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High-Tech Harvests: How Broadband Internet Access Affects Agricultural Firms

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HIGH-TECH HARVESTS: HOW BROADBAND INTERNET ACCESS AFFECTS AGRICULTURAL FIRMS

by

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Abstract

This thesis analyzes the causal impact of increased broadband accessibility on agricultural firm performance. I use 2017 Federal Communications Commission data on broadband access levels and 2019 Business Dynamics Statistics data on agricultural firm performance in order to analyze the impact of county-level broadband Internet access on three economic performance measures: establishment entry rate, establishment exit rate, and net job creation rate. I construct several ordinary least squares regressions that incorporate relevant population control variables, and find statistically significant evidence that broadband is associated with increased establishment entry rates and net job creation in the agricultural sector. Results related to the relationship between broadband access and establishment exit rates are more nuanced, and may be related to technologically-induced job destruction. These findings tentatively support optimism about the effects of expanded Internet access, but further analysis is needed in order to resolve the ongoing debate around the extent of the positive economic impacts of broadband expansion programs.

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Introduction

The COVID-19 pandemic has thrown many preexisting disparities into sharp relief. As individuals with consistent Internet access, our lives are no longer chiefly determined by our physical surroundings; instead, a majority of our work, leisure activities, and social interactions have been pushed online. As of December of 2020, 71 percent of employed Americans were currently working from home (Pew Research Center, 2020). However, a lack of broadband access left a significant population of rural Americans more isolated than ever. For people engaged in predominantly rural economies, such as agriculture, the damaging economic shifts caused by the pandemic were exacerbated by inconsistent Internet access. In many areas, broadband access cushioned the social and economic blow created by COVID-19, and it's crucial to assess the effect that a lack of broadband access creates. Thus, this research project explores how broadband Internet access interacts with a dominant rural industry: agriculture. The metrics that I use to measure impact include establishment entry rate, establishment exit rate, and net job creation rate within the industry.

The Internet is often heralded as a groundbreaking facilitator of the free flow of knowledge. In theory, it could be the ultimate mechanism of socio-economic convergence across regions — it has the capacity to ensure the equitable effusion of technological advances, educational resources, job opportunities, and available products. However, the rural-urban divide continues to persist and elevated poverty rates have remained consistent in rural areas despite the invention and proliferation of the Internet. As of 2015, 13.0 percent of the urban population was poor and 16.7 percent of the rural population was poor (Thiede et al., 2021). Furthermore, while average Internet access for Americans in urban counties surpasses 80 percent, access for

Americans in rural counties is roughly 55 percent (FCC, 2017). As urban lives and considerable economic sectors move online while rural residents are left without consistent broadband access, a closer examination of the economic effects of Internet access is essential in order to promote rural-urban convergence (and to prevent further divergence and rural economic exclusion).

Legislators have already taken notice of this potentially harmful divergence, and have introduced a wave of legislation in efforts to promote broadband access. In the 2021 session alone, nearly every state government has pending legislation related to broadband access (Morton, 2021). On the federal level, some recent pieces of legislation have included S.326, the Measuring the Economic Impact of Broadband Act of 2021, which would institute a biennial assessment of the effects of broadband access; H.R.2411, the Broadband for All Act of 2021, which would create a tax credit for the creation of broadband infrastructure; and H.R.205, the Accelerating Broadband Connectivity Act of 2021, which would fund broadband networks in rural areas. Many representatives rightfully see expanding Internet access as a way to tangibly improve the quality of life and economic prosperity of a significant number of their constituents, and are itching to pump money into Internet infrastructure projects.

However, one of the predominant problems facing rural broadband access has been our lack of knowledge about where gaps in Internet connectivity exist. Bridging the rural-urban Internet access divide is impossible without accurate data on who has access. On March 23rd of 2020, just as we entered lockdown, the Broadband Deployment and Technological Availability (DATA) Act was signed into law. The DATA act sought to improve the FCC’s ability to report data on broadband availability, and they anticipate to complete their updated map of broadband access by fall of 2022.

But, states haven't waited for the completion of the FCC's national map, and instead have started mapping projects of their own. States like Georgia, Maine, and Pennsylvania have worked with companies like Measurement Lab and LightBox to pin down highly specific broadband maps. According to CNET, as of early September, LightBox has pulled wifi and location data to complete a national map of Internet service that some experts are calling the most detailed map of its kind (Tibken, 2021). The FCC's most recent estimates show that roughly 14.5 million Americans lack Internet access. However, LightBox's work paints a more concerning picture. According to their website, LightBox has mapped roughly 97 percent of the U.S. using 2 billion wifi access points, determining that 60 million Americans still lack consistent Internet connection. The company has been able to collect data on addresses, occupancy classifications, and number of businesses or residences for the majority of U.S. structures. Though their state contracting projects are more specific, their current nationwide map still shows if an address has wifi access. It doesn't disclose information on the Internet speeds that each location can access, and notably lacks data for tribal lands (which consistently have deficient Internet access). Regardless of whether 14.5 or 60 million Americans lack broadband Internet access, policy makers have an obligation to allow their constituents to engage in the economy of the Internet age.

I use national broadband mapping resources from the FCC in conjunction with BDS datasets in order to determine whether or not recent broadband legislation has affected tangible change in the agriculture industry. I've chosen to study the agriculture industry in particular because of its integral role in rural communities. Agricultural firms must have access to large plots of land in order to operate; this prerequisite results in the majority of agricultural operations taking place in rural areas. Additionally, over 10 percent of rural workers are employed in resource-based activities such as agriculture, forestry, fishing, hunting and mining (US Census Bureau, 2016). Other rural employers include the education and retail industries, but those industries aren't specific to rural areas. The agriculture industry is a key operator in rural economies, and provides unique insight into how expanded broadband access is affecting workers in nonmetropolitan communities.

Literature Review

In order to deepen my understanding of how broadband Internet access has affected the agriculture industry and the rural areas that facilitate agricultural economies, I've surveyed a broad range of literature that examines the impact of broadband on macroeconomic growth and microeconomic firm and market performance. Though my study is specifically related to the impacts of broadband access, I'm also interested in exploring the broader impacts of Information and Communication Technologies (ICTs) on firms and the broader economy, so I also surveyed research on the effects of access to the broader field of telecommunications.

I've organized my literature as follows: section 2.1 discusses papers that delve into the nuanced economic effects of telecommunications and broadband Internet access, section 2.2 reviews literature where authors explored the various ways that telecommunications and broadband facilitate economic interactions, and section 2.3 outlines the takeaways from literature that specifically concerns telecommunications and broadband policy implications and advice for policymakers.

2.1 The Nuanced Effects of Telecommunications and Broadband Access

Theoretically, evening out disparities in technology access is a clear economic win. Expanding access to the Internet should hypothetically counter information asymmetry, improve firm productivity, and expand customer purchase options. However, as is demonstrated in much of the surveyed literature and within my own work, expanded telecommunications access has nuanced effects that change based on countless factors, including local industry makeup, socioeconomic standing, technological literacy, and policy implementation.

