Before the House Finance Committee

Representative Ryan Smith

Chair

Testimony of

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House Bill 378: Ohio Broadband Development Grant Program

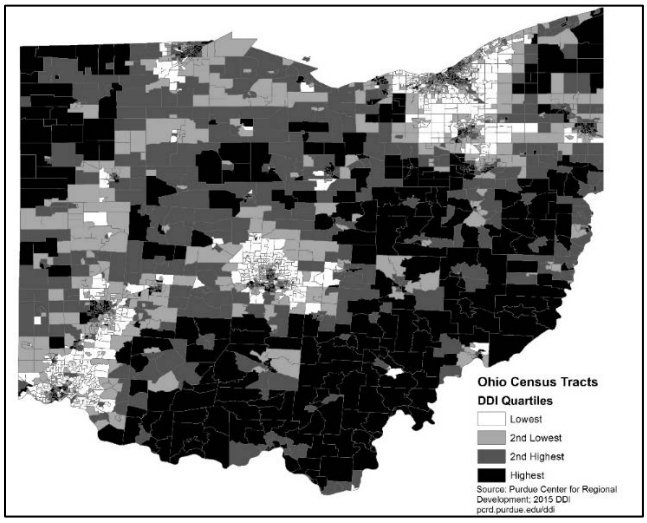
First, I would like to thank Chairman Smith and Ranking Member Cera for providing me with the opportunity to speak to the members of the House Finance Committee in support of House Bill 378, legislation that would create the Ohio Broadband Development Grant Program. I am assistant director of the Purdue Center for Regional Development. I hold an engineering undergraduate degree, a master's in economic development, and a PhD in Public Policy. I have worked my entire career in an Extension and Research position, primarily in the community economic development area. I am also a member of the National Digital Inclusion Alliance board.

The digital age continues to unfold and its applications become more and more sophisticated. Mature applications such as social media and e-commerce, to name a few, have been around for at least ten years and have transformed our socioeconomic landscape. Academic research on the positive impact of broadband is extensive (see Addendum). Today, we hear about artificial intelligence, mixed reality, driverless cars, telehealth, and telework among other. These newer applications will not only continue to disrupt the current context but have a tremendous potential to increase the quality of life for anybody that has access to the technology as well as the know-how.

The common denominator of these applications of course, is broadband. Not only access, but affordability and use as well. In the ten years I have been working with rural communities across the country helping them transition to, plan for, and prosper in the digital age, the digital divide is the number one threat to their community economic development. The digital divide exists between those that have access, can afford, and leverage the technology to increase their quality of life versus those that do not have access, cannot afford, and/or lack the skills to leverage the technology.

Public Policy 101 dictates that an agreement on the problem is the critical first step. For this reason, I developed a digital divide index or DDI to help define the issue and jumpstart meaningful conversations. This DDI ranges from zero to one hundred, where a higher number depicts a higher digital divide at the neighborhood or census tract level. This score is composed of both broadband infrastructure/adoption and socioeconomic characteristics known to impact technology adoption. DDI discussed today is from 2015 since one FCC dataset needed for 2016 (latest year available) has not been published.

Figure 1. Ohio Census Tracts by DDI Quartiles



Out of the approximately 11.5 million Ohio residents in 2015, 2.3 million or about 20 percent lived in neighborhoods where the divide was the highest (dark color in Figure 1). Moreover, of these 2.2 million about 900 thousand or 38 percent lived in rural areas versus less than 7 percent in urban neighborhoods, clearly highlighting a rural-urban divide. About 27 percent of those in prime working age (ages 25 to 54) in the neighborhoods with the highest divide were not in the labor force compared to 13 percent in neighborhoods with the lowest divide. More worrisome, however, is that a third of households in neighborhoods with the highest divide had children. In other words, approximately half a million children lived in neighborhoods where the divide was highest as of 2015.

In my experience, communities that implement digital inclusion strategies tend to look inward, leveraging existing assets for development purposes, but more importantly, understand that their communities are creative and talented and that this creativity and talent needs to be plugged into the digital economy. They are aware of issues and challenges associated with the digital age, such as privacy & security concerns, and take steps to mitigate their impact. They, regardless of size, make efforts to become more responsive by engaging digitally with their residents. They understand that developing a knowledge workforce begins at a younger age and strive to create a pipeline throughout K-12. They take proactive steps to manage their online reputations. They ensure coordination among community anchor institutions and businesses to increase digital skills and access to connectivity and devices.

