplus for broadband subscribers in the UK in 2010 was more than $2,600, and in the Netherlands more than $22,000. The significant gains in consumer surplus in the UK and Netherlands largely reflect the rapid decline in broadband price and increase in speed relative to the US, driven by increased competition resulting from local loop unbundling.

Economic Development

Proponents of broadband often argue that broadband is now an essential utility like roads or sewers, and thus plays a critical role in economic development. This argument is especially made in lagging, rural regions, where broadband access is limited and it is seen as a tool for attracting companies, helping existing companies grow, and spurring entrepreneurship.

However, it is not obvious that expanding broadband to rural regions will necessarily have positive effects on competitiveness and economic growth. While broadband access can expand the market for rural firms and provide access to urban consumers, the reverse is also true: broadband exposes rural firms to greater competition when their citizens purchase online products from elsewhere. Similarly, while broadband might help a rural firm increase its productivity, it also creates more opportunities for rural firms to outsource operations to a centralized hub in an urban center. It is also possible that the positive benefits of broadband in urban areas may diminish or disappear in a rural context. Most notably, information technology has been shown to have its largest effect by enhancing the productivity of high skilled workers, who tend to concentrate in urban areas (Autor, Levy, and Murnane, 2003). If rural workers do not have the necessary skills to enhance their

productivity using information technology, than broadband is less likely to generate the same level of economic benefits as in urban areas.

Identifying the effect of broadband expansion on economic variables has proven to be difficult. The core issue arises from the fact that it is challenging to determine whether broadband drives economic growth, or whether broadband providers expand into areas that they expect to grow in the future because of other factors. For example, Kim and Orazem (2016) find that broadband availability in a zip code in 1999 was highly correlated with the new firm creation rate in the same zip code in 1990, long before broadband existed. This correlation illustrates the close relationships between broadband expansion and expected economic growth.

Yet, researchers in recent years have made advancements in differentiating these effects using better data and more sophisticated statistical techniques. This current research has reached several convincing conclusions on the effect of broadband expansion in rural areas on economic development.

- **Adoption matters more than availability.** Whitacre, Gallardo, and Strover (2014) find that over just a four year period, increases in rural broadband adoption was associated with higher median household income, and higher levels of entrepreneurship. Yet, they found some evidence that higher levels of broadband availability alone were associated with lower levels of total employment in rural counties, consistent with the negative effects arising from increased outsourcing.
- **The skill composition of a rural area is critical.** Mack and Faggian (2013) consider the relationship between broadband, worker skills, and economic development. They find that broadband availability has a positive effect on employment in counties with high levels of educational attainment and a high share of workers employed in highly skilled occupations. Yet, they find that after controlling for regional differences in skill composition, the effect of broadband availability alone has an offsetting negative effect on economic development. This provides further evidence that extending broadband to rural areas may have adverse effects by reducing employment as firms outsource jobs or substitute technology for workers.
- **The effects of broadband vary across different types rural areas.** Kim and Orazem (2016) analyze the effect of broadband expansion in rural areas on new firm creation. They find a positive relationship between broadband expansion and new firm creation, but that the effect is largest in more populated rural areas and areas adjacent to metropolitan areas. They conclude that the positive relationship between broadband and entrepreneurship does not represent a closing of the economic gap between urban and rural areas, but instead represents a concentrating of rural economic activity in small towns and metro commuting areas.

