



Center
on Rural
Innovation



Beyond Connectivity:

The Role of Broadband
in Rural Economic
Growth and Resilience

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Executive Summary

Broadband access is increasingly recognized as essential infrastructure in today's economy, with the ability to connect residents and businesses to economic opportunities nationwide, even in remote rural areas. However, rural America has lagged behind metropolitan areas in broadband investment, exacerbating economic disparities between rural and nonrural America. The lack of connectivity has hindered rural communities' ability to participate in the 21st-century digital economy, especially with the rise of the knowledge economy. But broadband access may have the most significant potential impact on rural areas in accessing economic opportunities. While recent initiatives have expanded rural broadband access, it can become a transformative tool for rural economic development and resilience only when it is widely utilized and effectively leveraged.

Critically, as this study's findings reveal, higher broadband utilization (higher broadband adoption rates and a higher prevalence of small broadband service providers) improves the economic dynamism of rural areas. Higher broadband utilization also suggests that broadband can help mitigate the economic disadvantages often faced by rural areas. *Rural counties with high broadband utilization see increases in the number of businesses, whereas similar counties without high broadband utilization see the number of businesses decline.* Compared to the control group, rural counties in the high broadband utilization group have:

- **Business growth rates that are 213% higher**
- **Self-employment growth rates that are 10% higher**

Small broadband service providers, many of whom are cooperatives or small, locally operated facilities-based providers, are deeply invested in their communities and are more likely to offer higher-speed fiber broadband service, as well as innovative value-added services that more effectively utilize broadband infrastructure. By way of example, as highlighted in this study, in addition to expanding access to fiber broadband through its GigaZone network, Paul Bunyan Communications in Bemidji (Beltrami County, Minnesota) offers innovative programs like the GigaZone Gaming Championship and TechXpo to engage the community in the digital economy. Through partnerships with the Beltrami Electric Cooperative and Greater Bemidji, Paul Bunyan Communications has also helped establish a technology park and LaunchPad, a business incubator, to foster a dynamic economic ecosystem that supports startups and drives local economic growth. These types of



innovative ecosystems help build wealth and prosperity, and address the underemployment that is more common in rural communities. We find that compared to the control group, rural counties in the high broadband utilization group have:

- **Per capita income growth rates that are 18% higher**
- **GDP growth rates that are 44% higher**

Notably, we find evidence that existing residents are the primary beneficiaries of these economic gains (rather than new arrivals). In stark contrast, areas with the lowest levels of broadband utilization have lower income growth rates and are more likely to experience business closures and population decline. These findings highlight the critical importance of both expanding broadband access and fostering its effective utilization to drive economic growth, enhance resilience, and build a more prosperous future for rural communities.

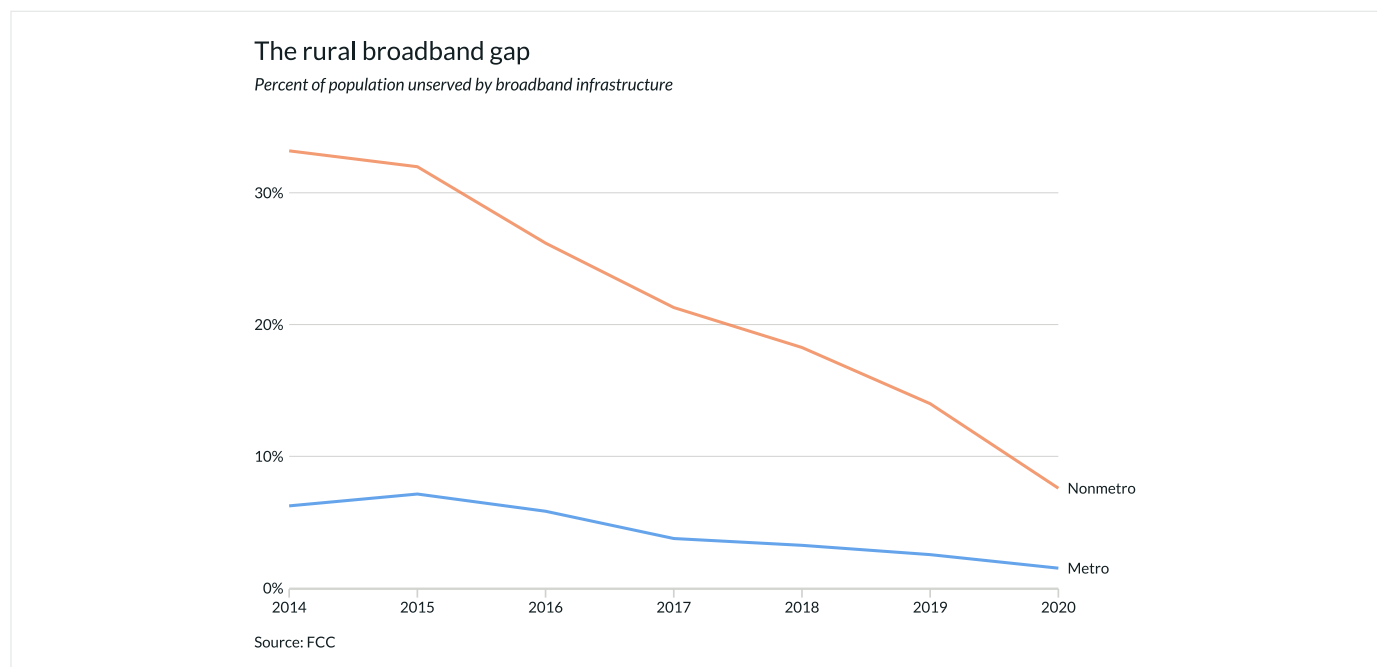


1. Closing the Rural Broadband Gap

With more and more services moving online, from accessing medical records to government services and job applications, broadband is increasingly considered critical infrastructure for most social and economic activities.^{1 2} This may be especially true for the business sector, as broadband can connect businesses to a broader base of customers across the country and globally. Broadband can also connect workers to employers across the country through remote work, expanding the options for where we work and live.³ Thus, broadband access may have the most significant potential impact on rural areas that have been geographically separated from access to economic opportunities, especially when broadband adoption is high and broadband infrastructure is utilized effectively. In this report, we show that higher broadband utilization in rural communities drives economic growth by increasing entrepreneurship while mitigating underemployment and increasing incomes, whereas low broadband utilization is linked to economic decline.

When it comes to broadband infrastructure investments, rural communities have lagged behind metropolitan areas for decades. Rural America has long struggled with inadequate infrastructure funding including for broadband infrastructure. Just 10 years ago there was nearly a 30 percentage point gap in broadband access between rural and nonrural places (see Figure 1). This lack of connectivity has hindered rural communities' ability to participate in the digital economy, especially with the rise of the knowledge economy.⁴ Over the last four decades, smaller towns and rural areas have fallen further behind as geographic inequality has widened, raising concerns within the U.S. Department of Commerce.⁵ Rural residents, including farmers and rural communities of color, who increasingly see the opportunities that broadband access can provide have called to close the digital divide and for the expansion of fiber internet access.^{6 7 8}

Figure 1: Recent broadband investments have helped close the rural broadband gap



¹ Mack, E. A., Loveridge, S., Keene, T., & Mann, J. (2024). A Review of the Literature About Broadband Internet Connections and Rural Development (1995-2022). *International Regional Science Review*, 47(3), 231-292. <https://doi.org/10.1177/01600176231202457>

² Baum, F., Newman, L., & Biedrzycki, K. (2014). Vicious cycles: Digital technologies and determinants of health in Australia. *Health Promotion International*, 29(2), 349-360. <https://doi.org/10.1093/heapro/das062>

³ Center on Rural Innovation. (2024, January). What is possible when high-speed broadband comes to town.

⁴ Center on Rural Innovation. (2023, October). The equity of economic opportunity in rural America. The Rural Aperture Project.

⁵ Office of the Under Secretary for Economic Affairs. (2023). Geographic Inequality on the Rise in the U.S. U.S. Department of Commerce. <https://www.commerce.gov/news/blog/2023/06/geographic-inequality-rise-us>

⁶ The Daily Yonder. (2023, December). 'We're cut off': Rural farmers are desperate for broadband internet. <https://www.agriculture.com/we-re-cut-off-rural-farmers-are-desperate-for-broadband-internet-8418322>

⁷ Muhammad, S. (2024, February). Delta Residents Demand 'Equitable Broadband Access for All' Mississippi Communities. <https://www.mississippifreepress.org/delta-residents-demand-equitable-broadband-access-for-all-mississippi-communities/>