Within their paper on broadband adoption and economic growth, Arvin and Pradhan (2014) maintain a macroeconomic focus and divide their studied countries into developed and developing countries. They structure their analysis in this way because they seek to determine whether broadband access and GDP improvements have a correlated or causal relationship — they want to test whether broadband is a consequence of economic growth rather than it's cause. Arvin and Pradhan's study has inconclusive results related to whether broadband and GDP growth were correlated or causal, which conflicts with many of the other preexisting studies on the subject as well as the widely adopted economic theories that support expanding broadband access.

Atasoy (2013) homes in on data from a single country, the United States, but maintains a macroeconomic focus and came to similar conclusions as Arvin and Pradhan about the uneven effects of broadband access. The author uses county-level panel data and from 1999 to 2007 to study the labor market effects of broadband availability in U.S. counties. This data was plugged into estimation of static ordinary least squares and fixed-effect models, as well as a Granger causality test and a falsification test. Atasoy finds that broadband availability increases employment for workers with college degrees but decreases employment for workers without college degrees, and that broadband-induced employment growth mainly stems from existing firms rather than newly founded firms. Ultimately, they conclude that the positive impacts of broadband availability are more pronounced in counties with higher compositions of and demand for skilled workers, and that rural areas benefit slightly more than urban areas from increases in broadband availability. My data work takes on a similar scope and methodology, but I observe the interaction between broadband availability and a specific industry: agriculture.

Conley and Whitacre (2016) pursue similar questions to myself and Atasoy (2013) within their study of broadband's effect on employees and entrepreneurs in different industries. Rather than dividing county labor forces into college-educated and 'unskilled' workers, they are particularly interested in broadband's effect on entrepreneurs and members of the creative class in rural areas. Like myself and Atasoy (2013), Conley and Whitacre (2016) base their analysis on county-level data. This study reaffirms the nuanced nature of the economic effects of broadband access. Surprisingly, they find that high usage of broadband in rural areas is associated with lower levels of creative-class employees. This may be because increases in broadband adoption may lead to discovered job opportunities in non-entrepreneurial sectors. Thus, it may be concluded that legislation focused on improving broadband adoption may not be the most effective way to bolster levels of rural entrepreneurship.

Similarly, Kandilov and Renkow (2010) are interested in observing the effects of broadband access on rural areas throughout the United States. However, they build upon this central question by specifically analyzing the impacts of two Department of Agriculture programs that were applied to rural areas: the Pilot Broadband Loan Program and the Broadband Loan Program. Kandilov and Renkow (2010) find that the Pilot program had a significant positive effect on employment, annual payroll, and number of firms in rural areas. Despite their initial confidence in the consistent positive effects of broadband, no significant effects are found from the Broadband Loan Program, but not enough time may have elapsed for accurate results to emerge. Though my data is only from seven years after Kandilov and Renkow published this paper, the prominence and availability of broadband access exploded in the 2010s as our economy moved online; during this transition period, it's essential for us to continue to empirically reflect on the changing effects of our broadband policies.

Within their paper, Briglauer et al. (2016) are also interested in examining policy impacts; however, they home in even further, analyzing the impact of a 2010 and 2011 state aid program focused on broadband deployment in the German State of Bavaria. Following their econometric analysis, they conclude that increased broadband access through state aid prevents rural depopulation, but does not contribute to a further closing of the economic divide in the form of creating new jobs. Despite economic theories around information asymmetry and the rural-urban divide, Briglauer et al. (2016) show that increased broadband access isn't a one-size-fits-all remedy for rural economic growth.

Finally, Canzian et al. (2015) demonstrate broadband's nuanced economic effects on a local scale. They seek to analyze the impacts of a government initiative for advanced (ADSL2+) broadband deployment on firm performance in the rural communities of the Italian Province of Trento. Canzian et al. (2015) find that broadband availability had a significant positive effect on annual sales turnover (40 percent increase) and annual value added (25 percent increase) from firms. They also found that broadband access particularly benefited hotels, restaurants, professional, scientific, technical, and administrative industries. The findings of this study may encourage politicians to pass legislation related to broadband access, especially if their constituents are involved in the industries listed above. Canzian et al. (2015) illustrate how industry makeup can determine the impact of broadband on a region; within my agriculturally-focused analysis, the potential positive impacts of Internet access are less clear-cut.

Arvin and Pradhan (2014), Atasoy (2013), Conley and Whitacre (2016), Briglauer et al. (2016), and Canzian et al. (2015) all contribute relevant findings concerning the regional effects of broadband access. Economic theories supporting the benefits of technology lead to the assumption that broadband access would be a universally positive implement. However, these papers have analytically illustrated some of the negative impacts of broadband and have introduced new ways to interpret industry-specific results that have been central to my own empirical analysis of the relationship between broadband and agriculture.

2.2 How Telecommunications and Broadband Facilitate Economic Interactions

Unlike the scientific and administrative industries, agriculture doesn't have many explicitly straightforward applications for Internet access. Thus, this literature review discusses how members of different countries, generations, and communities use the Internet within the agriculture industry.

Zuo (2021) examines the relationship between broadband pricing and labor market outcomes for low-income Americans. In order to approach this central question, they analyze geographic variation in Comcast coverage, individual variation in eligibility for subsidized household broadband programs, and temporal variation pre- and post-launch of regional broadband services. Ultimately, they find that broadband price accessibility increased Internet use, employment rates, and earnings of low-income individuals due to greater labor force participation and decreased probability of unemployment. The Internet is becoming an increasingly important resource for job-seekers, making lack of broadband access a barrier to participation in the labor market. Thus, discounted broadband access has significant positive impacts on low-income individuals' economic outcomes, and discounts should be incentivized via policy in order to bridge the income-broadband gap. My exploration of broadband's effect on agricultural establishments and job creation rates deepens Zuo's analysis of how Internet access affects employment trends.

Stockinger (2019) sets out to conduct a similar analysis of the Internet's effect on employment trends, but approaches their research question through a specific examination of the effect of broadband Internet availability on the employment growth of German establishments. Their analysis pulls from a database of a random sample of business establishments from 2005 to 2010 (the period in which broadband was introduced to rural regions of Western Germany), paired with the local availability of broadband and employment data from the Establishment History Panel of the Institute for Employment Research (IAB). Workers' and firms' broadband availability can't be precisely distinguished, which limits the author's ability to isolate demand- and supply-side effects (I experience similar limitations in my own econometric analysis). Nevertheless, this article's findings contribute to the general sentiment that broadband availability has positive economic effects, especially in knowledge-intensive industries. Stockinger (2019) finds that the perceived economic effects of broadband are more predictable, relevant, and robust in industries where broadband application is straightforward. Broadband doesn't currently have widespread straightforward applications in the agriculture industry, and my analysis takes this malleable usage into account.