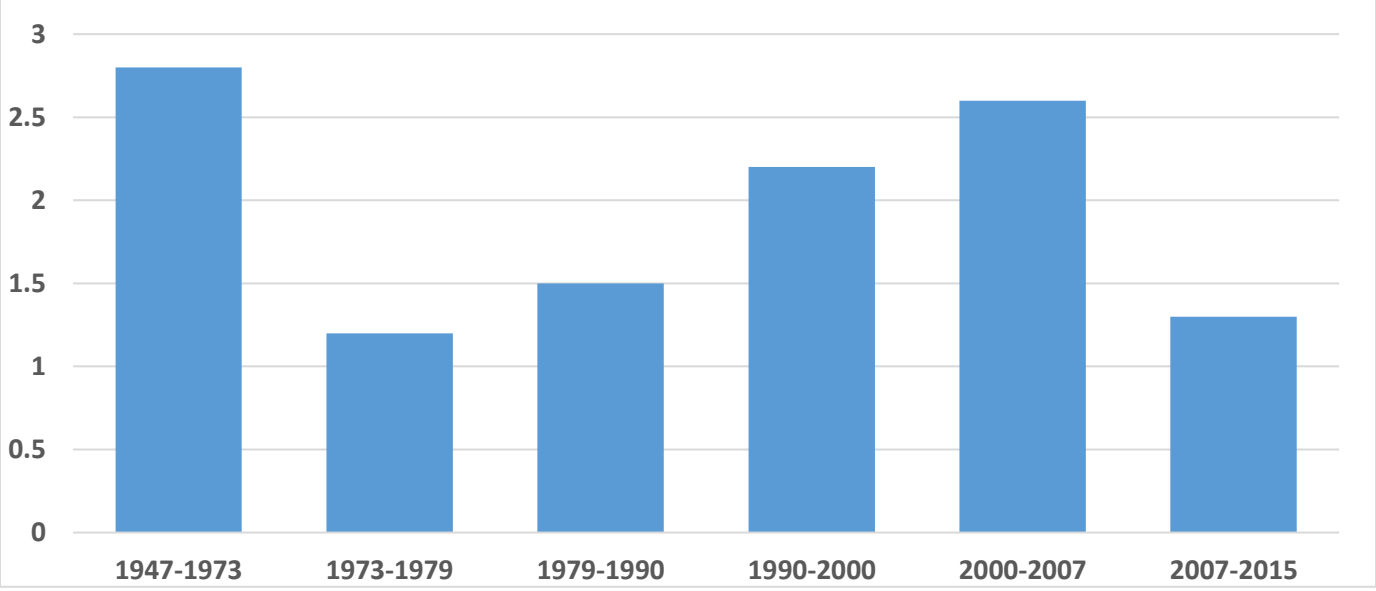
To summarize, the most recent research suggests that broadband can be an effective economic development tool in some rural areas, specifically more populated, metro adjacent areas that have a higher share of skilled workers. For areas that do not fall into those categories, the best case for broadband may not be economic development. Efforts to provide access in these areas--especially in areas with low skill levels--might need to be coupled with other economic development efforts aimed at offsetting the potential adverse effect of firms using information technologies to outsource work or replace workers with technology, such as supporting entrepreneurship and skills development.

Businesses & Workers

Information technology has changed the way businesses work in countless ways, and the growth of IT has been enabled by the rapid decline in the cost of computing technology, along with the growth of information sharing technologies like broadband. It is difficult to imagine a business today that doesn't rely on some form of information technology, from sophisticated computers and software to text messages. The pervasive effect of IT has captured the imagination of the public, policymakers, and the media, leading to eye-catching headlines dubbing the growth in IT "a new industrial revolution."

While IT has certainly reshaped the ways in which business is conducted, it has been remarkably difficult for economists to demonstrate that IT has actually improved productivity (Brynjolfsson & Shinku, 1996). Lack of reliable data and difficulty measuring productivity plagued efforts to clearly identify the productivity enhancing value of IT, especially prior to 2000, but research in the last 15 years has more consistently found a positive relationship between IT and productivity (Wheeler, 2009). Yet, even these positive results fall short in explaining why productivity growth has been so slow since the early 1970s. As Figure 6 shows, productivity[1] growth slowed significantly during the 1980s and 1990s compared to the period from 1947 to 1973, and only in the mid-1990s to early 2000s did it return to levels approaching the post-WWII era before dropping again during the Great Recession. While it is possible that productivity growth would have been even slower without the IT boom, it has been difficult to empirically show that IT has had the effects on productivity that would warrant its title as "an industrial revolution."