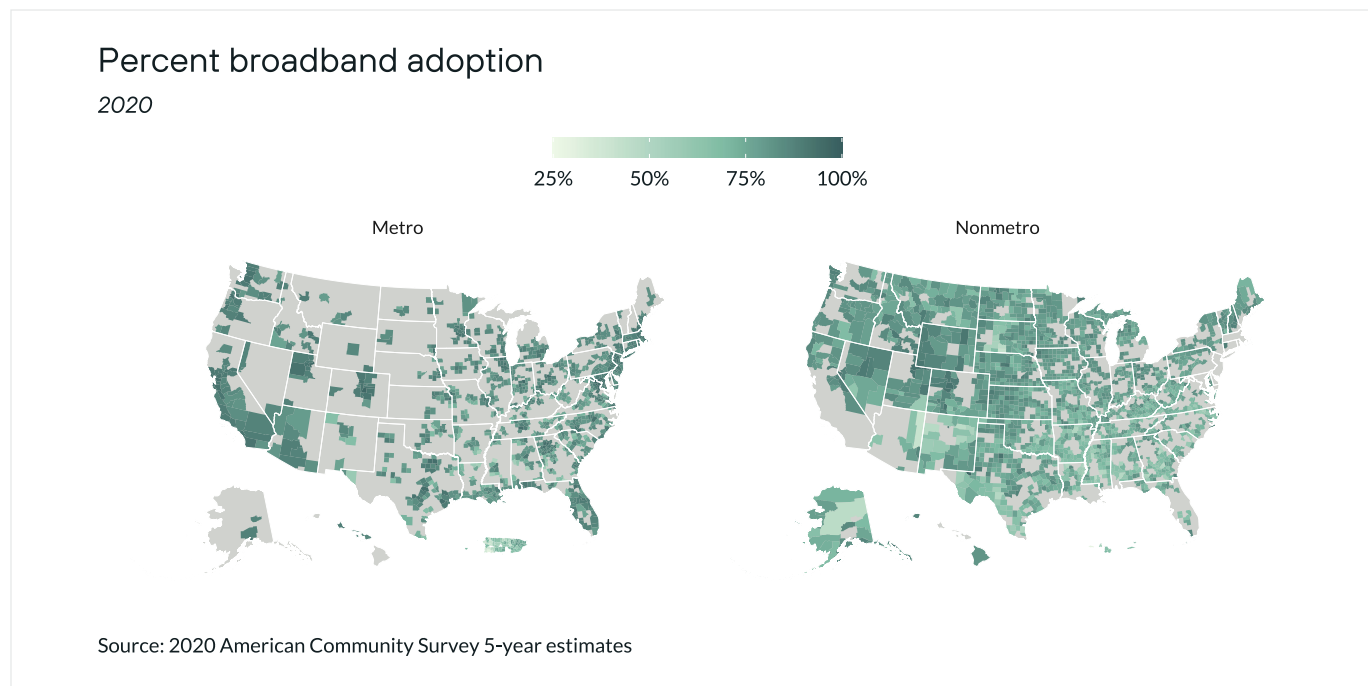
⁸ Lee, N.T., Seddon, J., Tanner, B., & Lai, S. (2022, October). Why the federal government needs to step up efforts to close the rural broadband divide. The Rural Broadband Equity Project. Brookings. <https://www.brookings.edu/articles/why-the-federal-government-needs-to-step-up-their-efforts-to-close-the-rural-broadband-divide/>

Recognizing the importance of closing rural broadband gaps, recent investments have connected millions more Americans across the country (see Figure 1). Many locally operated rural broadband service providers, including cooperatives and small commercial companies, have taken significant steps to bring broadband internet to areas that previously lacked access, similar to the role electrical cooperatives played historically in bringing electricity to underserved regions.⁹ Small, locally operated communications providers have played a crucial role in helping narrow the digital divide, enabling rural communities to participate in the broader economy by ensuring high-speed internet connectivity. Electric co-ops and municipal systems have also played a role in their respective communities. As local and regional actors, cooperatives often leverage their existing infrastructure assets, their ability to tolerate longer returns on investment, and obligation to serve all co-op members to help expand access to critical infrastructure; small commercial locally operated telecom firms operate under the same principles as well. These co-ops and other small broadband service providers stepping up to provide broadband service in rural areas are more likely to be willing to make the up-front investment in better quality infrastructure, higher

speeds, and fiber broadband (see Appendix A). Between 2015 and 2020, the rural population saw an increase of 26 percentage points in broadband access at 25/3 Megabits per second (Mbps) speeds and an increase of 49 percentage points in high-speed access at 100/20 Mbps speed according to Federal Communications Commission (FCC) data.¹⁰ Between 2015 and 2020, the share of the population in rural areas with fiber access increased over 20 percentage points, doubling from 20% to 40% of the population.

Though recent broadband investments are a significant step forward, the full potential of broadband can only be realized when it is widely adopted and effectively utilized. During their effective terms, federal programs such as the Emergency Broadband Benefit and the Affordable Connectivity Program that paid \$30 - \$50 per month for low-income households to connect to broadband helped to boost broadband adoption in rural areas.^{11 12 13} Broadband access that goes beyond basic internet connectivity, particularly fiber broadband, has been shown to move broadband adoption rates in rural areas to more than 80%.¹⁴ While installation is a capital-intensive undertaking, fiber offers far better long-term value than other technologies

Figure 2: Broadband adoption rates are now more similar across the country



⁹ Ali, C. (2021). Cooperatives: The Unsung Heroes of Broadband. The Benton Institute for Broadband & Society. <https://www.benton.org/blog/cooperatives-unsung-heroes-broadband>

¹⁰ Form 477 analysis by the Center on Rural Innovation.

¹¹ The ACP Enrollment Map from RuralLisc and the Center on Rural Innovation shows the percentage of ACP enrollment participation by ZIP code over time. <https://acp-enrollment.ruralinnovation.us/>

¹² Horrigan, J. B., Whitacre, B., & Galperin, H. (2023). Understanding the Affordable Connectivity Program Enrollment: Drivers of Uptake. John B. Horrigan, Benton Institute, Brian Whitacre, Oklahoma State University, and Hernan Galperin, University of Southern California "Understanding the Affordable Connectivity Program Enrollment: Drivers of Uptake."

¹³ Unfortunately, the Affordable Connectivity Program ended in early 2024.

¹⁴ Weng, Sophia. (2022). Could Investments in Community Broadband Bridge the Digital Divide? Urban Institute. <https://www.urban.org/urban-wire/could-investments-community-broadband-bridge-digital-divide#:~:text=Communities%20with%20fiber%20and%20dark.in%20communities%20without%20municipal%20broadband>

because it is more durable, easier to maintain, and it offers exceptional scalable, symmetrical performance, ensuring smoother online experiences for uses like video calls and 4K/8K streaming. Broadband services that go beyond basic internet connectivity, providing additional functionalities and solutions, can also help increase adoption rates and leverage broadband to stimulate economic growth. These value-added services encompass a range of offerings that augment the basic functionality of broadband such as digital navigator programs, e-government services, telehealth, and online education in rural areas. Additionally, initiatives such as pitch competitions, the development of business incubators and accelerators, the provision of public WiFi, coworking spaces, and tech expos can leverage the full potential of the infrastructure to drive economic growth by creating the necessary entrepreneurial ecosystem support that new businesses need to thrive. Through the expansion of broadband and related services, broadband adoption rates (residential broadband subscriptions as a share of the number of households) are now much more similar across the country than they were less than a decade ago (see Figure 2), though disparities still exist especially for rural communities with significant racial and ethnic minority populations. Broadband adoption rates average 80% across rural counties, just 5 percentage points below metropolitan counties at 85%.¹⁵

Previous infrastructure investments, such as rural electrification, spurred structural transformation that brought new manufacturing plants into rural areas.¹⁶ This continued the trend of U.S. industrialization primarily taking place within rural areas through the rise of new factory towns (rather than the relocation of rural workers to larger industrial hubs).¹⁷ Similarly, broadband infrastructure may drive another wave of structural transformation in rural areas. Broadband has the potential to spur economic growth by connecting and further integrating rural America into the fabric of our national and global economies.¹⁸

In this study, we find that higher broadband utilization increases economic dynamism in rural communities. *Rural counties with high broadband utilization see increases in the number of businesses, whereas similar counties without high broadband utilization see the number of businesses decline.* Using a propensity score matching technique, we find that both higher broadband adoption rates in rural counties and counties with a presence of small local broadband service providers — that may be more likely to provide additional broadband services to communities — experienced faster growth rates of new businesses compared to otherwise similar communities. Counties with high broadband utilization also had more people pulled into self-employment (opportunity



entrepreneurs) and higher growth rates of per-capita income. We find evidence that these benefits were largely accruing to existing residents (as we did not find a statistically significant impact on population growth), suggesting that higher broadband utilization may help address underemployment that is more prevalent in rural communities. These high broadband utilization places also experienced higher GDP growth. Conversely, counties with the lowest broadband utilization were more likely to experience population losses as well as lower per capita income growth and more likely to lose businesses. Our results suggest that leveraging broadband infrastructure effectively can help drive economic transformation in rural areas by spurring entrepreneurship.

In what follows, we discuss in more detail the relationship between broadband utilization and economic dynamism in rural America, our statistical methodology, and results. We then highlight rural communities where local broadband service providers are having an outsized positive impact on entrepreneurship and their local economy such as Paul Bunyan Communications in Bemidji, Minnesota (Beltrami County).

¹⁵ American Community Survey, 2022 5 year estimates.

¹⁶ Gaggl, P., Gray, R., Marinescu, I., & Morin, M. (2021). Does electricity drive structural transformation? Evidence from the United States. *Labour Economics*, 68, 101944. <https://doi.org/10.1016/j.labeco.2020.101944>

¹⁷ Eckert, F., Juneau, J., & Peters, M. (2023). Sprouting Cities: How Rural America Industrialized. NBER Working Paper 30874. <https://www.nber.org/papers/w30874>

¹⁸ Guzman, J., Murray, F., Stern, S., & Williams, H. (2024). Accelerating innovation ecosystems: The promise and challenges of regional innovation engines. In Jones, L., & Lerner, J. (Eds.), *Entrepreneurship and Innovation Policy and the Economy* (Vol. 3).