The DDI is a pragmatic and descriptive tool designed to increase awareness. Variables included in the index range from percent population without access to fixed 25/3 to average advertised download and upload speeds to socioeconomic indicators known to impact technology adoption. More information on the DDI's methodology is available at pcrd.purdue.edu/ddi.

Before I wrap-up, let me expand a bit on why average advertised speeds were included in the DDI. Speed is becoming extremely important as broadband applications become more sophisticated. As other regions in the world have access to faster speeds, the web and its applications will evolve accordingly. For example, try browsing the web today using dial-up.

Imagine the speeds required for 3D holograms or managing hundreds of real-time sensors in farms and manufacturing facilities and/or hundreds or thousands of driverless cars across the state. Would you like your driverless car to buffer when driving through a rural section of the state? If we could equate Internet speeds with miles per hour, on average today we get about 3 miles per hour to 50 miles per hour, depending on the technology. At this speed, look at what is possible today. Now, imagine having ubiquitous speeds of 1,000 miles per hour. What applications will surface then? I commend this bill for requiring the minimum broadband speed of 25/3. However, I strongly believe that aiming at the minimum speed today is like trying to drive a car looking through the rear-view mirror.

To wrap-up, remember that asking why do I need faster Internet is like asking why electricity if I already use candles? Nobody envisioned what electricity would bring. We are only starting to see what faster Internet can bring. More importantly, investments in infrastructure need to be paired with digital inclusion efforts, including, but not limited to improving digital literacy. A recent report by the Brookings Institution found that two-thirds of new jobs between 2010 and 2016 required medium to high digital skills. In order to learn digital skills, adequate broadband infrastructure is necessary.

Thank you so much for allowing me to share my research and expertise with you today.

Addendum

Research & Policy INsights

Broadband's Impact

A Brief Literature Review

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Center for Regional Development
Advancing Collaboration : Energizing Regions

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BRIAN WHITACRE

Brian Whitacre is a professor in the department of Agricultural Economics at Oklahoma State University. Brian's main area of interest is rural economic development, with a focus on the role that technology can play. Brian has published over 40 peer-reviewed journal articles, with most of them exploring the relationship between Internet access and rural development. His e-commerce workshops have been attended by over 1,500 small business owners across the state. Brian has won regional and national awards for his research, teaching, and extension programs.

ALISON GRANT

Alison Grant is currently pursuing her Ph.D. in the department of Agricultural Economics at Purdue University. She possesses a Master of Science degree in Food, Agricultural and Resource Economics from the University of Guelph in Ontario, Canada. Trained as an agricultural and resource economist, Alison Grant's research has focused on the economic impact of environmental externalities using econometric analysis. Specific research themes include modeling the impact of aggregate sites on surrounding rural residential property values; examination of the factors that affect farmland values and rental rates; determining the economic costs of pesticide policy in Ontario; and exploration into the application of water markets.

INDIANA ELECTRIC COOPERATIVES

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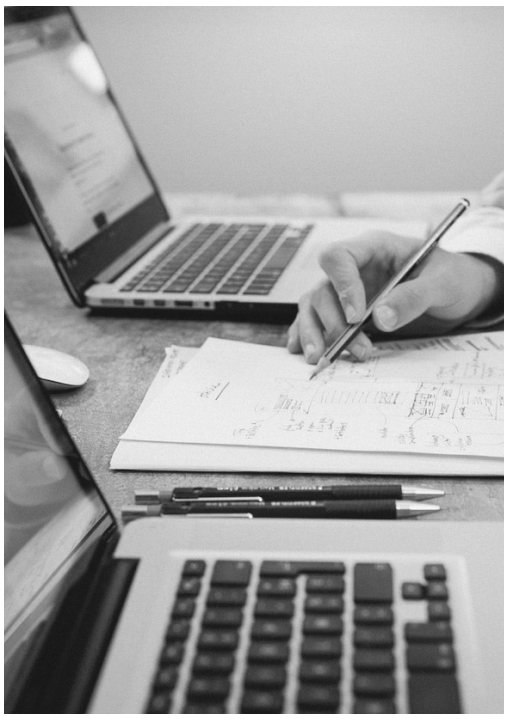
Introduction

Broadband applications continue to evolve as the technology matures and number of users increase. As of December 2017, more than 3.7 billion people around the world were using the internet (Internet Live Stats, 2017). According to the business data company Domo, more than 86,000 hours of video were watched in Netflix every minute of 2016 in addition to the approximately $222,200 in sales by Amazon (Data Never Sleeps 4.0, 2017).