Figure 6. Average Annual Percent Change in Productivity in the Non-farm Business Sector



Source: Bureau of Labor Statistics

The evidence relating the benefits of IT to workers is more conclusive. The rise of IT has corresponded with a sustained growth in wages for skilled workers relative to unskilled workers. IT has been shown to complement highly skilled workers that perform complex problem solving and communication tasks—making them more

[1] The Bureau of Labor Statistics measures productivity by output per labor hour

productive and increasing their wages—while substituting for both high-skilled and low-skilled workers who perform routine tasks (Autor, Levy, and Murnane, 2003). The types of routine jobs that have been replaced by IT range from accountants, to secretaries, to factory machine operators. This technological skill bias has likely contributed to the growth in income inequality in the US since the 1980s. It has also likely contributed to the increased disparity of employment opportunities for high-skilled and low-skilled workers. This is especially true since the Great Recession in which job losses were concentrated in routine occupations, and these jobs have not return during the recovery period (Jaimovich and Siu, 2012).

One area of particular interest for policymakers is the role broadband and the internet can play in helping unemployed people find new work opportunities. Ohio has invested in the development of the Ohio Means Jobs website which aggregates job listings and provides support services to students and job seekers. Kuhn and Mansour (2014) find that using the internet to find a job in 2008 and 2009 reduced the average period of unemployment by 25 percent. While they note that the rise of "catch all" job boards like the Ohio Means Job website likely helped by expanding the network of potential businesses a job seeker could apply to, they note that several other factors likely contribute to the strong effect of using the internet in job search. These additional factors include the growth of job websites for individual industries or communities providing specialized support, and social media networks that have created new opportunities for people to leverage their on-line and off-line relationships to find job opportunities.

As the job search process continues to shift online, it is important that unemployed individuals have internet access at home, or if home access is not available, in public facilities like libraries. As Table 6 shows, 23 percent of unemployed individuals in Ohio in 2015 did not have a computer with internet access in their home. With such a large number of unemployed individuals lacking the resources to search for jobs from home, it is imperative to insure that they have access to internet in public facilities.

Table 6. Share of Ohio Population 16 or Older Without a Computer with Internet Access at Home by Employment Status

Unemployed	23%
Not in labor force	37%

Source: 2015 American Communities Survey

Considering this evidence within the context of the costs and benefits of broadband expansion, the vast majority of benefits stem from benefits to consumers. Broadband can greatly expand consumer access to products and services at lower prices, resulting in large economic gains. The evidence regarding the economic development benefits of broadband expansion are less assuring. While more populated rural areas adjacent to metros likely have opportunities to spur some economic development through broadband expansion, these gains are likely to come at the expense of smaller, more remote rural areas. The economics literature suggests broadband expansion into low skilled rural areas can actually have unintended consequences that reduce employment. This suggests that broadband expansion policies should be coupled with targeted economic development efforts that

include entrepreneurial support, internet literacy, and skills development to mitigate the potential losses associated with broadband expansion. Finally, internet job search can significantly reduce the length of unemployment for job seekers, producing additional economic benefits for workers and the state.

Broadband Policy

Broadband policy in the US is composed of a complex system of federal and state programs and agencies. Before moving onto our policy recommendations in the next section, we offer a brief overview of broadband policies at the state and federal levels.

Federal Broadband Policy

Policies aimed at expanding broadband access in the US have roots in the Communications Act of 1934. This legislation established the Federal Communications Commission (FCC), and put in place policies that supported universal telephone access. Today, telephone service is ubiquitous, and available in some of the most rural and remote areas of the country. Telephone expansion policies have long been supported by the Universal Service Fund that is funded by a fee assessed on the end-user revenues generated by telecommunication companies.

The Telecommunications Act of 1996 expanded the traditional universal service policies to include emerging telecommunications technologies like mobile phones and high-speed internet. New programs funded by the Universal Service Fund were created with a particular focus on promoting universal broadband access.