Zheng et al. (2021) presents a helpful case study that illuminates how the Internet is being used within the agriculture industry. The authors seek to learn more about the relationship between Internet use and technical efficiency of banana production in China. Within their own literature review, they only found one other study related to the Internet's effect on technical efficiency of crop production, but it also found that it increased efficiency of crop production. Zheng et al. also find that the Internet produces increased technical efficiency in crop production, but that these effects are varied based on preexisting technical efficiency of different firms. If legislators created policies based on these findings, they would promote programs that encourage Internet use in rural areas in order to increase agricultural efficiency and eliminate information asymmetry.

Subejo et al. (2019) provide another case study that demonstrates how Information and Communication Technologies (ICTs) are used in the daily lives of Indonesian farmers in the coastal area of Kulon Progo Regency Yogyakarta. The authors find that farmers primarily use ICTs to access agricultural information around technical production, marketing, policy, success stories, human interest stories, and financing access. Subejo et al. also conclude that farmers had fairly horizontal access to and utilization of electronic media, but those who heavily utilized ICTs were generally young, well-educated, higher-earners, and were adjacent to stronger communications infrastructure. While both Zheng et al. (2021) and Subejo et al. (2019) conduct their empirical analyses in countries in East Asia with different access to technology, political structures, and government regulations than the United States, the core structure and tasks within the agriculture industry bridge international divisions, making both pieces of literature relevant to economic understanding of broadband and telecommunications applications within agriculture.

Rather than completing location-based empirical analysis, Behjati et al. (2021) evaluate current technologies in order to determine how Internet access could shape the agriculture industry in the years to come. The authors develop a farm monitoring system that incorporates unmanned aerial vehicles (UAVs), low-power wide-area networks (LPWANs), and Internet of Things (IoT) technologies to help farmers develop actionable strategies to improve farm productivity. Before delving into their specific recommendations, they review literature surrounding UAV applications in smart farming, water quality monitoring solutions, aerial IoT communications, and drone path planning optimization; these technological assets all have the capacity to improve farm efficiency and inter-location communications. Their system consists of three main recommendations: (i) sensing nodes which are distributed throughout the farm, (ii) implementing a LoRaWAN®-based communication network, which collects data from sensors and conveys them to the cloud, and (iii) developing a path planning optimization technique, which optimizes the drone path for effectively sweeping the farm and collecting data from all established sensors. This system, paired with reliable Internet access, is a clear demonstration of how telecommunications will improve agricultural productivity, and reduce cost and danger associated with farm work. However, the realistic availability of consistent broadband access is a source of unreliability within this study and its applications. Additionally, though they may make life on the farm safer, these technologies also have the capacity to substitute labor, enable offshoring of knowledge-intensive tasks, and promote local job destruction in agricultural firms.

Zuo (2021), Stockinger (2019), Zheng et al. (2021), Subejo et al. (2019), and Behjati et al. (2021) contextualize how the Internet is being used by low-income individuals, rural residents, and farmers. The authors of this literature illustrate the positive effects of ICTs on employment and agricultural productivity; however, they temper their technological optimism with concerns about job destruction. The Internet has the capacity to substitute or complement labor, and the outcome differs in different regions and industries. This nuance is essential to my interpretation of my quantitative work within my thesis.

2.3 Telecommunications and Broadband Policy Guidance

In this literature review so far, we've discussed the various effects of increased broadband access and have reviewed how people are using telecommunications technologies to engage in the economy. Now, we'll be leveraging these findings while evaluating economic literature that advocates for specific policies related to Internet access.

Po-An Hsieh et al. (2012) evaluate the evolution of the Internet TV initiative in LaGrange, Georgia. Rather than pursuing a typical evaluation grounded in econometric analysis, the authors primarily rely on the application of the Actor-Network Theory (ANT). This qualitatively-based methodology incorporates the four stages of project translation: problematization, interessement, enrollment, and mobilization. The authors find that the program was hindered by a lack of consistent interpretation of the legislation across stakeholders (i.e. the government, service providers, socioeconomically advantaged residents, and socioeconomically disadvantaged residents). Ultimately, Po-An Hsieh et al.'s findings offer insights for policymakers intending to achieve universal broadband access, and a framework (Actor-Network Theory) with which to analyze policy implementation. Even if a policy is theoretically and econometrically sound, the challenge of project translation should be anticipated and accounted for during economic analysis.

The challenge of project translation is especially apparent in regulatory policies, and the regulation of ICTs is no exception. While Po-An Hsieh et al. (2012) ground their policy analysis in organizational studies, Briglauer (2015) uses EU27 panel data to gain insight into the effect of regulatory policies and industry competition on the implementation of new communications infrastructure. Ultimately, Briglauer concludes that popular forms of broadband access regulation and competition from mobile operators have significantly hindered investment in new infrastructure, which implies that legislators shouldn't heavily regulate broadband infrastructure.

However, other literature advocates for government involvement in promoting telecommunications infrastructure. Röller and Waverman (2001) present the familiar hypothesis that telecommunications have a positive effect on GDP growth, and additionally advocate for the theory that telecommunications infrastructure is subject to positive network externalities. They confirm that telecommunications adoption has a positive relationship with GDP growth, and that the network externalities related to the industry resulted in a critical mass of access to telecommunications infrastructure that hovers around 40 percent. Thus, Röller and Waverman (2001) would support government initiatives that help countries reach that critical mass of telecommunications infrastructure access.

Gruber et al. (2014) also investigate the ideal role of governments in promoting broadband access. In order to approach this core research question, the authors specifically seek to evaluate the net economic benefits of the European Commission's 2020 broadband infrastructure deployment targets detailed in the Digital Agenda for Europe initiative. Following their analysis, they conclude that the benefits of the DAE may vary considerably based on the preexisting broadband infrastructure available in each of the member countries. They also conjecture about the problems posed by lack of investment in infrastructure; though societal benefits outweigh the costs, they conclude that the private sector is reluctant to invest because they can only capture a portion of the benefits of the infrastructure. Thus, Gruber et al. recommend that the public sector should be responsible for subsidizing high speed broadband infrastructure.

Prieger (2013) also advocates for government involvement in remedying the broadband gap, and his analysis of the rural-urban divide leads to even more specific policy recommendations for the federal government. Following his examination of the rural-urban broadband digital divide, he ultimately comes to the conclusion that the rural-urban division still persists, but that access to slow forms of fixed broadband is relatively equitable. He raises the relevant point that industry-funded studies find large impacts of mobile broadband access, reminding surveyors of broadband-related literature to take certain economic findings with a grain of salt. Prieger's research findings support three forms of federal efforts to address the broadband gap; (1) to provide better information about the broadband market to consumers, (2) to remove the legal obstacles to broadband deployment, and (3), to provide subsidies for broadband deployment and usage.