An important series of questions arise. What impact does broadband and its applications have? More importantly, do the benefits outweigh the costs of deploying and maintaining this technology? In 2005, broadband research was rarely directed at the impact of the technology on social and personal issues (Firth & Mellor, 2005). Today, multiple books have been written attempting to describe the changing socioeconomic landscape and emerging trends being shaped by the growth of digital applications (Brynjolfsson & McAfee, 2014; Mele, 2014; Rifkin, 2014; Friedman, 2016; Kelly, 2016; West, 2016; Schwab, 2017; Wadhwa, 2017) while recent research concluded a link exists between broadband and human development in U.S. counties (Devaraj, Sharma, Wornell, & Hicks, 2017).



More specifically, there has been a significant amount of scholarly research focusing on what broadband may portend for individuals, communities and regions. This article is intended to highlight some of the more salient research findings on a variety of topics including economic development, migration, civic engagement, education, telework, telehealth, smart cities / big data and agriculture.

Economic Development

The one area garnering considerable interest by state and local leaders is the link between broadband and economic growth. Studies conducted at the national level indicate a positive, causal relationship between broadband infrastructure and gross domestic product growth among twenty-two Organization for Economic Cooperation and Development (OECD) countries (Koutroumpis, 2009). Other studies, focusing on the local economy, also found a positive relationship between broadband availability and economic growth (Kolko, 2012; Holt & Jamison, 2009), as well as higher housing prices (Molnar, Savage, & Sicker, 2015). On the other hand, other studies have concluded that no significant impact of having faster broadband deployment on household incomes, employment rates (Kolko, 2012), or changes in unemployment rates (Jayakar & Park, 2013).

Entrepreneurship, which is a popular economic development strategy, also benefits from broadband access. A research paper tested the hypothesis that start-up activity is enhanced by infrastructure finding that indeed start-up activity is positively associated with infrastructure in general but that certain types of infrastructure, like broadband, are more conducive than highways and railroads to start-up activity (Audretsch, Heger, & Veith, 2015). Another study distinguished between innovative/non-innovative entrepreneurs and nonfarm proprietors using three sets of determinants including demographic/location, infrastructure and socioeconomic in three southern states. Results indicated that non-innovative entrepreneurs are more sensitive to broadband access, among other variables (Gallardo & Scammahorn, 2011).

Crowdfunding and peer-to-peer networks are having an impact on entrepreneurship finance models (Bruton, Khavul, Siegel, & Wright, 2015). According to the World Bank, $96 billion per year by 2025 could be invested through crowdfunding in developing countries (The World Bank, 2013). For example, the platform Kickstarter reached its 100,000th successfully funded project in a little less than 7 years with participation from 165 countries, 86,000 creators, 9 million supporters, and an average distance between creator and backer of 2,300 miles (Kazmark & Nichols, 2016).

A nascent area worth discussing as well is the impact of e-commerce. Early evidence from Oklahoma suggested that counties with higher increases in broadband adoption did not see any loss of local sales tax revenue (Whitacre B. , 2011) Although there has been some discussions on the popular press regarding a “retail apocalypse” (Thompson, 2017), a recent report from the Progressive Policy Institute found that e-commerce has actually added about 261,000 net jobs between 2007 and 2017 (Mandel, 2017). This finding is supported by a recent report by the company comScore that found retail digital commerce (including desktop and mobile) reached $100.1 billion in the first quarter of 2017, an increase of 20 percent year over year and the first quarter ever to breach $100 billion in sales in a non-holiday quarter (Lipsman, 2017).