Developing policies that support universal broadband access presents some unique challenges. Telephone service was largely based on a single technology, copper wires. This made it easier to develop policies that supported the provision of this single technology. As broadband emerged, it quickly became a multi-modal technology, delivered to customers by copper telephone wire, coaxial cable used in cable television, wireless receivers, and satellite. Multiple technology options can offer advantages by increasing competition and by offering several solutions for delivering service to customers in a variety of circumstances. Yet, the complexity that this variety introduces can pose challenges to crafting and evaluating broadband expansion policies (Combini and Jang, 2009).

The FCC plays a central role in federal broadband policy. One of its most important roles is defining minimum speed requirements for broadband. In most cases, the FCC broadband definition sets the criteria for the minimum technological requirements that qualify for public funding from both state and federal government programs, and thus has significant policy implications. Some rural representatives have expressed concern that setting high federal broadband benchmarks might actually discourage investment in rural areas where consumers might be willing to use lower speed services (Daines, 2016).

The FCC also administers several programs funded through the Universal Service Fund aimed at expanding broadband access and increasing adoption that have been impactful in Ohio:

- **Connect America Fund:** The Connect America Fund provides subsidies to carriers to expand and upgrade networks to deliver broadband in unserved areas. In the most recent 6 year funding cycle beginning in 2015, $10 billion in Phase 1 funding was allocated to telecom providers to extend broadband to unserved areas. Six companies were allocated a total of $58 million per year to expand service in Ohio,

with the largest annual allocations going to Frontier Communications ($22.9 million), CenturyLink ($15.9 million), and AT&T ($14.8 million). The Connect America Fund is expected to distribute an additional $1.98 billion in funds over the next 10 years as part of its Phase II program. These funds will target unserved areas that providers declined to serve during the Phase I funding round and "extremely high-cost census blocks." Funds will be distributed using a reverse auction mechanism in which providers will bid to provide the highest quality service at the lowest subsidy rate.

- **E-Rate:** The E-Rate program provides financial support to schools and libraries to make critical telecommunications investments, including broadband. The program prioritizes libraries and schools in rural or high poverty areas by providing more generous subsidies. Since the program was founded in 1996, Ohio schools and libraries have received more than $1 billion in funding.

- **Lifeline:** The Lifeline program dates back to the Reagan administration and was created to provide subsidies to low income households to obtain telephone service. As technology has shifted from landline telephone service to mobile telephone service, the Landline program has evolved to subsidize plans that include mobile broadband. Today, the program provides a $9.25 per month subsidy to low income households below 150% of the federal poverty line to obtain a telephone service that can include mobile broadband. As of 2015, there were 608,259 Lifeline subscribers in Ohio out of 1.6 million eligible households, a 38% utilization rate. One barrier to use stems from the fact that telecoms must opt into the program for customers to receive the subsidy. As a result, there is only one broadband specific plan offered in Ohio. This plan provides customers access to the iPass public Wi-Fi network. While this plan makes it easier for customers to access public Wi-Fi networks, it does not necessarily provide assistance for obtaining a broadband subscription in the home. With the change in administration, one of the first acts of the new FCC chairman Ajit Pai was to scrutinize the federal process for approving providers to participate in the Lifeline program. In March 2017, Chairman Pai announced plans to eliminate the federal process for designating eligible providers in the Lifeline program, turning responsibility over to state governments to approve which companies can participate.

Since most areas that lack broadband tend to be in rural and remote areas of the country, the US Department of Agriculture (USDA) also administers a set of programs aimed at promoting broadband access. The Community Connect Broadband Grants program provides direct funding for broadband expansion in rural areas. The Community Connect Broadband Phase I grant program is project specific, as opposed to the Connect America Fund which is allocated by the number of households that are expected to be served. While this program offers valuable support to broadband expansion in rural communities, it is only budgeted $10 million in funding in FY 2017, far too little to have a significant national impact. USDA also administers several loan programs aimed at rural utility cooperatives and traditional telecoms to support broadband expansion in rural areas.