In order to maximize the economic effects of legislation related to Internet access, policymakers should also consider what devices their constituents will need to use in order to access the Internet. In their empirical study on computer proliferation in rural China, Gao et al. (2018) attempt to determine the effect of computer penetration on the income of rural farmers, concluding that rural computer penetration increased rural incomes over time, but the effects remained limited. Their findings support legislation that would encourage rural computer usage as one of many potential methods of reducing the rural-urban income gap.

Finally, Kandilov (2017) conducts econometric analyses in order to evaluate the USDA Broadband Loan Program. The author prefaces their work by acknowledging that the agriculture industry has experienced positive outcomes in counties receiving broadband loans (as compared to non-recipient counties). Ultimately, she finds that the USDA broadband loans have a positive effect on high-speed Internet and total commodity sales. Thus, this study would support the argument that broadband loan programs should be focused on firms who specialize in crop sales, as these were the farmers who experienced a net increase of total sales following broadband availability.

Po-An Hsieh et al. (2012), Briglauer (2015), Röller and Waverman (2001), Gruber et al. (2014), Prieger (2013), Gao et al. (2018), and Kandilov (2017) all provide insight into the optimization of policies related to expanding telecommunications and broadband access. Though there is not a consensus on the extent of the role that the government should take in promoting Internet access, the majority of the authors support subsidies as a key way to bridge the digital-divide. However, whether we *should* invest in expanding access is still up for debate. The passage of future policies will hinge on whether or not Internet access is primarily considered a right, a utility, or a luxury. Within the scope of my thesis I will not be able to present a definitive answer to that central question, but I will expand upon previous literature to explore how Internet access shapes communities and impacts agricultural economies.

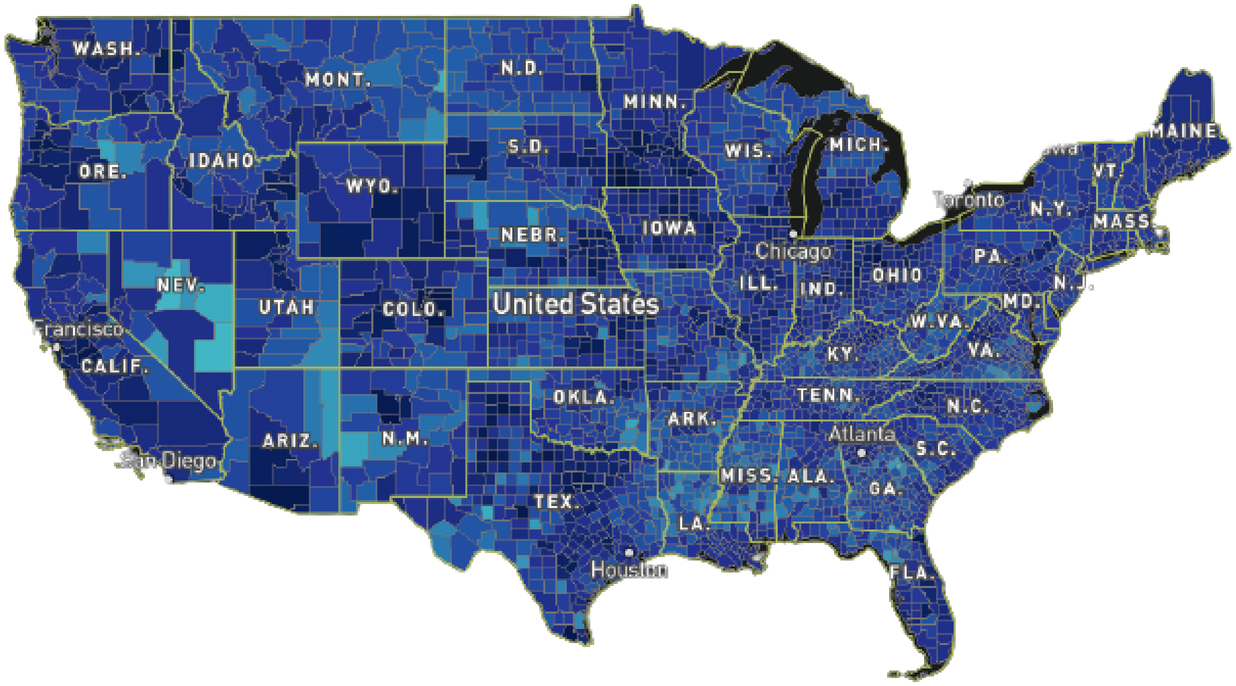
The Theory and Model

As the literature demonstrates, the Internet is a powerful tool for the expansion of knowledge. Government support for broadband access through regulatory policy has the potential to maximize productivity through education, job matching, and technological advancement. A basic production cost model demonstrates that when productivity increases, average total cost falls, and firm profits increase, which causes existing forms to hire new employees and incentivizes new firms to enter the market. This supply-side theory implies that regional access to the Internet is tied to economic growth, illustrated by factors such as higher establishment entry and net job creation rates.

Thus, access to the Internet (or lack thereof), could be a determining factor in the socio-economic convergence of rural and urban regions. Access to broadband is a potential tool to improve the quality of life and firm operations in many rural communities, and as was outlined in my introduction, many legislators have taken action to expand consistent Internet access to their constituents. My data section explores whether this supply-side factor has actually economically impacted one of the most prominent rural industries: agriculture. As illustrated by the original bid-rent model outlined by Heinrich von Thünen, most firms in the agricultural sector require large swaths of land in order to operate (Pászto, 2020). Thus, agricultural firms prefer land that is located further away from metropolitan hubs. This rural land is also less expensive, as most non-agricultural businesses and households prefer to locate themselves as close as possible to the amenities and business opportunities presented in metropolitan areas. This theory explains the essential role that the agriculture industry plays in rural communities. The industry plays a unique and pivotal part in nonmetropolitan areas; thus, observing how broadband specifically impacts agricultural firms provides key insights into the Internet's impact on rural communities.

Theoretically, it's logically consistent that offering public funding for broadband programs would improve any region's economic outcomes. However, economic literature has unearthed significant nuances in the effects of broadband expansion. Therefore, comprehensive economic analysis related to this assumption should be conducted in order to ensure that public funds are allocated as efficiently as possible.

Figure 1: Federal Communications Commissions 2017 map of broadband access



Darker colors signify higher rates of broadband access

I explore the confluence of broadband and agricultural productivity at the national level. In order to examine the level of broadband connection in different regions of the country, I use the Federal Communications Commission's 2017 map data on the percent of households with broadband access by county. The FCC visualization of this data is shown in Figure 1, and is their most recent map to date. The key metric provided by this map is the percentage of the population in a given county with broadband access , along with a considerable number of relevant control variables, such as the percentage of the population below the poverty line, the county's rural-urban continuum code, population density, age breakdowns, gender breakdowns, education levels, number of health professionals per capita, and population health outcomes.

While this dataset has been criticized for inaccurately mapping broadband access on tribal lands and for its lack of granularity (as it only relays data on the county level), the scope of the map and included variables in the dataset can still offer insight into the general relationship between broadband access and agricultural productivity. Future econometric analysis may be able to achieve more specificity by employing more precise maps created by private firms, such as broadband maps created by LightBox.