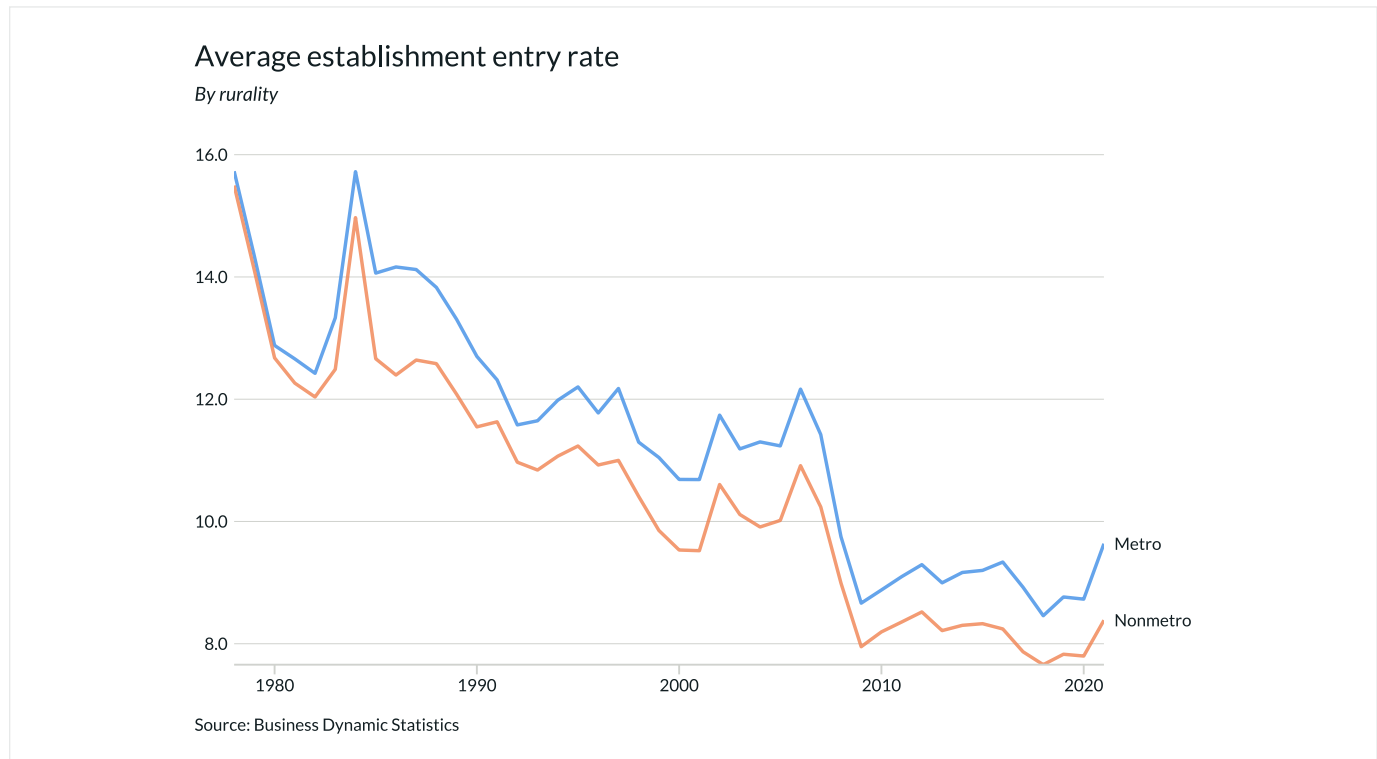
2. Rural Economic Dynamism and Broadband Access

Business startups have long been associated with a more dynamic economy, long-term economic growth, and prosperity.¹⁹ Entrepreneurship is vital for economic growth and job creation not only in large metropolitan areas but also in rural areas — despite challenges like limited infrastructure and fewer agglomeration economies associated with being near a large number of businesses and consumers.²⁰ Small businesses and self-employment are linked to higher employment and income growth, even in more remote and lagging rural regions such as Appalachia and the rural Cotton Belt.^{21,22} High-growth entrepreneurs may be particularly crucial for rural economic development, as they generate jobs, increase incomes, create wealth, enhance residents' quality of life, and enable rural

communities to participate in the global economy.²³ Supporting entrepreneurship and innovation remains a key strategy for rural economic development and resilience.²⁴

Given the vital role of entrepreneurship in driving economic growth and innovation, there is growing concern over the decades-long decline in business dynamism (measured by business entry rates; see Figure 3). Business entry rates have declined in metropolitan and rural (nonmetropolitan) counties, though rural areas have experienced the largest declines. These trends of declining entrepreneurship have widened the gap between rural and nonrural places.²⁵

Figure 3: Declining business dynamism across rural and urban areas



¹⁹ Acs ZJ, Armington C. Entrepreneurship, Geography, and American Economic Growth. Cambridge University Press; 2006

²⁰ Conroy, T., Deller, S. & Kures, M. 2019. "Entrepreneurship in Rural Employment in the US." In Rural Policies and Employment, edited by S. Davidova, K. Thomson, and A. Mishra, 93–108. Europe: World Scientific. https://doi.org/10.1142/9781786347091_0006

²¹ Stephens, H. M., & Partridge, M. D. (2011). Do Entrepreneurs Enhance Economic Growth in Lagging Regions? Growth and Change, 42(4), 431–465. <https://doi.org/10.1111/j.1468-2257.2011.00563.x>

²² Weinstein, A. & Erouart, M. (2024). Swimming Upstream on the Path to Thriving. The Rural Aperture Project. Center on Rural Innovation. <https://ruralinnovation.us/blog/rural-aperture-project-swimming-upstream-on-the-path-to-thriving/>

²³ Jason Henderson, 2002. "Building the rural economy with high-growth entrepreneurs," Economic Review, Federal Reserve Bank of Kansas City, vol. 87(Q III), pages 45–70.

<https://www.kansascityfed.org/documents/1136/2002-Building%20the%20Rural%20Economy%20with%20High-Growth%20Entrepreneurs.pdf>

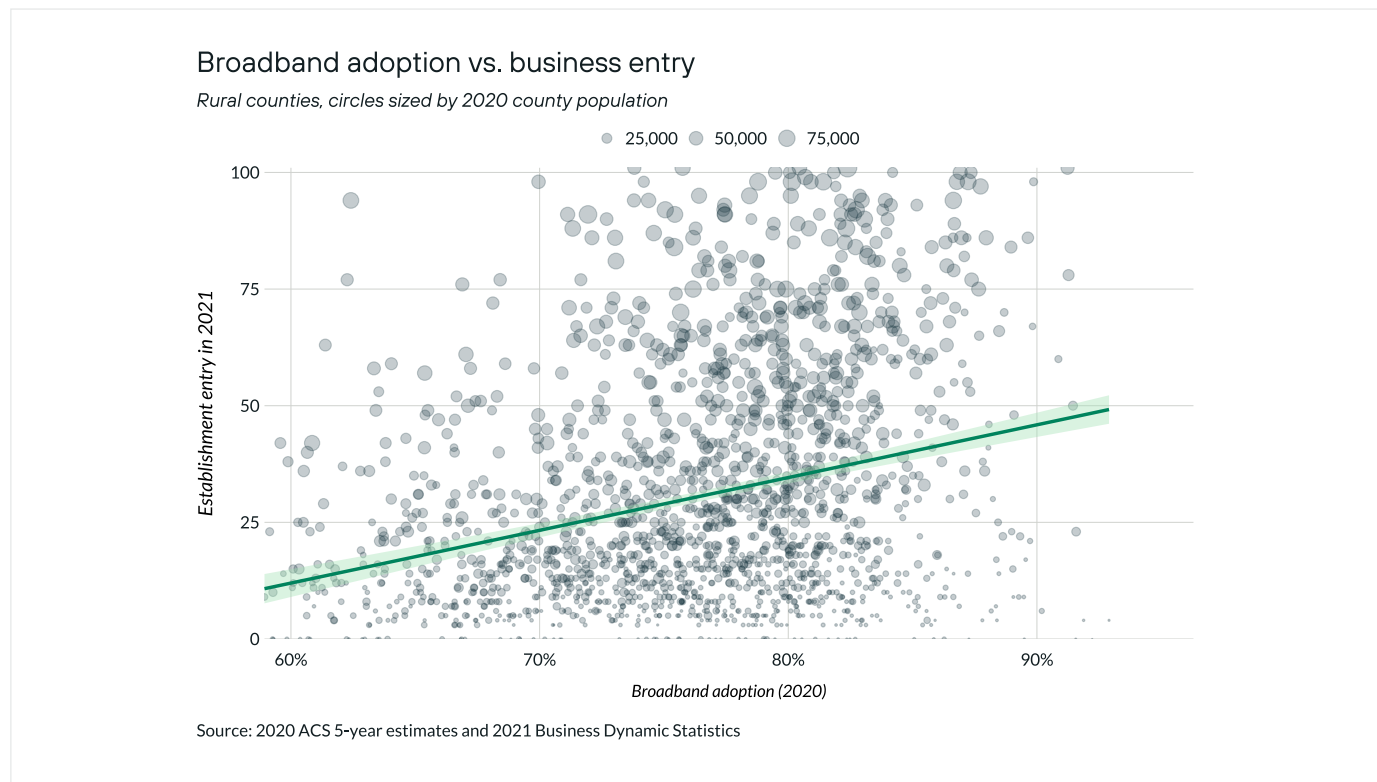
²⁴ Deller, S. & Conroy, T. (2016). Survival Rates of Rural Businesses: What the Evidence Tells Us. Choices, 31(4). <https://www.choicesmagazine.org/choices-magazine/submitted-articles/survival-rates-of-rural-businesses-what-the-evidence-tells-us#:~:text=In%20fact%2C%20the%20analysis%20reveals,where%20the%20rate%20is%2067%25>

²⁵ Center on Rural Innovation. (October, 2023). The equity of economic opportunity in rural America. <https://ruralinnovation.us/blog/equity-economic-opportunity-rural-america/>

Broadband access can significantly lower barriers to starting a business for rural residents by connecting them to global markets and essential resources. High-speed internet, for example, mitigates challenges like limited access to banks and the lack of competition for small business loans.²⁶ It also enables rural entrepreneurs to connect with venture capital funders, who are concentrated in larger coastal metropolitan areas; access to such capital has been shown to improve business outcomes.²⁷ High-speed internet enables entrepreneurs to conduct market research and leverage digital marketing strategies, expanding their customer base and facilitating e-commerce, which allows rural businesses to sell products and services beyond their local area. Broadband can support remote work and collaboration, widening the pool of potential employees

and reducing reliance on physical proximity to urban centers. Additionally, internet access enables households to access online training and education resources, supporting aspiring entrepreneurs in getting started. Overall, this connectivity fosters innovation and economic growth in rural communities, especially as business activities increasingly shift online. Indeed, Figure 3 shows that there was a notable uptick in business entry rates across rural and nonrural places as businesses adjusted to a new way of doing business — online. With business activities moving online, rural places that effectively leverage broadband (with higher broadband adoption rates) have an advantage. Figure 4 shows that rural counties with higher broadband adoption rates have seen significantly more business startups.