Ohio's Broadband Policy

As we've noted, the FCC is the designated body within the federal government charged with defining, regulating, and promoting broadband service. In contrast, Ohio does not have a single state office or agency that coordinates the state's broadband policy. Yet, many state agencies touch broadband policy, including: the Ohio Development Services Agency, Ohio Department of Administrative Services, Ohio Department of Education, Ohio Board of Regents, Ohio Public Utilities Commission, Ohio Consumers' Council, Ohio Department of Transportation, Ohio Office of Information Technology, and the Ohio Department of Public Safety. These state

agencies impact broadband in diverse ways, from building broadband infrastructure, advocating for Ohio consumers' broadband needs, and increasing access at Ohio's schools and universities.

Without a defined state body to coordinate Ohio's broadband strategy and policy, the state has delegated some of these responsibilities to the non-profit organization Connect Ohio. Connect Ohio has served in this role since 2008, and until 2014 it was largely funded by stimulus money distributed through the Department of Commerce's Broadband Technology Opportunities Program and State Broadband Initiative. This funding supported Connect Ohio in developing detailed maps of broadband coverage in the state, providing outreach to local governments to assist in broadband planning, and supporting Ohio consumers that lack broadband service options. It also provided support for digital literacy and workforce development programs such as Digital Works. Digital Works focuses on providing job training in IT and computer based customer service professions and assists in placing graduates in jobs. Since 2013, the program reports that it has trained and placed more than 700 students.

When the two federal grant programs funding Connect Ohio expired in 2014, Ohio did not have an established plan for continued funding for Connect Ohio. The state provided Connect Ohio with stopgap funding in 2015, but the Ohio Senate removed a longer-term funding plan from the 2016 biennial budget. As a result, the state support expired at the beginning of 2016 and the organization was forced to downsize to a single employee, putting its broadband mapping, consumer support, and workforce development programs on hold. Digital Works, which had operated several training sites around the state, with a particular focus on rural areas, was forced to lay off its staff and reduce training to just two locations—Gallipolis and Columbus. The state eventually stepped in and provided one additional year of funding in July 2016, and since then Connect Ohio has been rebuilding its staff and programs.

Conclusion & Policy Discussion

As we have noted through this policy analysis, broadband is now an essential utility which generates significant economic value for consumers and is an essential part of business. Ensuring that Ohio residents and businesses have access to high quality and affordable broadband should be a high policy priority for the state. Yet, the recent saga around Connect Ohio's funding speaks to the lack of a coherent, forward-looking broadband policy in Ohio. We hope to offer several ideas and suggestions for improving Ohio's broadband policy moving forward.

Throughout this paper, we have talked about both broadband access and broadband adoption. Both of these issues are absolutely critical to maximizing the value of broadband in the state. Yet, we are only going to focus on the issue of expanding broadband access in our policy discussion. We do this for two reasons. First, broadband access policy is more clearly about maximizing benefits and minimizing costs, topics that are familiar to economists. Second, the economics literature does not offer us many insights on the most effective policies for increasing broadband adoption (training programs on internet literacy, subsidies on computer hardware, subsidies for broadband subscriptions, etc.). This is an area ripe for future research, but we do not feel confident about making recommendations without a research foundation. Yet, we do note that given the necessity of broadband access to economic activity, community wellbeing, and educational outcomes, it is nearing the point where universal access and use of broadband will be a high priority.

We believe Ohio can strengthen its broadband policy in several ways:

Establish a State Broadband Office

The State of Ohio touches the issue of broadband in many different ways and across many different state agencies. At a given moment, the Ohio Department of Higher Education might be expanding its state-wide public broadband network to serve Ohio's educational institutions and local governments; the Ohio Department of Transportation might be constructing on public right of ways that could be used to extend broadband infrastructure; and the Ohio Department of Education might be distributing grants to Ohio school districts to expand one-to-one laptop programs. Each of these programs help expand broadband access and use, but without a plan and designated state leader to coordinate these efforts, it is likely that the state is missing opportunities to leverage its existing programs to lower the cost and accelerate the rate of broadband expansion and adoption.