I merged the 2017 FCC broadband dataset with a Business Dynamic Statistics dataset that charts many of my outcome variables of interest at the county level. This dataset attached North American Industry Classification System (NAICS) codes to each data point, which allowed me to modify my analysis to solely home in on statistics related to the agriculture industry. My primary outcome variables of interest include the establishment entry rate, establishment exit rate, and net job creation rate.

Because I have one central independent variable of interest (percent of population with broadband access) and several dependent variables of interest (the establishment entry rate, establishment exit rate, and net job creation rate), my econometric analysis consists of several ordinary least squares regressions. The dependent variable will change in each regression, but the independent variables are outlined as follows:

$$
\begin{aligned}
Y_i = {} & \beta_0 + \beta_1 pctpopwbbacc + \beta_2 rural + \beta_3 pctpopwbbacc \times rural \\
& + \beta_4 povpct + \beta_5 medianhhinc + \beta_6 pop\_2014 + \beta_7 age\_18\_to\_65\_pct + \beta_8 male\_pct \\
& + \beta_9 rural\_pct + \beta_{10} high\_school + \beta_{11} some\_college + \beta_{12} unemployment \\
& + \beta_{13} poor\_fair\_health\_pct + \beta_{14} years\_lost\_per\_100000 \\
& + \beta_{15} poor\_physical\_health\_days\_within + u_i
\end{aligned}
$$

Y_i represents the dependent variables of interest that I've tested (establishment entry rate, establishment exit rate, and net job creation rate). Rate refers to the percent change of the variable relative to the preexisting level of the variable. β_0 is equivalent to the y-intercept of the linear regression with the given dependent variables. u_i is the random error term, or the distance between the line and the Y_i value that captures what the model's dependent variables can't explain. Because I'm studying the effect of Internet access on rural agricultural firms, percent of population with broadband access (*pctpopwbbacc*) is my primary independent variable of interest within this OLS regression.

As is demonstrated in the reviewed literature, expanded broadband access has varying, sometimes oppositional effects on different industries and regions. Improved broadband access will affect metropolitan counties with workforces that are predominantly engaged in online labor very differently from nonmetropolitan counties with a heavily agrarian workforce. In order to incorporate this key component of regional and urban economic theory, it is essential to include an independent variable in my model that specifies whether the county was metropolitan or nonmetropolitan. I used the USDA rural-urban continuum codes available in the FCC dataset in order to create a nominal variable that I named "rural." This nominal variable was coded to equal 1 when the county's rural-urban continuum code was 4 or greater, meaning that it was classified as a nonmetropolitan county. The nominal variable was coded to equal 0 when the county's rural-urban continuum code was less than or equal to 3, meaning that it was classified as a metropolitan county. Descriptions of each of the individual rural-urban continuum codes may be found in Table 1.

Table 1: USDA Rural-Urban Continuum Codes

Metropolitan Counties	
Code	Description
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetropolitan Counties	
Code	Description
4	Urban population of 20,000 or more, adjacent to a metro area

5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

Additionally, I created an interaction term that encapsulates the “rural” dummy variable and broadband access quantitative variable. This interaction term allows my regression functions to have a different intercept and slope for the nonmetropolitan and metropolitan counties present in my data. It also accounts for the distinct environments that have the potential to lessen or magnify the economic effects of expanded Internet access.

I also include a variety of control variables related to relevant population characteristics. These control variables were collected in the FCC dataset, and include data related to economic standing, community size, population age, gender breakdowns, education level, employment, and health. I choose to include these variables because they are all theoretically related to the agriculture industry, employment, and the openings and closures of establishments.

The percent of the population below the poverty line (*povpct*), median household income (*medianhhinc*), and unemployment rate (*unemployment*) in each county could all have a direct relationship with the amount of disposable income that people have available to support local firms and start their own businesses, affecting both employment rates and establishment opening and closure rates.

Population (*pop*_2014), percent of population that is currently employable (*age*_18_*to*_65_*pct*), and the health and lifespan of the local population (*poor_fair_health_pct, years_lost_per_100000, poor_physical_health_days_within*) all have the capacity to affect the number of people who are available to work in specific industries.

Regional gender breakdowns (*male_pct*) and education levels (*high_school*, *some_college*) also have potential effects on who is willing and qualified to pursue different professions. According to the USDA's 2014 Census of Agriculture, the agriculture industry is still predominantly white and male-dominated, with women making up 30 percent of all farm operators, and white farmers owning 96 percent of the land, 97 percent of the value, and 98 percent of the acres of farmland. Unfortunately, the FCC dataset does not include information on racial composition of each county, but the USDA statistics speak volumes about the people who control the agriculture industry.

The effects of these control variables are shown within betas 4 through 15, but in future references to the model, they will be encapsulated by $\beta_4\boldsymbol{X}$ (with $\boldsymbol{X}$ acting as a stand in for all of the control variables). Thus, in the future, the model will appear as follows:

$$Y_i = \beta_0 + \beta_1 pctpopwbbacc + \beta_2 rural + \beta_3 pctpopwbbacc \times rural + \beta_4\boldsymbol{X} + u_i$$

Data

I use data from the Federal Communications Commission's 2017 broadband map and the 2019 Business Dynamics Statistics datasets. These datasets are the most recent of their kind, and the data was available via the BDS and FCC government websites. Both datasets consist of cross-sectional data.

BDS tabulations are created through a combination of administrative and survey-collected data submitted by employers. Within my edited BDS dataset, there are 3,248 observations. I've dropped a significant number of the original observations; within this round of data research, I've solely been interested in observations obtained in 2019 that concern the agricultural industry (North American Industry Classification System code 11). Observations from the year 2019 are used because it was the most recent reliable dataset provided by BDS, and would reflect the initial effects of the broadband policies that were implemented in the late 2010s. Because I focus on a single industry sector (agriculture) and year (2019), I'm able to drop the sector and year variables from my dataset. I also slightly modified the location variables of the original BDS dataset. I knew that I wanted to use 5-digit Federal Information Processing (FIPs) codes as my common location variable between the BDS and FCC datasets, but the BDS data separated each FIPs code into state and county codes, so I recoded the BDS data to be compatible with the generalized FCC FIPs variable. In my current FCC dataset, my main variables of interest include establishment entry rate, establishment exit rate, and net job creation rate (job creation rate - job destruction rate). The summary statistics associated with these variables are located in Table 2.