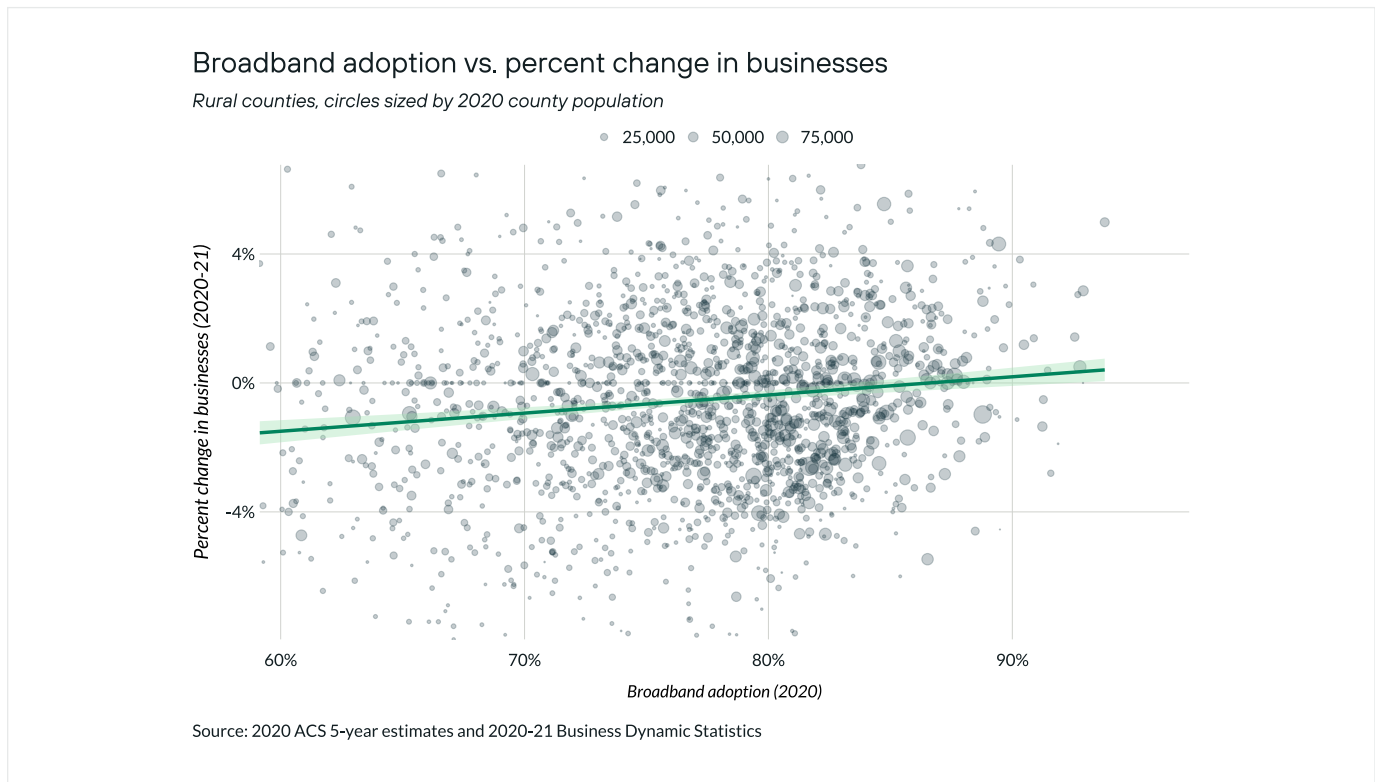
Figure 4: Higher broadband adoption rates are associated with more business startups in rural counties



²⁶ Prieger, J. E. (2023). Local banking markets and barriers to entrepreneurship in minority and other areas. *Journal of Economics and Business*, 124, 106108. <https://doi.org/10.1016/j.jeconbus.2023.106108>

²⁷ Parhankangas, A. (2012). The economic impact of venture capital. *Handbook of Research on Venture Capital: Volume 2: A Globalizing Industry*, 124–158. DOI:10.4337/9781849801683.00014

Figure 5: Higher broadband adoption rates are associated with more business startups in rural counties



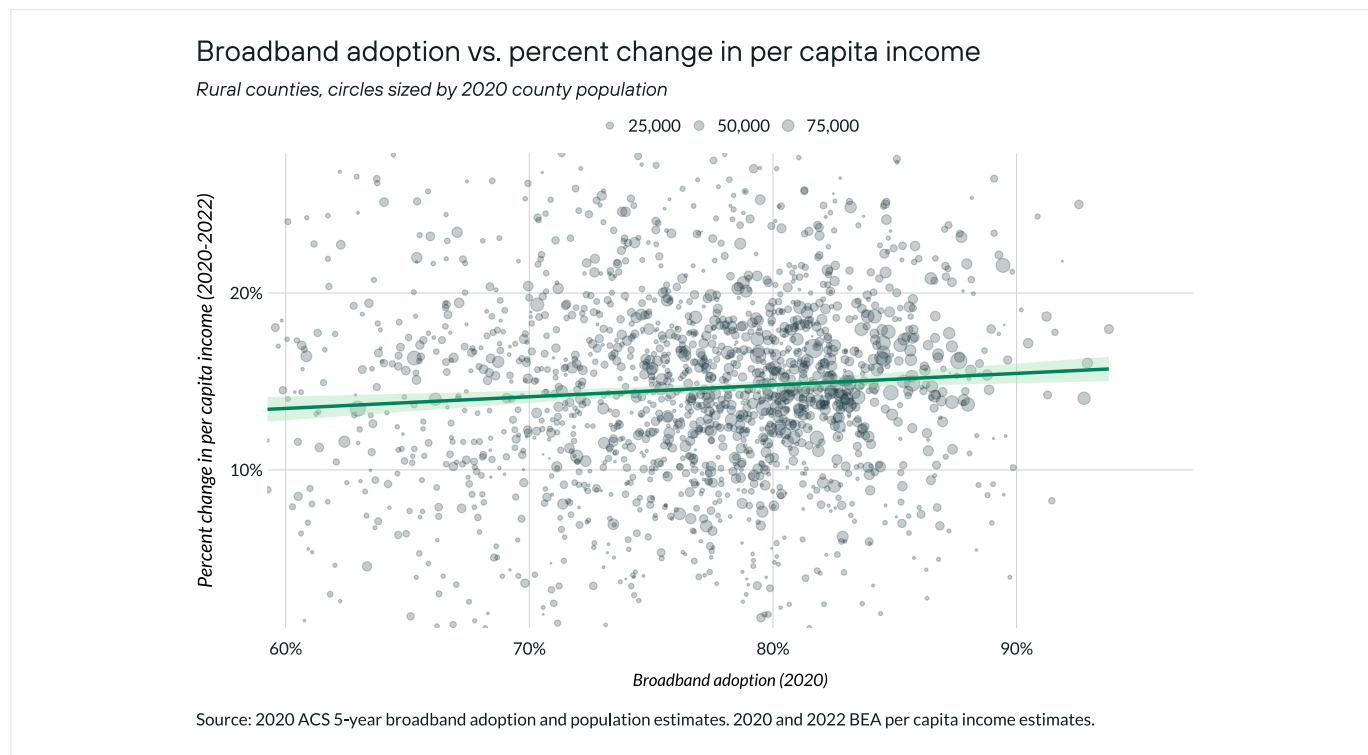
Higher broadband adoption rates increase the number of new businesses and the growth rate of the number of businesses. Figure 5 shows the positive relationship between broadband adoption rates and the percent change in businesses in rural places. By supporting the growth of entrepreneurship in rural places and helping economies grow from the ground up, broadband can change the growth path of rural communities when it is leveraged and utilized effectively.

Business ownership can also work to build rural wealth creation. When rural residents are business owners, the benefits of their work accrue more to them and their community than might be realized by firms headquartered outside of the rural community. Rural businesses contribute to their communities by

generating local revenue through the sale of goods and services outside their local area, while also providing essential goods and services within their communities. As new and existing rural businesses leverage broadband, they may also expand the economic opportunities available in their community through job creation. Rural workers are more likely to be underemployed working in jobs that do not fully utilize their skills and availability compared to their urban counterparts.²⁸ The new jobs available in startups and through broadband itself (for example, remote work) may work to mitigate underemployment in rural areas boosting local incomes. Figure 6 shows that higher broadband adoption rates are associated with higher growth in per capita income in rural counties.

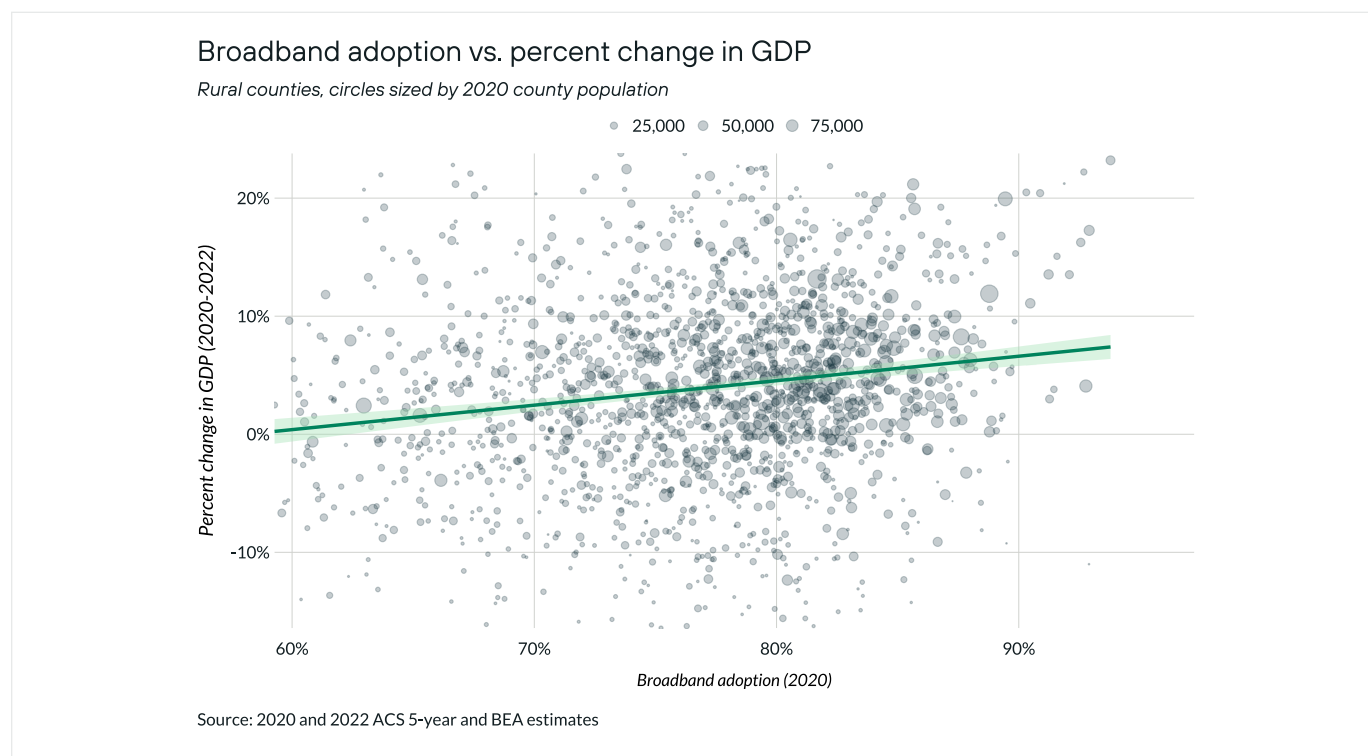
²⁸ Slack, T., Thiede, B. C., & Jensen, L. (2020). Race, Residence, and Underemployment: Fifty Years in Comparative Perspective, 1968–2017. *Rural Sociology*, 85(2), 275–315. <https://doi.org/10.1111/ruso.12290>