We recommend that Ohio follow the proactive steps that many other states have already adopted by establishing a state broadband office. While in most states such an office is established within the development agency, other agencies could be considered. Ohio's OARnet is already overseeing the expansion of broadband in both urban and rural communities to serve libraries, schools, and local government, and this experience would likely be valuable in providing leadership to align other state agencies around the goal of expanding service to residents and businesses. An early responsibility of a state broadband office should be to develop a state broadband plan that can be used to align other state agencies that are already working on broadband related issues, and establish a set of measurable goals for the state related to broadband access, adoption, and use.

We also recommend continued support for Connect Ohio. While a state broadband office should focus on aligning state resources and agencies around broadband expansion, Connect Ohio fills a vital need of broadband research, mapping, consumer support, and community engagement. The research and information provided by Connect Ohio are public goods, and are worthy of public support. While these duties could be rolled into a state broadband office, there are advantages to having this work conducted by a non-governmental organization that can leverage private resources and provide impartial research and policy recommendations.

Adopt a "dig once" policy

The most effective way to speed the expansion of broadband service is to reduce the cost of expansion. A major cost barrier to broadband expansion arises when significant excavation of existing roadways is required. To reduce these costs, the federal government and many states have adopted "dig once" policies to reduce the need to tear up streets and roads when broadband providers extend services. Dig once policies typically require that private broadband providers be notified when public right of ways are excavated so that they can be given the opportunity to install broadband infrastructure. They also often require that dedicated internet conduit be laid in the right of way during new construction to prepare for future broadband needs.

There are several ways that the state can promote dig once policies. It can require ODOT to integrate dig once policies into its own projects, and make the utilization of dig once policies a requirement of local government projects that received ODOT funding. It can also help to facilitate coordination between local governments and internet providers. Colorado offers a strong model for these types of policies. In 2015, Colorado adopted legislation[2] that requires that the department of transportation develop a system for notifying broadband

[2] C.R.S. 38-5.5-109

providers of all public projects that require trenching. In concert with this policy, the Northeast Colorado Association of Local Governments included a legislative template to aid local governments in adopting dig once policies in the draft of its regional broadband strategic plan.[3] San Francisco[4] and Boston both offer examples of large cities that have adopted dig once policies to support telecommunication expansions while reducing the excavation of public right-of-ways.

Given that there could be several different current or future internet providers in a single area, there may be logistical challenges for state and local government offices to inform all ISPs when right of ways are being excavated. The state could play a valuable role in creating a web-based system that automates the process of sharing information from state and local government offices about planned right of way excavations with ISPs. While this would likely require an initial investment, streamlining the use of dig once policies could have a significant effect on reducing the costs of broadband expansion.

Strengthen Public-Private Partnerships Policies

Another strategy for reducing the cost of broadband expansion in hard to serve areas is utilizing public infrastructure. These partnerships can range from leasing unused public fiber optic capacity ("dark fiber") to private ISPs to deliver service in an area, to leasing the use of tall structures like communications towers or water towers to support wireless broadband delivery.

There are already strong examples of public-private partnerships increasing access to broadband and fiber services in the state. The OARnet 100-gigabit-per-second fiber network was originally built to connect Ohio's institutions of higher education, but is now being made available to hospital systems, private companies engaged in R&D, and private data centers.

Another example of Ohio's efforts to use public-private partnerships to expand broadband access by allowing cellular phone and wireless broadband providers to use Multi-Agency Radio Communications System (MARCS) towers as broadcast sites. This approach of using publicly owned communication towers to extend broadband coverage in rural areas is used by other states including Virginia and Wisconsin. Most of the MARCS towers in Ohio are used by Agile Communications, which provides 1 Gbps backhaul service to the MARCS to support the state's voice and data communications system serving more than 50,000 public safety workers. As part of the agreement with the state, Agile is permitted to use the towers to provide high-speed wireless broadband to consumers and businesses.