None of these studies, however, looked specifically at rural areas. Focusing on rural areas is important since they are lagging behind urban areas when it comes to broadband deployment and use (Perrin, 2017; Good, 2017). Furthermore, rural places need digital connectivity in order to compensate for their remoteness (Salemink, Strijker, & Bosworth, 2015). Studies that have given specific attention to rural areas have noted a positive relationship between rural broadband access and adoption and greater economic growth (Stenberg, et al., 2009), attraction of new firms (Kim & Orazem, 2017), higher household incomes (Whitacre, Gallardo, & Stover, 2014), small business growth (Shideler & Badasyan, 2012), increase in annual sales and value added (Canzian, Poy, & Schuller, 2015), and growth in annual payroll and number of business establishments (Kandilov & Renkow, 2010). In addition, a recent article explored the effects of USDA broadband loan programs on agriculture and found a positive impact on farm sales, expenditures, and profits among rural counties adjacent to metropolitan counties (Kandilov, Kandilov, Liu, & Renkow, 2017).

Additional studies have estimated the economic impact of rural broadband or lack thereof. The Hudson Institute estimated that broadband companies contributed $2.4 billion in 2015, supporting over 65,000 jobs and $100 billion in e-commerce (Kuttner, 2016). Another report conducted by Ohio State University attempted to estimate the economic benefits associated with increasing broadband access and adoption in Ohio. Using two research articles

that estimated broadband consumer surplus ($1,850 per household per year was used in practice), they concluded that reaching full broadband coverage and adoption among currently unserved Ohio households would result in $2 billion in economic benefits over the next 15 years (Rembert, Feng, & Partridge , 2017). Following a similar methodology, another study found that assuming full access of 25/3 Megabytes per second (Mbps) fixed broadband in the United States and a 20 percent adoption would result in $43.8 billion in economic benefits over 15 years (Gallardo & Rembert, 2017).

Important to note is that distinguishing between broadband access/availability and adoption is critical. Even if broadband is available, subscribing or using it (adoption) is not a given. In fact, Internet know-how or utilization is not randomly distributed among the population. For example, a study among young (college-age) Internet users found that parental education, gender, and race/ethnicity impacted the level of web-use skills (Hargittai, 2010). Furthermore, the relationship between entrepreneurs and creative class workers found that broadband adoption actually had a negative relationship with creative class type of workers in rural communities, while higher broadband availability is associated with a higher level of entrepreneurs (Conley & Whitacre, 2016). Another study found that increases in broadband adoption were more significantly related to changes in median household income and percentage of nonfarm proprietors than broadband availability (Whitacre, Gallardo, & Strover, 2014). Thus, it is important to distinguish between the impact of broadband access/availability and adoption/utilization since the digital divide consists of both (Gallardo, 2016).

Migration & Civic Engagement

Those on the wrong side of the digital divide are being left behind in more than just economic terms. One study looked at in-migration and broadband technologies and found that broadband had a mild positive impact on net migration in urban areas. For rural areas, however, having only a single broadband technology (e.g. DSL) available did not have a significant impact on rural in-migration. On the other hand, rural counties with at least two broadband technologies did experience significant in-migration relative to similar counties without broadband (Mahasuweerachai, Whitacre, & Shideler, 2010). In other words, broadband variety in rural areas helps with out-migration in rural counties.

Less connected communities are also missing improved civic engagement. Multiple case studies were analyzed where broadband-enabled applications helped local government become more responsive, transparent and cost-effective by implementing open data portals, smart city strategies and digitally interacting with their residents (Goldsmith & Crawford, 2014). According to a case study conducted by the Massachusetts Institute of Technology Media Lab – Laboratory for Social Machines, a Spanish town of 3,500 residents saved about 13 percent per year or $380,000 each year since 2011 running most of the town's communications through Twitter (Powers & Roy, 2015; Scott M. , 2016).

Indeed, information and communications technology are relevant in increasing policymakers' capacity to respond according to a World Bank report, yet policymakers need to have the willingness to do so (Peixoto & Fox, 2016). Likewise, internet use and diffusion matter to community participation and overall civic engagement (Stern, Adams, & Boase, 2011; Whitacre & Manlove, 2016). However, a study found online political participation mirrors offline

participation even when Internet access is controlled for, maintaining long-standing patterns of unequal political participation. In other words, political participation online is lower among lower socioeconomic status compared to higher socioeconomic status (Schlozman, Verba, & Brady, 2010).