Table 2: Descriptive Statistics for Dependent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Establishment entry rate	1,039	4.557	12.402	0	120
Establishment exit rate	1,026	4.247	13.213	0	200
Net job creation rate	1,776	-3.556	42.018	-250	174.779

As demonstrated by their respective means, establishment entry and exit rates were relatively similar, at 4.557 percent and 4.247 percent respectively. These rates balance out to a slightly increasing net establishment creation rate. However, it's notable that despite this slight increase in net establishment creation, the net job creation rate is negative, sitting at about -3.556 percent. This could be explained by the adverse impacts of increases in technological availability; as broadband expands, technological improvements have the capacity to replace human labor and to destroy jobs. This complicates my original hypothesis that broadband would improve the economic wellbeing of rural residents through productivity gains and job growth facilitated by Internet connectivity. Broadband may still improve overall economic well-being as measured by increases in gross domestic product, but may not improve the individual economic conditions for all people living in rural areas.

My independent variables are sourced from the most recent FCC dataset. The FCC constructed their broadband dataset and map from responses from Form 477, a survey filled out by facilities-based broadband service providers in June and December each year. Within this survey, respondents report fixed-broadband deployment data at the census block level — this may result in an overestimated rate of broadband coverage, as service may not be provided to every location in which service is reported. Within my edited FCC dataset, there are 3,142 observations. I eliminated a considerable number of observations that were not conducted at the county level, as I used county-level FIPs codes to merge the BDS and FCC datasets. Additionally, I dropped a majority of the variables measured within the dataset. Originally, the dataset contained 95 variables, and my finalized regressions incorporate 14 of these variables, which are predominantly control variables; the FCC dataset contains a surprising amount of information related to gender, age, education level, access to healthcare, and health outcomes, and I've incorporated the variables that are the most relevant to the agriculture industry. The variables that I'm most interested in are the percent of the population with broadband access, poverty rates, median household income, population size and density, and the rural-urban continuum code associated with each observed location. Summary statistics for all of the relevant independent variables may be found in Table 3.

Table 3: Descriptive Statistics for Independent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max

% of population with broadband access (total)	3,140	64.149	32.553	0	100
% of population with broadband access (rural)	1,974	54.619	32.836	0	100
% of population with broadband access (urban)	1,166	80.283	24.794	0	100
Rural	3,250	.641	.48	0	1
Poverty (%)	3,139	16.847	6.463	3.2	52.2
Median household income	3,139	47,115.40	12,102.241	21,658	125,635
Population (2014)	3,140	101,543.93	326,268.88	86	10,116,705
Age 18 to 65 (%)	3,140	60.186	3.938	40.7	100
Male (%)	3,140	50.115	2.831	43	100
Rural pop (%)	3,136	58.589	31.479	0	100
Population with maximum education of high school (%)	2,671	83.047	9.447	20	100
Population with maximum education of college (%)	3,135	55.743	11.637	2.8	100
Population unemployed (%)	3,134	7.25	2.647	.9	27.7
Population endorsing poor or fair health (%)	2,736	17.26	6.123	4.4	50.8
Years of potential life lost per 100,000 population	2,995	7,999.16	2,420.339	2,398	25,394
Avg # of poor physical health days within the past 30 days	2,801	3.825	1.145	1.1	10

These summary statistics reveal that in 2017, roughly 64.149 percent of Americans had broadband access. Coincidentally, the Rural variable reveals that roughly 64.1 percent of counties are associated with nonmetropolitan FIPs codes. However, I'm inclined to believe that these matching percentages are purely coincidental and weren't caused by any specific economic mechanisms. Rural counties did have lower percentages of broadband access than urban counties, with 54.619 percent and 80.283 percent of the of the population with broadband access respectively.

Some of these statistics, such as mean poverty rate in each county (16.847 percent), male percentage (50.115 percent), and population unemployed (7.25 percent) may differ from nationwide estimates, as these average statistics were calculated by summing the data from each county and dividing by the total number of observations. Because the BDS data is also available at the county level, these discrepancies shouldn't cause a problem within my subsequent OLS regression analysis.

Results

My quantitative work and economic analysis is focused on the dependent variables of establishment entry rate, establishment exit rate, and net job creation. The populations, dominant industries, and health outcomes of the studied counties varied wildly, so focusing my analysis on dependent variables measured in rates ensured that regression coefficients wouldn't be skewed by the population size of each county, as these rates are measured in the percent change of the variable relative to the preexisting level of the variable. Additionally, these three rates encapsulate my other outcome variables of interest, such as job creation, job destruction, and firm deaths.

Establishment Entry Rate

The first OLS regression I ran with my combined dataset examines the effect of broadband access on establishment entry rate. This regression is modeled by:

$$estabs\_entry\_rate = \beta_0 + \beta_1 pctpopwbbacc + \beta_2 rural + \beta_3 pctpopwbbacc \times rural + \beta_4 \boldsymbol{X} + u_i$$

Table 4 outlines the values of the regression coefficients, their p-values, and how they shift based on control variables.

Table 4: Regression Results With Establishment Entry Rate as the Dependent Variable

	(1)	(2)	(3)	(4)	(5)	(6)
pctpopwbbacc	.033***	-.087*	.021*	.105***	-.003	.078***
	(.012)	(.048)	(.012)	(.015)	(.02)	(.027)
pctpopwbbacc^2		.001**				
		(0)				
rural			-1.962***	6.987***	-.699	6.613***
			(.73)	(1.502)	(.892)	(1.862)
1.rural#c.pctpopwbbacc				-.122***		-.103***
				(.022)		(.027)
povpct					.108	.096
					(.117)	(.117)
medianhhinc					0*	0
					(0)	(0)
pop_2014					0***	0***
					(0)	(0)
age_18_to_65_pct					-.275*	-.269*
					(.144)	(.143)
male_pct					-.286	-.215
					(.192)	(.189)
rural_pct					-.011	.003
					(.023)	(.023)
high_school					.015	.021
					(.043)	(.044)
some_college					-.032	-.04
					(.058)	(.058)
unemployment					-.114	-.166
					(.215)	(.216)
poor_fair_health_pct					-.037	-.037
					(.146)	(.146)
years_lost_per_100000					0	0
					(0)	(0)
poor_physical_health_pct					.479	.379
					(.65)	(.652)
_cons	2.341***	4.133***	4.281***	-2.537***	31.495***	22.369**
	(.898)	(1.135)	(1.041)	(.946)	(11.813)	(11.352)
Observations	1038	1038	1038	1038	900	900
R-squared	.007	.013	.012	.03	.045	.054

*Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1*

Broadband access does not appear to have a particularly strong impact on the entry rate of agricultural establishments, but the p-values attached to the various regressions within the table imply that increased broadband access has a slightly positive impact on establishment openings.

Once more control variables are added, it also appears that if a county is a rural, nonmetropolitan area, establishment entry rate increases substantially. This result reaffirms the findings from Weiler et al. (2017) and other regional economics literature that show that rural areas encourage entrepreneurship. Additionally, rural areas are inherently better-suited to the entry of agricultural establishments, as they offer more space to farm, garden, or to execute other agricultural projects; this pattern is explained by the bid-rent model. However, this result is potentially negated by the coefficient attached to the interaction term between rural and broadband, as its negative value means that the positive effect of broadband on entry is lower in rural areas.