Figure 6: Higher broadband adoption rates are associated with more business startups in rural counties



As the number of businesses increases and incomes increase, the size of the local economy grows. Figure 7 shows that higher broadband adoption rates are associated with higher GDP growth in counties.

Figure 7: Higher broadband adoption rates are associated with more business startups in rural counties



Although the correlations shown in Figures 4 through 7 are suggestive, the rural places with higher broadband adoption rates could have factors associated with higher broadband adoption rates such as educational attainment that are driving the increase in business dynamism and income growth. Thus, we use a statistical method, a propensity score matching technique, to match counties with high broadband utilization (high broadband adoption rates and a higher prevalence of small broadband service providers) to otherwise similar counties that have lower broadband access. We similarly use a propensity score matching technique to match rural counties with low broadband utilization to otherwise similar counties that have better broadband utilization. The propensity score matching helps to identify the causal effect of better broadband utilization on business dynamism (growth in the number of businesses) and prosperity for residents in rural areas. In what follows, we show that counties with higher broadband utilization have higher growth rates in entrepreneurship (new businesses and higher self-employment), higher per capita income growth rates, and higher GDP growth rates than otherwise similar counties. Counties with low broadband utilization are more likely to experience population losses, a reduction in the number of businesses and a significant decline in local business dynamism.





3. Methodology

We hypothesize that broadband infrastructure in rural places (nonmetropolitan counties) has the highest impact when it is utilized and leveraged effectively. Fiber broadband and various additional broadband services for residents and local businesses may help residents and businesses get connected and utilize broadband to improve their local economies and their communities. Thus, we measure the impact of rural broadband by estimating the broadband adoption rates (the percentage of households with a broadband subscription in a county calculated using the 5-year average sample from the American Community Survey). Aside from demographic factors such as income and education, various programs and broadband services are associated with higher broadband adoption rates. For example, programs such as digital literacy training provided by a library are associated with higher broadband adoption rates.²⁹ The presence of children in the home who may be exposed to digital literacy training in their local schools is also associated with higher household broadband adoption rates.³⁰ Broadband will likely have a larger impact on the community when it is used more widely.

This wider scope of broadband usage is often realized in areas served by locally operated broadband providers. Smaller broadband service providers are connected to the local market, giving them a deep understanding of preferences for additional broadband services, and enabling them to adapt to changing local preferences. Smaller broadband service providers may also work to get more households online by offering faster broadband and additional broadband services. To assess the impact of smaller broadband providers on the levels of service that consumers receive and ultimately the benefits that accrue to those communities, we create a measure of the presence of small broadband service providers in a county using Federal Communications Commission (FCC) data on the footprints of broadband service providers based on their FCC Registration Number (FRN).³² We consider a broadband service provider small if it serves between 10,000 and 50,000 locations where a location can be a household, business, or organization. We then create a county small broadband service provider location quotient to measure

the presence of small broadband service providers in a county (i.e., the share of locations in a county covered by any small broadband service provider compared to the nation).³³ We find that this small broadband service provider location quotient is associated with higher broadband speeds, a higher share of locations with fiber access, and slightly higher broadband adoption rates (see Appendix A).

Using broadband adoption rates and the small broadband service provider location quotient, we create three categories that classify counties as having high broadband utilization, low broadband utilization, or neither. High broadband utilization places are defined as places having broadband adoption rates greater than 80% in 2020 and a small broadband service provider location quotient greater than 3 (i.e., the share of locations in a county covered by a small broadband service provider is three times greater than the national share of locations covered by a small broadband service provider).³⁴ In rural areas, fiber broadband is what typically moves a rural area above 80% broadband adoption rates. Low broadband utilization places are defined as having broadband adoption rates less than 70% in 2020 and a small broadband service provider location quotient less than 1 (the national average). Figure 8 shows the difference in the growth rates in the number of businesses across these broadband utilization groups. Rural counties with the highest broadband utilization have the highest growth rate in the number of businesses while other rural counties see declines in the number of businesses. A table of descriptive statistics is provided in Appendix B; it shows that rural counties in the highest category of broadband utilization have the highest growth rates in entrepreneurship, income growth, and GDP growth whereas the rural counties with the lowest broadband utilization have declines in entrepreneurship, and lower income and GDP growth rates.

²⁹ Whitacre, B., & Rhinesmith, C. (2015). Public libraries and residential broadband adoption: Do more computers lead to higher rates? *Government Information Quarterly*, 32(2), 164-171. <https://doi.org/10.1016/j.giq.2015.02.007>

³⁰ Clements, Michael E. and Abramowitz, Amy, The Deployment and Adoption of Broadband Service: A Household-Level Analysis (August 15, 2006). TPRC 2006, Available at SSRN: <https://ssrn.com/abstract=2118320>

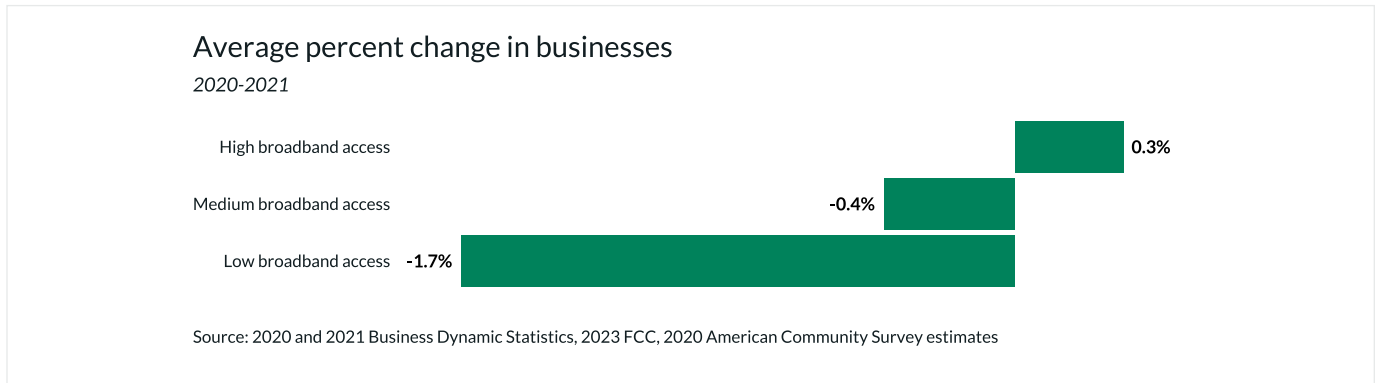
³¹ More competitive broadband markets are also associated with higher broadband adoption rates. Aron, D., & Burnstein, D. (2003). Broadband adoption in the United States: an empirical analysis. In: A. Shampine (Ed.), *Down to the wire: Studies in the diffusion and regulation of telecommunication technologies*

³² Because of data availability, we use FCC data from 2023. See the Center on Rural Innovation Interactive Rural Broadband Service Map: <https://ruralinnovation.us/resources/mapping-and-data-analytics/interactive-rural-broadband-service-map/>. The number of FRNs has not changed substantially between 2020 and 2023 decreasing by only 110 FRNs from approximately 3,053 in 2020 to 2,943 in 2023.

³³ The small broadband service provider (BSP) location quotient (LQ) is calculated using this equation: Small BSP LQ = (small BSP share of broadband coverage within the county / small BSP share of broadband coverage nationally). A small BSP LQ > 1 indicates that the county has a higher concentration of service delivered by one or more small BSPs than the nation. We find similar results using alternative measures of the prevalence of small BSPs, for example, using average BSP size or a ranking system based on the average BSP size in a county. Small BSP's cover around 11.8% of the broadband service locations across the nation. We see a wide range of county small BSP location quotients across the nation ranging from 0.0 - 8.41, with a mean of 2.19 and a median of 0.67. As part of this analysis, BSPs are inclusive of the following technologies DSL, Cable, Fiber, and Fixed Wireless.