A recent study conducted by the Brookings Institution looked at the rural counties with high upward mobility and found that counties with higher upward mobility also had a higher out-migration. The authors argued that this was because the counties were able to successfully influence an individual prior to entering adulthood rather than families moving out when their children are young. More importantly, the study concluded that investments in human capital, family planning and 21st century infrastructure, such as broadband, have the potential to bolster opportunity in rural counties (Krause & Reeves, 2017).

Education

Regarding education, broadband applications affect both K-12 and higher education. About the former, the homework gap is a major issue. According to the Pew Research Center, about 5 million households, or about a third, with school-age children lacked high-speed internet service at home as of 2013 (Horrigan J. , 2015). Further and according to another study, 50 percent of students surveyed were unable to complete homework due to lack of broadband and 42 percent said they received a lower grade due to lack of broadband as well. Researchers conclude that the homework gap has serious life-long implications (McLaughlin, 2016).

Lack of fast broadband access for K-12 students at home and schools are also partially responsible for delaying needed reforms to better align the K-12 educational model to the digital age, as well as access to technology and resources. These reforms include minimizing memorization and test-taking, encouraging student-centric or adaptive education, promoting self-paced or personalized learning, and making learning addictive, similar to video games (Jain, 2013; Zakaria, 2015). Some examples of more digital age aligned educational models that incorporate some or all of the reform elements discussed above and require fast broadband access include the “flipped” classroom (Davis, 2013), “AltSchool” (Lapowsky, 2015), “Teach to One” (Brown, 2012), and “ALEKS” (Oremus, 2015).

While massive open online courses (MOOCs) have tremendous potential of "democratizing" higher education—enrollment in MITs first virtual course back in 2012 almost equaled the total number of MITs alumni in its 150 years of existence (Rifkin, 2014)—its impact has not been entirely positive. A study found that MOOCs may in fact be increasing disparities since those registering and completing the courses lived in more affluent and better educated neighborhoods (Hansen & Reich, 2015) and that online courses seem better suited for academically prepared students (Dynarski, 2017). On the other hand, digital inclusion, or the intersection of available high-speed internet and strengthening digital skills (Rhinesmith, 2016), can complement MOOCs since better digital skills lead to higher employability (Pirzada & Khan, 2013) and are valued by employers (Raish & Rimland, 2016).

Telework

Closely related to improving digital skills and broadband is telework or telecommuting. Telework is defined as "Working away from the traditional office using computers and telecommunications facilities to maintain a link to the office." (Belanger, 1999). Research points to the fact that telework is in fact possible due to information technology (Nilles, 1975; Tung & Turban, 1996; Scott & Timmerman, 1999) and is one of the strongest predictors of broadband adoption in metropolitan areas, along with income and education (Tomer & Kane, 2015).

According to research from the Brookings Institution, 13 percent of all new commuters between 2000 and 2014 worked from home, bringing the total number to around 6.5 million (Kane & Tomer, 2015). In addition, telework reduced vehicle trips & emissions in a California pilot study (Koening, Henderson, & Mokhtrain, 1996), increased voluntary/charitable activities compared to non-teleworkers (Kamerade & Burchell, 2004), increased job satisfaction and productivity (Bailey & Kurland, 2002), increased out-of-home activities resulting in a higher work-family balance (He & Hu, 2015) and decreased work-family conflict (Duxbury , Higgins, & Neufeld, 1998).

A related trend to the rise in teleworking is the emergence of the online gig economy. Although the gig economy—alternative workers, independent contractors, and office temps—has been around for a while, improvements in information technology allow these gig workers to plug into a "collection of markets that match providers to consumers on a gig (or job) basis in support of on-demand commerce." (Donovan, Bradley, & Shimabukuro, 2016). In fact, business models and the economy itself are changing because of this on-demand or sharing economy (Parker, Van Alstyne, & Choudary, 2016; Sundararajan, 2016; McAfee & Brynjolfsson, 2017).