Furthermore, even though rural, less populous areas appear to encourage greater establishment entry rates, a given county's 2014 population also appears to have a positive, but miniscule relationship with establishment entry rate. This relationship was bound to be positive, because larger populations offer a larger base of customers and employees, encouraging establishments to open more frequently. Its scale is also unsurprising, as a one-person increase in population won't have much effect on whether an agricultural entrepreneur decides to open a new establishment. An unexpected effect related to population age is that as the portion of the working age population increased, establishment entry rate decreased. I initially anticipated that a larger employee base would result in a greater rate of establishment entry, as people would have more disposable income and employers would have a greater number of employees to staff their establishments. However, this coefficient could only be corroborated at the p-values of .06 and .056, which provides indefinite evidence of the connection between the working age population and establishment entry rate. The p-values attached to the rest of my population controls were not low enough to reject the null hypothesis that the variable coefficients were equal to zero.

Establishment Exit Rate

The second OLS regression I ran examined the effect of broadband access on establishment exit rate. This regression is modeled by:

$$estabs\_exit\_rate = \beta_0 + \beta_1 pctpopwbbacc + \beta_2 rural + \beta_3 pctpopwbbacc \times rural + \beta_4 \boldsymbol{X} + u_i$$

Table 5 outlines the key characteristics of my regression coefficients.

Table 5: Regression Results With Establishment Exit Rate as the Dependent Variable

	(1)	(2)	(3)	(4)	(5)	(6)
pctpopwbbacc	.007	-.099	.002	.05***	-.033	-.027
	(.014)	(.074)	(.018)	(.018)	(.033)	(.032)
pctpopwbbacc^2		.001				
		(.001)				
rural			-.608	4.662*	.953	1.494
			(.787)	(2.423)	(.883)	(3.294)
1.rural#c.pctpopwbbacc				-.07**		-.007
				(.031)		(.04)
povpct					-.143	-.144
					(.163)	(.165)
medianhhinc					0	0
					(0)	(0)
pop_2014					0**	0**
					(0)	(0)
age_18_to_65_pct					-.154	-.154
					(.171)	(.17)
male_pct					.111	.116
					(.292)	(.3)
rural_pct					-.008	-.007
					(.031)	(.029)
high_school					-.115*	-.114*
					(.063)	(.063)
some_college					.241**	.24**
					(.107)	(.105)
unemployment					.539**	.534**
					(.26)	(.272)
poor_fair_health_pct					.2	.202
					(.165)	(.17)
years_lost_per_100000					0	0
					(0)	(0)
poor_physical_health_pct					.976	.963

					(.962)	(.976)
_cons	3.79***	5.488***	4.403***	.474	-4.91	-5.576
	(1.051)	(2.082)	(1.576)	(1.563)	(24.083)	(24.229)
Observations	1025	1025	1025	1025	910	910
R-squared	0	.004	.001	.005	.043	.043

*Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1*

My key variable of interest, the percent of the population with broadband access, doesn't have a statistically defensible effect on establishment exit rate in the majority of my regressions. Its positive coefficient of 0.05 in regression (4) is a notable exception, as this coefficient is attached to a p-value that was less than 0.01. This regression incorporates the interaction variable between broadband access and rural status, but doesn't possess the various control variables that I add in regressions (5) and (6).

Once again, the 2014 population variable has a consistently low p-value. It is once again miniscule, which makes sense when you consider the units in which the population variable was measured (as the addition of one more person to a population is unlikely to dramatically shift the establishment exit rate). However, I was surprised that the population variable is still positive. Intuitively, I would assume that a larger population would serve as a larger consumer base that would support agriculture establishments by providing labor and financial solvency. It may be possible that a larger population results in quicker turnover rates for agriculture establishments; the scope of my paper doesn't permit the in-depth exploration of this pattern, but it could be a relevant area of further study in regional economics.

My control variables related to education are also associated with some statistically relevant coefficients. When the percentage of the population with a maximum education of high school increases, the establishment exit rate decreases. Conversely, when the percentage of the population with a maximum education of college increases, the establishment exit rate increases. These coefficients demonstrate that as a given county's education levels increase, rates of agriculture establishment closures also increase. This makes sense, as many jobs within the agriculture sector don't require a college degree, and many college graduates reside in more metropolitan areas and seek employment in sectors outside of agriculture. This frequent incompatibility results in the education coefficients demonstrated in regressions (5) and (6).

Within the establishment exit rate regressions, the unemployment variable also has a statistically significant and logically consistent coefficient. Unemployment is positive, has a p-value of less than 0.05, and sits at a value of roughly 0.53, meaning that as it increases by 1 percent, the exit rate of agriculture establishments increases by about 0.53 percent. Local establishment closures are directly linked to increased rates of unemployment, and the decreased disposable income created by unemployment results in establishment closures. This unfortunate cycle is demonstrated by the relatively large coefficient attached to unemployment within the fifth and sixth establishment exit rate regressions. Aside from broadband access, 2014 population, education levels, and unemployment, the p-values attached to the rest of my variable coefficients are larger than 0.1 — not low enough to reject the null hypothesis that the variable coefficients were equal to zero.

Net Job Creation Rate

The third OLS regression I ran examines the effect of broadband access on net job creation rate. This regression is modeled by:

$$net\_job\_creation\_rate = \beta_0 + \beta_1 pctpopwbbacc + \beta_2 rural + \beta_3 pctpopwbbacc \times rural + \beta_4 \boldsymbol{X} + u_i$$

Table 6 illustrates the coefficients, p-values, and robust standard errors related to the variables in my various net job creation rate regressions.

Table 6: Regression Results With Net Job Creation Rate as the Dependent Variable

	(1)	(2)	(3)	(4)	(5)	(6)
pctpopwbbacc	.114***	.286*	.097**	.134*	.039	.195*
	(.033)	(.16)	(.044)	(.072)	(.057)	(.11)
pctpopwbbacc^2		-.002				

		(.001)				
rural			-2.307	1.689	-2.407	12.012
			(2.145)	(7.462)	(2.723)	(9.233)
1.rural#c.pctpopwbbacc				-.054		-.2*
				(.09)		(.113)
povpct					.41	.393
					(.327)	(.326)
medianhhinc					0	0
					(0)	(0)
pop_2014					0	0
					(0)	(0)
age_18_to_65_pct					-.324	-.309
					(.417)	(.417)
male_pct					.677	.78
					(.624)	(.618)
rural_pct					-.006	.026
					(.058)	(.061)
high_school					.203	.207
					(.175)	(.176)
some_college					-.084	-.097
					(.147)	(.147)
unemployment					-.253	-.345
					(.492)	(.491)
poor_fair_health_pct					-.754**	-.74**
					(.352)	(.351)
years_lost_per_100000					0	0
					(.001)	(.001)
poor_physical_health_pct					2.727	2.516
					(1.667)	(1.666)
_cons	-11.293***	-14.052***	-8.929**	-11.942*	-40.059	-56.825
	(2.461)	(4.412)	(4.017)	(6.399)	(38.708)	(38.79)
Observations	1774	1774	1774	1774	1569	1569
R-squared	.007	.008	.007	.008	.009	.012

*Robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1*

The coefficient attached to the percent population with broadband access variable has a consistently low p-value. Within my various regressions, the broadband coefficient is consistently positive and hovers around 0.15, meaning that if the percentage of the population with broadband access increases by 1 percent, the net job creation rate for the agricultural sector would increase by about 0.15 percent. This positive correlation between Internet access and job creation aligns with previous economic literature; the Internet allows people to connect with educational resources and greater numbers of job opportunities, and it allows firms to reach a greater number of customers and potential employees. These benefits are bound to increase net job creation, which is reflected in the various regressions shown in Table 2.3.