³⁴ Weng, Sophia. (2022). Could Investments in Community Broadband Bridge the Digital Divide? Urban Institute. <https://www.urban.org/urban-wire/could-investments-community-broadband-bridge-digital-divide#:~:text=Communities%20with%20fiber%20and%20dark,in%20communities%20without%20municipal%20broadband>

Figure 8: Declining business dynamism across rural and urban areas



Because there could be confounding factors affecting economic outcomes including entrepreneurship, we use a statistical methodology called propensity score matching to account for these factors modeled after Whitacre et al. (2014).³⁵ Propensity score matching is a statistical technique that matches treated and untreated units in observational studies based on their probability of receiving the treatment, to account for confounding factors and to estimate the treatment effect more accurately. We first calculate a propensity score, the probability that a community has high broadband utilization (high broadband adoption and a higher small internet service provider location quotient), based on the factors research shows to increase the likelihood of broadband adoption (education, income, age, race or ethnicity, and urbanization) for each rural county.³⁶ The table of results with the first stage that shows the confounding factors associated with high broadband treatment and low broadband treatment is provided in Appendix C.

The results of this regression are then used to estimate the propensity scores for each county — the likelihood that they would be in the high treatment group and the likelihood they would be in the low treatment group. We then match each high treatment county with its five nearest neighbors — counties that are most similar in propensity score but are not in the high treatment group, despite having a similar likelihood of being in the high treatment group. We similarly match each low treatment group with its five nearest neighbors. We then use these matched groups to compare a set of community economic outcomes for those in the treatment group compared to the nearest neighbors that are not in the treatment group.

With communities in the high broadband utilization treatment group matched to untreated communities (and communities in the low broadband utilization group matched to untreated communities), we estimate the causal relationship between broadband utilization and local economic outcomes. We examine the impact on entrepreneurship because researchers widely agree that entrepreneurship is among the most important predictors of the long-term economic success of communities. Specifically, we estimate the impact of being in the high broadband treatment group (or low broadband treatment group) on business growth (firm growth rates and establishment growth rates) and on self-employment growth rates. We also measure the impact on community wealth — the per capita income growth rate and GDP growth rate. The following results show that communities in the high broadband treatment group see improvements in local economic dynamism.

³⁵ Whitacre, B., Gallardo, R., & Stover, S. (2014). Broadband's contribution to economic growth in rural areas: Moving towards a causal relationship. *Telecommunications Policy*, 38(11), 1011-1023. <https://doi.org/10.1016/j.telpol.2014.05.005>

³⁶ See Appendix C for the logit results of the factors associated with higher broadband utilization.



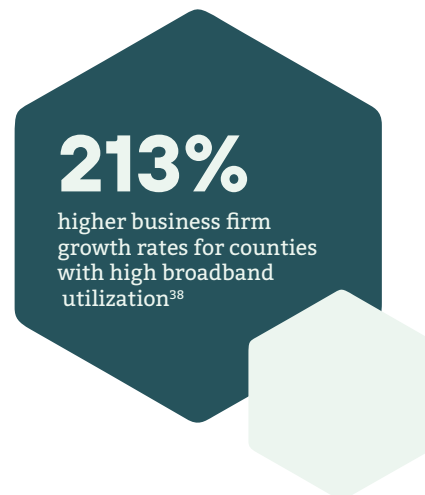
4. Results

A comparison of various local economic outcomes for rural counties in the high and low broadband treatment groups shows that high broadband utilization helps to spur local entrepreneurship, growing the economy from the ground up. As high broadband utilization supports budding businesses in rural areas, it seems to ignite a chain reaction of growth and innovation, leading to a stronger and more dynamic economy. GDP growth rates are higher in rural counties with higher broadband utilization (lower in counties with lower broadband utilization) and per capita income growth rates are higher in rural areas with higher broadband utilization (lower in places with lower broadband utilization). We find evidence that these benefits are largely accruing to existing residents — as we did not find a statistically significant impact on population growth — which suggests that higher broadband utilization may help address underemployment that is more prevalent in rural communities whereas counties in the low broadband utilization group experience population decline. These results suggest that higher broadband adoption and the additional services offered by small broadband service providers are improving the economic dynamism of rural communities.

Table 1 shows the results of the impact of being in the high broadband utilization treatment group (broadband adoption rates greater than 80% of local households and a small broadband service provider location quotient greater than three times the national average) on county economic outcomes.³⁷ The results show the change in entrepreneurship for treated counties, matched untreated counties, and the difference between the two (p-values less than 0.10 or 10 percent and t-statistics greater than about 1.65 in absolute value are generally indicative of statistically significant results with smaller p-values and larger t-statistics indicating more statistical significance). *Rural counties with high broadband utilization see increases in the number of businesses, whereas similar counties without high broadband utilization are seeing the number of businesses decline.* For counties with high broadband utilization, business growth rates are 0.68 percentage points higher

(or 213% higher) than the control group in just one year (2020-2021) measured by firm growth rates and 0.65 percentage points higher (203% higher) for establishment growth rates.³⁸ A firm is a business organization that may consist of one or more establishments under common ownership or control, while an establishment is a single physical location where business activities are conducted. Firm and establishment growth rates are indicators of entrepreneurship and a more dynamic economy and they are leading indicators of long-term economic success.³⁹

High broadband treatment counties are also associated with about 1% higher self-employment growth in just two years (2020-2022) — indicative of an increase in opportunity entrepreneurs as residents are pulled into self-employment by greater access to the economic opportunities associated with self-employment. Self-employment may also act as a precursor to a business startup. Previous research shows that higher self-employment in rural counties is a leading indicator for higher employment, higher income, and lower poverty rates over time.⁴⁰ Thus, the impact of high broadband utilization on recent growth in entrepreneurship (self-employment and business growth) is likely indicative of longer-run economic success and well-being in these communities.



³⁷ The sources of the data are provided in the table of descriptive statistics in Appendix B. The years provided are the most recent data available. For example, the most recent business data available from the Census BDS is from 2021.

³⁸ This amounts to over 4 additional new firms and over 4 additional new establishments created on average in just one year for rural areas that are in the high broadband treatment group.

³⁹ These results are supported by previous research that uses an instrumental variables approach to estimating the impact of broadband availability. Additionally, Appendix D contains the results of a robustness check running a regression analysis of nonmetropolitan counties measuring the impact of the small BSP location quotient and of the broadband adoption rates on firm and establishment growth rates. The regression model uses a variety of controls to control for the differences across places including state fixed effects. The results suggest a statistically significant and positive relationship between the broadband adoption rates (and the small BSP location quotient) and growth in the number of businesses (higher firm and establishment growth rates). Stephens, H. M., Mack, E. A., & Mann, J. (2022). Broadband and entrepreneurship: An empirical assessment of the connection between broadband availability and new business activity across the United States. *Telecommunications and Informatics*, 74, 101873. <https://doi.org/10.1016/j.tele.2022.101873>

⁴⁰ Rupasingha, A., & Goetz, S. J. (2013). Self-employment and local economic performance: Evidence from US counties*. *Papers in Regional Science*, 92(1), 141-161. <https://doi.org/10.1111/j.1435-5957.2011.00396.x>

**Table 1:** The impact of high broadband utilization on the local economy in rural areas

OUTCOME	TREATED	CONTROL	DIFFERENCE	PERCENT DIFFERENCE	T-STAT	P-VALUE
Firm growth rate (2020-2021)	0.36	-0.32	0.68	213%	2.329	0.020
Establishment growth rate (2020-2021)	0.33	-0.32	0.65	203%	2.334	0.020
Self-employment growth rate (2020-2022)	10.34	9.38	0.96	10%	2.809	0.005
Employment growth rate (2020-2022)	5.88	5.06	0.82	16%	1.440	0.151
Population growth rate (2020-2022)	0.23	0.22	0.01	5%	0.052	0.959
Change in Employment: Population (2020-2022)	5.31	2.64	2.67	101%	1.227	0.221
Per capita income growth rate (2020-2022)	11.68	9.93	1.75	18%	2.714	0.007
GDP growth rate (2020-2022)	4.61	3.2	1.41	44%	1.821	0.069

Counties in the high broadband treatment group are already seeing per capita income with growth rates that are 1.8 percentage points higher (18% higher) in just two years (2020-2022) than the control group. This amounts to an increase of nearly \$500 per capita annually on average for residents in rural communities in the high broadband treatment group. The size of the local economy has grown with GDP growth rates 1.5 percentage points higher (44% higher) for high broadband treatment groups between 2020 and 2022.

Table 2 shows the results of the impact of low broadband utilization (broadband adoption rates less than 70% of local households and a small broadband service provider location quotient less than 1, the national average) on the economic outcomes of rural counties. Counties that are likely to have low broadband utilization (for example, because they have lower incomes and higher poverty rates) are losing businesses during this time, but the counties that are in the low

broadband utilization group see significantly more businesses shuttering. The counties with low broadband utilization experience a 1.4 percentage point (572%) greater loss in the number of firms and a 1.5 percentage point (517%) greater loss in the number of business establishments compared to otherwise similar counties.⁴¹ The declining business activity is likely to leave more residents without jobs forcing them to either move away (as noted by the statistically significant population loss) or be pushed into self-employment out of necessity rather than opportunity (as evidenced by the growth in self-employment that is accompanying the decline in the number of businesses). The declines in economic dynamism that rural communities in the low broadband treatment group are experiencing are leading to 1.4 percentage points lower per capita income growth and 2.7 percentage points (85%) lower GDP growth rates than similar counties that have better broadband utilization.⁴²

⁴¹ This amounts to losing over 3 firms or establishments on average each year for rural areas that are in the low broadband treatment group.

⁴² This amounts to a loss of about \$270 per capita per year.

**Table 2:** The impact of low broadband utilization on the local economy in rural areas

OUTCOME	TREATED	CONTROL	DIFFERENCE	PERCENT DIFFERENCE	T-STAT	P-VALUE
Firm growth rate (2020-2021)	-1.68	-0.25	-1.43	-572%	4.335	<0.0001
Establishment growth rate (2020-2021)	-1.79	-0.29	-1.50	-517%	4.543	<0.0001
Self-employment growth rate (2020-2022)	10.81	9.43	1.38	15%	2.737	0.007
Employment growth rate (2020-2022)	4.41	4.70	-0.29	-6%	0.798	0.426
Population growth rate (2020-2022)	-0.91	-0.10	-0.81	-810%	4.305	<0.0001
Change in Employment: Population (2020-2022)	2.49	2.81	-0.32	-11%	0.531	0.596
Per capita income growth rate (2020-2022)	8.04	9.34	-1.3	-14%	2.420	0.016
GDP growth rate (2020-2022)	0.47	3.15	-2.68	-85%	3.045	0.003

Various robustness checks (results shown in Appendix D and E) show that higher broadband utilization (higher broadband adoption rates and a higher small broadband service provider location quotient) is associated with higher growth rates in the number of businesses in rural counties as well as higher growth rates in per capita income and GDP.