A report from Intuit predicts that by 2020, about 40 percent of American workers will be contingent workers and full-time jobs will be harder to find (Intuit, 2010). Recent research support Intuit's prediction. The American Action Forum measured gig workers using nonemployer statistics and found that gig workers outpaced total employment growth between 2002 and 2014 (Rinehart & Gitis, 2015) while research based on survey data by Harvard and Princeton economists found that 94% of the almost 10 million jobs created between 2005 and 2015 took place in the alternative work—defined as independent contractors, freelancers, and contract company workers—category (Katz & Krueger, 2016).

Telehealth

Aside from telework, broadband can also provide health care services through telehealth. According to the U.S. Department of Health and Human Services, telehealth is defined as "use of electronic information and telecommunication technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration" (U.S. Department of Health & Human Services, 2015). In addition to increasing patients' quality of life, telemedicine (which is considered a telehealth component) contributed an average of $522,000 dollars to local rural economies (Whitacre B. E., 2011) and reduced hospitalizations of nursing home residents and generated savings for Medicare (Grabowski & O'Malley, 2014). A pilot patient-centered medical home model using information technology also reduced medical and pharmacy costs lowering hospital admissions and readmissions (Rosenberg, Peele, Keyser, McAnallen, & Holder, 2012). Another study estimated over $180,000 in annual potential savings per rural medical facility (Schadelbauer, 2017). However, although telehealth is nearing mainstream acceptance, significant legal and administrative obstacles remain (Chapman, 2017) in addition to lack of broadband or bandwidth (Settles, 2017).

Also related to telehealth is the mHealth market that is expected to reach $102 billion dollars globally by 2022 according to the market research firm Zion (Zion Market Research, 2016). mHealth is defined as the provision of health services enabled by mobile communications (The Boston Consulting Group, 2012) and according to the cardiologist and futurist Eric Topol has the potential to revolutionize healthcare (Topol, 2016).

Smart Cities, Big Data, & Artificial Intelligence

On top of telework and telehealth, broadband is central to the smart city concept. This concept relies on the Internet of Things (IoT), which allows the "physical world to be digitized, monitored, measured and optimized" resulting in an estimated economic impact between $3.9 and $11 trillion per year by 2025 (Baily & Manyika, 2015). A key component of the IoT is big data and artificial intelligence. Futurists argue that the oil of the 21st century is big data, but like oil, it needs to be refined—through algorithms—into gasoline to be useful (Sondergaard, 2015). A report completed by the professional services company PwC estimated that artificial intelligence alone will add $15.7 trillion to the world economy by the year 2030 (PwC, 2017) and that great potential exists when electrical devices are "cognified" (Kelly, 2016).

Artificial intelligence and IoT are components of what is being termed Industry 4.0, impacting manufacturing productivity and growth. Using Germany as an example, the Boston Consulting Group estimated that Industry 4.0 would boost productivity by €90 to €150 billion and employment by 6 percent across all manufacturing sectors over the next five to ten years. Industry 4.0 refers to a fourth wave of technological advancement preceded by the steam engine, electrification and automation that includes augmented reality, autonomous robots, simulation, additive manufacturing (also called 3D printing) and cybersecurity among other technological advancements (Rubmann, et al., 2015).

Industry 4.0 will rely on fully integrated data and product flows allowing customization through machine-to-machine and machine-to-human interaction. Already, this is causing artificial intelligence related jobs to garner $300,000 to $500,000 per year (Metz, 2017). This movement is also impacting manufacturing, provides opportunities to urban

and rural areas alike, and consists of decentralized creativity, "democratizing" manufacturing using online tools and 3-D printing as a source of experiential learning and skills-building. It also provides a venue to solve problems from the bottom up by entrepreneurs, do-it-yourselfers, artisans and tinkerers (Muro & Hirshberg, 2017).

Just like the IoT will revolutionize manufacturing and smart cities, driverless car technology is getting ready for prime time as well. Intel defines the "passenger economy" as the economic and societal value generated by fully autonomous pilotless vehicles. This value—reaching $7 trillion by 2050—includes more productive use of driving time, shorter commutes due to less traffic and curbside appeal in free parking and urban space (Lanctot, 2017).

However, IoT will also generate a larger, more vulnerable network to cyberattacks. For this reason, cybersecurity is an emerging trend worth keeping in mind. According to the research firm Juniper, cybercrime will cost upwards of $2 trillion by 2019 (Juniper Research, 2015). In addition, the Cybersecurity Ventures company estimates there will be a demand of about 3.5 million cybersecurity workers by 2021 (Cybersecurity Ventures, 2017).