The agreement between Agile Networks and the state has highlighted some of the challenges to successfully using public-private partnerships to expand broadband. In 2015, the state authorized Agile Networks to sublease MARCS towers to T-Mobile which installed equipment to provide cell phone and mobile broadband service. It was later reported that Agile Networks was collecting lease payments from T-Mobile instead of passing the revenue to the state. The issue brought to light the complicated legal environment that public-private partnerships sometimes operate in, particularly the legal limits that the IRS places on the amount of private revenue that can be generated by infrastructure funded by public bonds. Of course, as with all private-public partnerships, the problem of pushing the risk and losses onto the public entity (while the private partners receive the lion-share of the profits) needs to be managed. The case of the MARCS towers should motivate the

[3] https://www.colorado.gov/pacific/washingtoncounty/atom/58321
[4] http://sfgov3.org/modules/showdocument.aspx?documentid=6885

state to clarify and strengthen its regulatory policy around the use of public-private partnerships to extend broadband access. While these policies often seem like win-win cases, they can sometimes have unexpected costs. Particularly, these policies can be anticompetitive if they give one company an unfair advantage over competitors and create monopolies that lead to higher costs or lower quality services. Since broadband is not regulated by the state as a monopoly, this is a potentially large concern.

A strong public-private partnership policy should be primarily focused on extending coverage into areas that are currently unserved or underserved. In these cases, subsidizing a natural monopoly model may be appropriate, and the policy should provide regulations on the price and quality of service offered by the designated provider. These policies should also be structured with recognition that new entrants may have interest in providing service in an unserved or underserved area in the future, at which point the provision of service should be left to competitive market forces.

As technology changes, public-private partnerships might become necessary to deploy next generation technologies in areas that already have broadband service. These changes will force policymakers to consider the tradeoffs between models of public participation. In some cases, it might be optimal for the public to own and develop vital communications infrastructure that can be utilized by private partners—such as the OARnet system. In other cases, it might be best for the public to allow for the use of public facilities and right-of-ways by private users to deploy communications infrastructure—such as Agile Communication's use of the MARCS towers. In either case, public-private partnerships should be structured with the goal of maintaining neutrality in terms of provider and technology while expanding access to the highest quality services at the lowest price.

While creating and enforcing a strong public-private partnership policy might be ambitious, entering into such partnerships to deliver broadband services without clear purpose or regulatory controls can result in adverse effects.

Considerations for Establishing a Broadband Investment Fund

As we've noted, there are several low cost policies that the state of Ohio can adopt that can speed the pace of broadband expansion to unserved or underserved areas of the state. Yet, ensuring that all Ohioans have access to high-speed broadband will likely require targeted state investment that helps to reduce the large fixed costs of building broadband infrastructure in remote rural areas. Many states have already established state broadband funds, including Minnesota, Massachusetts, New York, and Colorado.

A central question of any public subsidy program is how much should be spent to expand access. In section 2, we discussed the economic research estimating the consumer benefits of broadband. Estimates of the average annual benefits received by US broadband subscribers range from $1,500 (Greenstein and McDevitt, 2012) to $2,200 (Nevo et al., 2016) per household. Given advancements in internet services and broadband quality, we believe using $1,850 per household per year—the average value of these two estimates—is a conservative estimate for the economic benefits received by broadband subscribers today, and the benefits are likely growing as the internet is increasingly integrated into our lives. Using data from the FCC on broadband access and Census data on average household size per county, we estimate that 393,000 Ohio households are unserved by broadband service.

Table 7 provides estimates on the economic benefits that would be generated by expanding broadband access to all unserved households based on different adoption scenarios. In the most optimistic scenario in which all

newly served households buy a subscription, the economic benefits generated by expanding broadband to all unserved households is $728 million per year. If 28 percent of newly served households adopted broadband service—equal to the national broadband adoption rate for rural areas according to the FCC—the economic benefits would exceed $200 million per year. Even when considering a conservative case in which only 15 percent of newly served households purchase a broadband subscription, the economic benefits would exceed $100 million per year.

Table 7. Estimated Economic Benefits of Broadband Expansion to Serve all Ohioans

Adoption Rate	Annual Economic Benefits	Discounted Present Value of benefits over the next 15 years*
100%	$728,573,069	$6.6 billion
28% (US rural average)	$204,000,459	$1.9 billion
15% (low adoption)	$109,285,960	$1.0 billion

Unserved Ohio Households: 393,000
Benefits per year: $1,850
*We use a 7% discount rate and a 15 year pay-back period to account for the risk of new technology making an initial investment obsolescent. This is a very high discount rate in today's environment, so our estimates should be considered well on the low side.