The coefficient attached to the interaction variable between broadband access and rural (nonmetropolitan) status also possesses a relatively low p-value in regression (6). The coefficient is valued at -0.2, meaning that when a county is rural, the positive association between broadband access and net job creation decreases. Increased broadband access may have a smaller effect on net job creation in rural counties because in nonmetropolitan areas, the agriculture industry consists of farms. Where metropolitan employees may be working on the corporate, logistical, and research and development sides of the agriculture industry, nonmetropolitan employees are predominantly assigned physical tasks that keep crops growing and farms running. When broadband expands to rural areas, it has the potential to enable farming technologies that replace the need for human employees. As Behjati et al. (2021) describe, expanded broadband allows for the use of aerial drones, water quality monitoring systems, and optimized communication systems. These technologies monitor farms much more efficiently than any human employee could. Thus, expanded broadband access could even result in agricultural job destruction in rural counties; this explains the negative interaction coefficient between broadband access and nonmetropolitan NAICS status.

The final variable attached to statistically significant coefficients is the percent of the county population who self-reported poor or fair health when asked whether their health was excellent, very good, good, fair, or poor. In the two regressions where this population control variable was included, its coefficient hovers around -0.75, meaning that when the percent of the population endorsing poor or fair health in a given county increases by 1 percent, net job creation in that county's agriculture sector would decrease by 0.75 percent. This makes sense, because jobs in the agriculture sector are oftentimes very physically demanding. Thus, when county health declines, agriculture job creation rates decrease. Aside from county population endorsing poor or fair health, broadband access, and the broadband/rural interaction term, the p-values attached to the rest of my variable coefficients are larger than 0.1 — not low enough to reject the null hypothesis that the variable coefficients were equal to zero, and not low enough to confidently incorporate them into my regression analysis.

My econometric analysis reemphasizes the nuanced effects of expanded broadband access that were discussed in my literature review. The resources provided by widespread access to the Internet increase productivity, which in turn increases gross domestic product. However, despite increases in this metric of economic well-being, individual agricultural workers may be worse off due to stagnant rates of job creation or potential job destruction due to the proliferation of farming technology. Agriculture is an industry that lacks straightforward broadband applications, and further econometric observation is essential in order to implement policies that expand broadband access and protect agricultural communities.

Conclusion

There is already considerable policy attention being paid to federal and state government investment in expanding broadband Internet access, and this interest is only growing as our lives move further online. The newly-passed federal infrastructure bill includes $65 billion explicitly dedicated to improving rural broadband access. However, my analysis has demonstrated that the empirical evidence of a causal relationship between increased broadband infrastructure and improved agriculture establishment performance is indefinite. The r-squared values attached to my OLS regressions are relatively small (with a top value of 0.054, found in regression (6) in Table 4). Furthermore, strengthened broadband access has the potential to usher in technologies that may adversely affect rural employment rates. These findings reaffirm many of the nuanced conclusions presented in preexisting literature, and I'm curious to witness the long-term economic effects of the widespread rollout of broadband-focused legislation.

Prior to this thesis, the essential role that the Internet plays within my own life led to the assumption that broadband access would be a universally positive implement that was increasingly essential to economic engagement. I'm a member of the first generation whose culture, lifestyle, and technological literacy has been crafted by the Internet since childhood. The literature I analyzed enabled me to expand my own understanding of the online world as I became familiar with how members of different countries, industries, and communities use the Internet. Thus, my econometric analysis acknowledges the gains and losses inherent in broadband expansion.

Though the results of my macroeconomic OLS regression analysis don't definitively demonstrate a causal relationship between broadband access and a bolstered agricultural economy, they still contain information that supports a relationship between agriculture and broadband. The connection between increased establishment entry rate and expanded broadband access is predominantly positive and statistically significant. I also found that net job creation and broadband access has a statistically significant positive correlation. The relationship between broadband access and the agricultural establishment exit rate has less statistical support, and would benefit from further analysis as the economic effects of broadband-centric policies are realized in the coming years.

This thesis is connected to many essential areas of future study. My analysis worked with the 2017 FCC map of broadband access, and though it provided many beneficial population control variables, the map has been criticized for its lack of granularity (as results are reported at the county level) and questionable accuracy relative to maps created by private firms. Future research may benefit from a micro-level economic analysis that uses data from a map created by a private firm rather than the FCC. Alternatively, researchers can use the upcoming FCC map that is being constructed as a result of the 2020 federal DATA Act.

Furthermore, though I've been able to incorporate a decent number of control variables, metrics concerning race and ethnicity aren't included in either of my central datasets. To ensure equitable broadband policy implementation, race-based analysis must be incorporated. As of 2020, 21 percent of rural residents were people of color (Loh et al., 2020), and broadband-based policies have the potential to massively impact their lives. Finally, future analysis about the agricultural sector would benefit from environmental control variables. The performance of agricultural firms is highly contingent on the weather conditions of a given season or year, and data on weather, natural disasters, and soil quality would prevent statistical oversights and paint a fuller picture of the circumstances of different agricultural firms in a given year.

Though current data availability pushed my econometric analysis towards a national scope, the confluence of broadband and agricultural productivity is ripe for more specific regional study. Alongside federal legislation, states such as Georgia have devoted considerable resources to improving broadband access in rural areas. One such piece of legislation is the Georgia Broadband Deployment Act. This initiative created a team of five state agencies (known as the Inter-Agency Team) committed to establishing broadband programs and increasing infrastructure and services across the state. With so many state resources and dollars going towards these projects, further econometric analysis is essential, and should be conducted on the microeconomic level. In order to implement effective legislation, policymakers must be attentive to the industry makeup, technological literacy, and educational background of the regions that their programs will impact.

Many policies like the Georgia Broadband Deployment Act were passed around the country over the past decade, and we’re continuing to pump a lot of federal and state resources into increased broadband Internet access. It makes logical economic sense to ensure that everyone has access to the Internet; it allows for proliferation and adoption of technology, expanded economic engagement between firm owners and their potential customers, and equitable inclusion in a culture and economy that is increasingly moving online. However, it is essential that we continue to analyze the actual effects of broadband access in order to ensure that government funds are benefiting communities as effectively as possible.

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