Agriculture

Finally, IoT and big data already have an impact on agriculture (Gilpin, 2015). A technique called "precision agriculture" has relied on multiple technologies, such as GPS-guided equipment for several decades (Alabama Cooperative Extension System, 2014; CBS News, 2015) and now is leveraging newer technologies, such as unmanned aerial systems (Dillow, 2015). Researchers argue these efforts have revolutionized agriculture to a point that in fact has "liberated the environment" by decoupling agricultural inputs compared to outputs (Ausubel, 2015). A study found that the U.S. counties most heavily involved in agricultural production have better connectivity than the average nonmetro county; however, many still lack the capacity to upload large amounts of information that may be required for some precision agricultural techniques (Whitacre, Mark, & Griffin, 2014).

Conclusions

Broadband and the digital applications it makes possible are impacting residents, businesses, and governments alike. This condensed literature review has focused on the array of research that has documented broadband's impact on topics ranging from economic development to civic engagement and fields as diverse as healthcare and agriculture.

While some researchers argue that the true impact of digital applications are not being properly measured (Brynjolfsson & McAfee, 2014), recent research has found that the Internet sector in the U.S. was responsible for six percent of real GDP in 2014 or about $966 billion surpassing chemical products, accommodation and food services among others (Siwek, 2015). Furthermore, research found that the digital services subsector of advanced industries was responsible for 60 percent of the advanced industries employment growth since 2014 (Muro, Kulkarni, & Hart, 2016) and that digital flows—only 15 years old—now have a larger impact on centuries old goods trade (Manyika, et al., 2016). These impressive figures have ample room to grow considering that one estimate put the U.S. economy as running at about 18 percent of its digital potential (Manyika, et al., 2015).

Broadband applications are already impacting the workforce. A study found that nearly two-thirds of new jobs created between 2010 and 2016 required medium to high digital skills in the U.S. (Muro, Liu, Whiton, & Kulkarni, 2017). Further, a global study of 46 countries estimated that by 2030 between 75 million to 375 million workers—about 3 to 14 percent of the global workforce—will need to switch occupational categories (Manyika, et al., 2017).

In addition, research is also showing that automation is a legitimate threat to employment and wages. A study found that up to 47 percent of total US employment is susceptible to being computerized over the next two decades (Frey & Osborne, 2017). Furthermore, a report by the McKinsey Global Institute found that 1.1 billion workers and $15.8 trillion in wages worldwide are technically automatable today (Manyika, et al., 2017). Lastly, between 1990 and 2007 for every industrial robot added per one thousand workers, employment and wages decreased in local labor markets (Acemoglu & Restrepo, 2017).

There are ample opportunities and challenges associated with this rapidly evolving digital age. Frameworks, such as the Intelligent Community concept, exist to help communities and regions transition to, plan for, and prosper in the digital age (Bell, Jung, & Zacharilla, 2014; Intelligent Community Forum, 2015). But perhaps the most pressing issue is the digital divide. The digital divide consists of people or communities who have access, can afford, and have the knowledge to leverage the technology to improve their quality of life versus those that do not have access, cannot afford, and lack the knowledge. Those on the wrong side of the divide are left further and further behind making digital inclusion strategies critical.

A little more than 50 percent of U.S. adults felt unprepared, traditional learners or reluctant when it came to digital readiness (Horrigan J. B., 2016). Another multi-country study of people ages 16 to 65 found that a little less than 70 percent either couldn't use a computer or their computer skills scored terrible or poor (OECD, 2016). Lastly, 67 percent of adults in the world used the Internet occasionally or owned a smartphone but a 33-percentage point difference exists between developed and emerging countries (Poushter, 2016).

The digital divide is a complex concept but recent efforts exist to measure it and enable communities to have meaningful discussions about it. The Brookings Institute recently published a digital distress report looking at Census tracts in metropolitan statistical areas, including household broadband subscriptions (Tomer, Kneebone, & Shivaram, 2017). The Purdue Center for Regional Development has also developed a digital divide index at the census tract and county level considering both infrastructure as well as socioeconomic indicators affecting technology adoption (Gallardo, 2017).

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