These economic benefit estimates, even under a very conservative scenario, demonstrate the enormous value of broadband access to consumers. Given that these consumer benefits occur continuously over time, and are not just a one-time gain, the economic value of expanding access to all Ohioans under the most conservative adoption scenario is $1 billion over the next 15 years. Even using conservative assumptions, we are underestimating the economic benefits because we are not including the likely case in which broadband service produces even more benefits to consumers in the future, as well as network effects that increase the value of the internet by increasing the number of connections and the market for e-marketers. Our estimate also does not incorporate any additional economic benefits arising from entrepreneurship, business uses, or improving employment outcomes. Thus, it represents a lower bound for the economic benefits produced by reaching universal broadband coverage in Ohio. The point being that the potential economic benefits generated by broadband expansion and adoption are quite large and justify much more than the tiny sliver of funding it currently receives.

While there are clear benefits to the state providing direct funding to support broadband expansion, several issues could potentially reduce the effectiveness of the public investment, or even create adverse effects. The first issue, as is the case with any public infrastructure project, is to insure that the public costs are minimized while providing a valuable public benefit. The second issue complicating a broadband subsidy program is the potential for creating adverse effects on competition. As we've noted above, privileging a single technology or firm over others can have adverse effects on prices and quality of service if competition is reduced—and ultimately such favoritism leads to lower economic growth.

There are several ways that a broadband funding policy could be structured to address these issues. First, funding priority should be given to projects associated with other infrastructure projects ("dig once"). This will further reduce the project costs. Second, priority should be given to projects which either build upon the Ohio Middle Mile Consortium's existing open access fiber infrastructure, or expands this infrastructure. Finally, the state should recognize that providing grants and subsidies that benefit a single company in order to bring internet access to unserved areas might seem like a worthy goal in the short run, but such policies can have negative long-term effects. Subsidizing a single company in rural areas where the cost of entry is already high can create a monopoly environment that can potentially crowd out other providers and reduce competition in the long run. Thus, clear guidelines should be set regarding the price, speed, and quality of service for companies receiving broadband grants, and strict monitoring should be adopted to ensure compliance.

Local Government Policies

While we have focused most of our analysis on state policies, there are many ways local governments can encourage and support broadband investment. First, local governments should treat broadband like other types of critical infrastructure such as roads, water, and sewer, and integrate broadband into the comprehensive planning process. This can include taking an inventory of existing broadband infrastructure, mapping this infrastructure, and integrating it into broader infrastructure planning. This is especially true in unserved and underserved rural areas. Integrating broadband into local government infrastructure planning will provide a foundation to efficiently and effectively use dig once policies to lower the cost of expanding broadband in these unserved or underserved areas, and will help in demonstrating demand to advocate for private investment.

Local governments must also become more aware of how its infrastructure relates to future broadband technology. This issue was particularly brought to light when Senate Bill 331 was signed into law late last year. S.B. 331 gives wireless providers full access to public right of ways to install next generation 5G wireless internet technology. The bill quickly sparked controversy as it greatly restricts what municipal governments can do to regulate the deployment of this wireless technology on public infrastructure in the right of way. Currently, dozens of cities across the state have joined on a lawsuit challenging the bill. S.B. 331 points to the critical need for municipal governments to be prepared for the emergence of new technologies like 5G that will rely heavily on public infrastructure.

Ohio has already demonstrated itself to be a leader in broadband infrastructure development. Yet, there are still gains to be made by expanding broadband access to unserved areas of the state. Each year that passes without a coherent state broadband policy and targeted investment to extend broadband access represents lost economic benefits that could be accruing to these unserved households. States across the country are already adopting aggressive policies to achieve universal broadband coverage, and these efforts will likely contribute to the success of these states in the future. Adopting a coherent broadband policy targeting expansion should be a top priority for the state in the coming years.

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