Our results suggest that rural communities with high broadband utilization experience greater entrepreneurial activity, driving local economic dynamism that increases county GDP growth rates and per capita income growth rates for existing rural residents. In contrast, areas with low broadband

utilization face economic stagnation and population decline, highlighting the critical role of broadband in fostering rural innovation, resilience, and well-being. Next, we take a deeper look at rural communities where local broadband service providers are having an outsized positive impact on entrepreneurship and their local economy.

5. Case study: Beltrami County, Minnesota

In Beltrami County, collaboration is key. The local broadband cooperative extends its reach across the community, meeting today's infrastructure needs and laying the groundwork for sustainable growth.

The city of Bemidji has long recognized the importance of balancing progress with the preservation of its unique Northwoods character. Central to this vision is the development of essential infrastructure that supports both the community's daily life and its long-term aspirations. The city's [mission](#) of "Responsible Growth with Northwoods Character, preserving our history and providing diverse opportunities for success" reflects its commitment to blending tradition with progress. This vision is well-supported by the region's tradition of locally rooted utility cooperatives whose members share the benefits: the Beltrami Electric Cooperative and Paul Bunyan Communications.

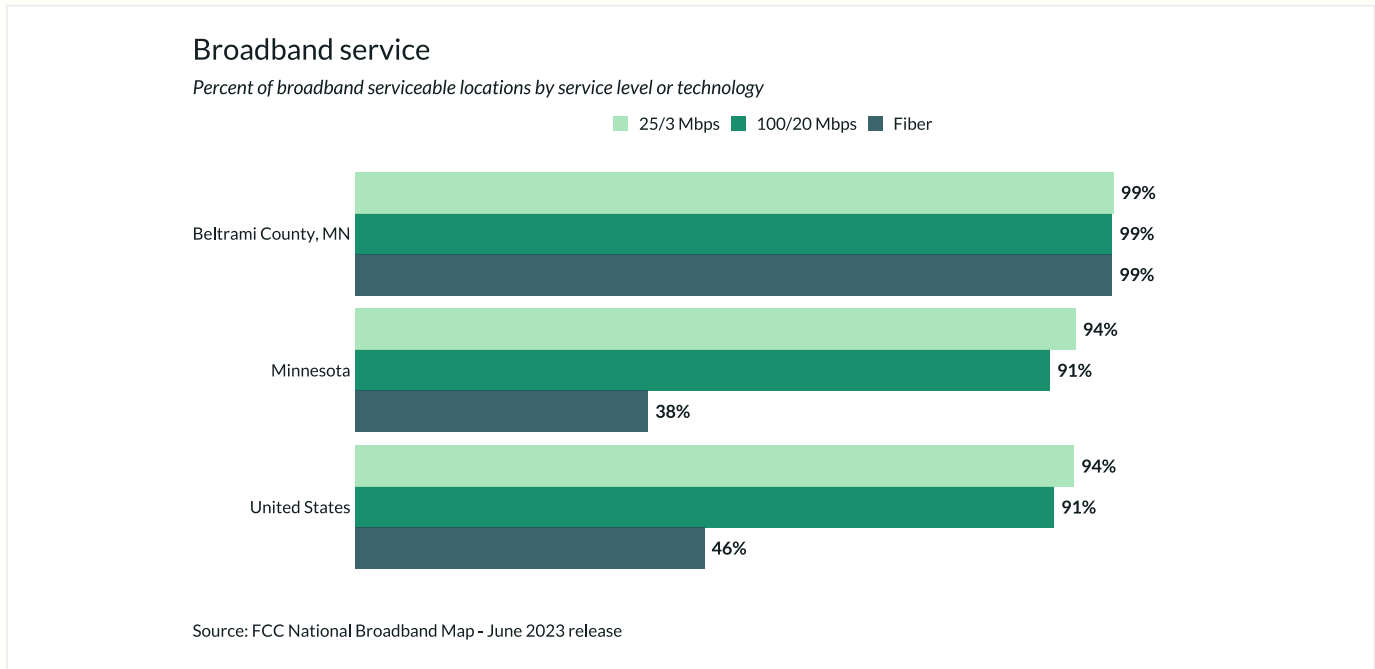
The establishment of the Beltrami Electric Cooperative in 1940 was a response to the dire need for electrification in rural areas at a time when the quality of life gap between urban and rural communities was high — in 1935 less than 11% of American farms had access to [electricity](#). Commercial power companies were often unwilling to invest in rural electrification, leading local farmers to band together to create their own cooperatives. This initiative not only brought electricity to the area, transforming the agricultural landscape by enhancing productivity and living standards, but also laid the groundwork for future community-driven initiatives.

Paul Bunyan Communications, [founded](#) in 1952 and originally known as Paul Bunyan Telephone, has been instrumental in enhancing connectivity in Bemidji and its surrounding rural areas. Named after the [legendary lumberjack](#) whose mythical footprints are said to have created Minnesota's 10,000 lakes, Paul Bunyan Communications has grown from a modest telephone service provider to a comprehensive telecommunications cooperative. It now offers a wide range of services, including high-speed internet, television, and voice services, fulfilling the critical mission of connecting the community to the broader world and supporting the region's economic and social development. Indeed, as Paul Bunyan Communications CEO Gary Johnson said, "If you look at our mission statement, it talks about us being a driver of economic development. It talks about us having the goal of improving the lives of members we serve in our region."



Paul Bunyan Communications has been a pioneer in deploying advanced telecommunications infrastructure, such as high-speed gigabit fiber services called the Gigazone, making it one of the largest all-fiber optic rural broadband networks in the country. Figure 9 below shows that Beltrami County's fiber access at 99% of locations far outpaces both Minnesota and the nation. This is significant as fiber broadband is the gold standard of broadband infrastructure. While more expensive to install, it offers better long-term value because it is more durable, easier to maintain, and ensures smoother online experiences for uses like video calls and streaming due to symmetrical download and upload speeds. It is also considered to be "future-proof" and scalable because its high data transmission capacity can handle current and future broadband demands, while ensuring much faster speeds and more reliability. For these reasons, and the cooperative's guiding philosophy — "working together to focus on service rather than profit, on shared values rather than share value" — Paul Bunyan Communications [decided in 2004](#) that an all-fiber network would be the best long-term and high-value option for their residential and business customers.

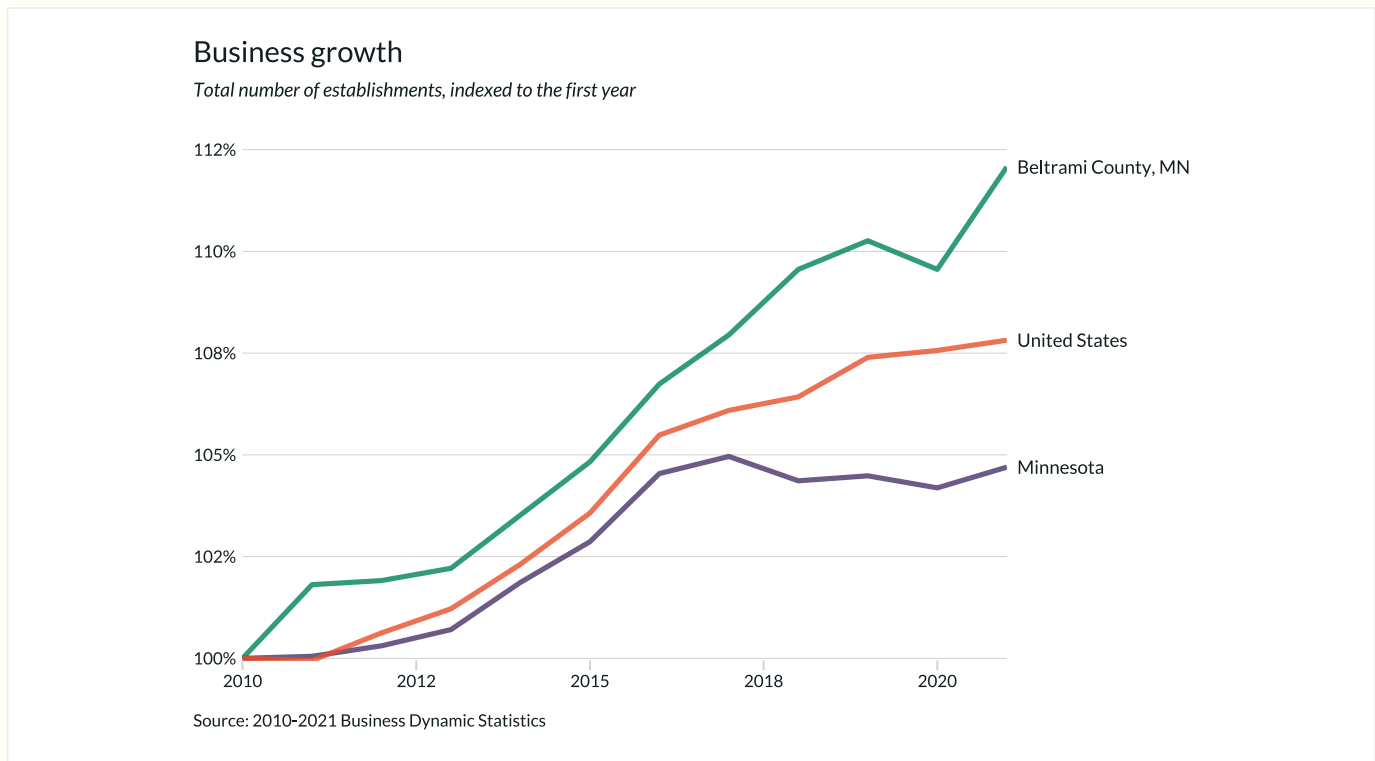
Figure 9: Beltrami County is a leader in fiber access



Paul Bunyan Communications' growth from a local telephone cooperative to a leading broadband provider reflects a broader trend of community-driven infrastructure development. The cooperative's investments, including the \$100 million [GigaZone project](#), northern Minnesota's first high-speed gigabit fiber network, have positioned Bemidji and surrounding areas as innovative, connected communities. To further enhance its services, Paul Bunyan Communications also offers a range of value-added broadband services. For residential areas they provide SmartHome services complete with enhanced parental controls and advanced network security powered by their GigaZone mobile app. To support WiFi roaming they have implemented the [SmartTown](#) initiative, providing outdoor WiFi in public spaces and ensuring that residents and businesses stay connected, even in previously underserved areas. Additionally, the [SmartBiz](#) program caters to the specific needs of local businesses by offering secure networks, easy-to-manage employee access, and redundancy options to safeguard against power outages — all without the need for extensive IT support. This is particularly beneficial for small businesses that might not otherwise afford these enterprise-level services.

Beltrami County's cooperatives, Paul Bunyan Communications and Beltrami Electric Cooperative, have a collaborative history characterized by shared ventures and mutual support within their community-focused missions. One of their notable partnerships was the formation of Cooperative Development, LLC in 1996, a [joint initiative](#) between the two cooperatives to create Bemidji's Technology Park. This business park was established to provide a conducive environment for technology-oriented businesses, offering advanced communication and infrastructure services. Supporting new tech businesses is beneficial for the community, as tech jobs are high-paying and high-growth jobs that help ensure that the region remains competitive and resilient in an increasingly digital economy.

Figure 10: Growth in the number of businesses in Beltrami County has outpaced similar counties, Minnesota, and the nation



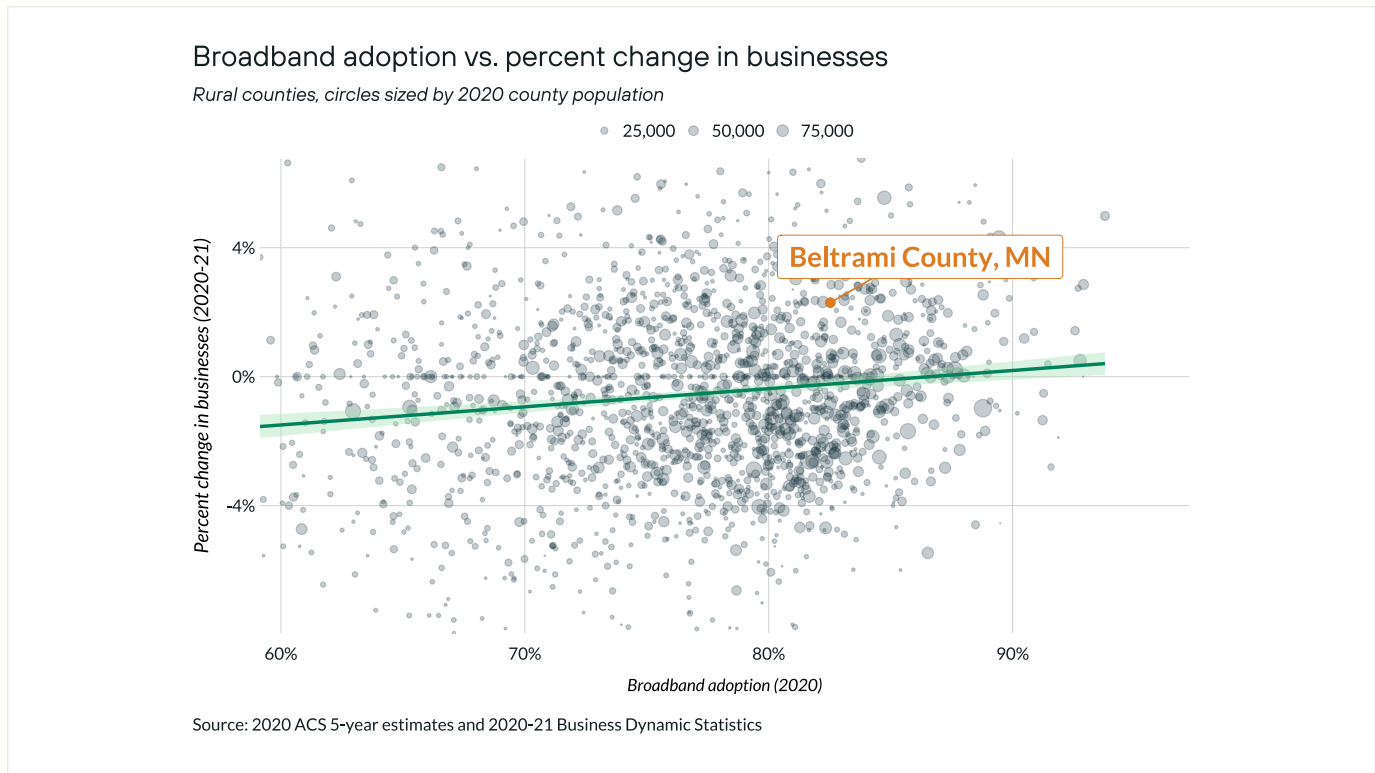
And based on Beltrami County’s steady business growth it seems Paul Bunyan Communications’ approach is paying off. Since 2010, the number of businesses in Beltrami County has grown by 12.1% (which amounts to an average annual increase of 1.1%), outperforming both the state and the country as a whole (see Figure 10 above). [AirCorps Aviation](#) General Manager Erik Hokuf said that the exceptional broadband services in Bemidji have made it possible to expand their business, [generating \\$4 million in annual revenue](#) instead of an estimated \$300,000-\$400,000 without fiber. In addition to the growth of new businesses and revenue, the per capita income in Beltrami County also increased by 7% between 2020-2022.

[Greater Bemidji](#) — the region’s innovative economic development organization — has built off this momentum to highlight entrepreneurship, innovation, and quality of life as key goals in their strategic planning. Through initiatives like [LaunchPad](#), a startup support initiative that provides education, capital, and community resources to aspiring entrepreneurs and early-stage companies, and the Headwaters Angel Network, which provides access to capital, Greater Bemidji actively encourages entrepreneurs and supports business growth and expansion. These efforts have allowed the community

to connect with broader economic opportunities and capitalize on its broadband infrastructure to expand its tech and entrepreneurship capabilities, due in no small part to the support of community-engaged cooperatives like Paul Bunyan Communications, who helped build the LaunchPad through donations of equipment and gigabit internet service.

Figure 11 below shows that these varied broadband services and community partnerships that leverage broadband infrastructure make Beltrami County stand out when it comes to business growth. Startups like [Hemo Research](#), a technology design and development firm, are leading examples of how local innovation paired with a supportive ecosystem can drive economic vitality. Hemo Research was a finalist in the [NORTHSTARTup pitch competition](#) that takes place during Paul Bunyan Communications’ GigaZone TechXpo, and a \$25,000 prizewinner at the Minnesota Startup Cup. Startups like Hemo Research not only create high-quality jobs — electric, computer, firmware, and software engineers in Hemo Research’s case — but also foster wealth and prosperity for residents by growing economic benefits locally, supporting other businesses, and contributing to a more resilient and prosperous community.

Figure 11: Beltrami County stands out for its exceptional growth in the number of businesses driven by outstanding broadband services



As a cooperative, Paul Bunyan Communications also has the unique ability to reinvest in its members, reflecting their deep commitment to the community's well-being. In 2020, they demonstrated this dedication by achieving a record-high capital return and distributing \$4.1 million back to their members — a powerful testament to the success and sustainability of their operations. This commitment to the community was further highlighted when the [FCC recognized Paul Bunyan Communications](#) for their significant COVID-19 response through the Digital Opportunity Equity Recognition ([DOER](#)) Program, partnering with schools to set up free broadband for families in need and free [WiFi hotspots](#) for students and families in unserved areas. In 2023, in recognition of their contributions to Bemidji, Paul Bunyan Communications CEO Gary Johnson, Marketing Supervisor Brian Bissonette, and Technology Experience Manager Leo Anderson received Excellence Awards from NTCA-The Rural Broadband Association, highlighting their contributions to healthcare and economic development in the region.

The county has also capitalized on broadband infrastructure and strong broadband service provider partnerships to meet critical healthcare needs that help build the important foundational elements for economic growth. For example, Paul Bunyan Communications [partnered](#) with local healthcare providers to enhance telemedicine services. One of their major clients, Sanford Health, has been a leader in this effort by offering virtual obstetrics telemedicine. [This service](#) supports expecting parents in nearby communities who lack access to local birthing facilities, some of whom would otherwise have to drive two or more hours for a visit. These types of partnerships are crucial for healthcare access in rural regions like Beltrami County that have experienced hospital closures, and, in winter months, experience dangerous road conditions that make long travel to medical care risky. Research highlights that better internet access significantly boosts telemedicine usage, demonstrating strong demand for these services, especially in rural areas.^{43 44}

⁴³ Wilcock, A.D., Rose, S., & Busch A.B. (2019). Association between broadband internet availability and telemedicine use. *JAMA Intern Med.*179(11):1580–1582. doi:10.1001/jamainternmed.2019.2234

⁴⁴ Pandit, A.A., Mahashabde,R.V., Brown,C.C., et al. Association between broadband capacity and telehealth utilization among Medicare Fee-for-service beneficiaries during the COVID-19 pandemic. *Journal of Telemedicine and Telecare.* doi:10.1177/1357633X231166026



Counties with better broadband availability experienced a 47% increase in telehealth utilization, reflecting that when reliable internet is accessible, more people use telemedicine.⁴⁵ Service providers like Paul Bunyan Communications, and medical providers like those at Sanford Health demonstrate the importance of supporting fiber broadband expansion, as its capacity for high symmetrical speeds directly enhances |telemedicine access and performance, and supports healthcare needs in underserved communities. Not only are these healthcare access improvements beneficial for the health of the community, but improved health outcomes and healthcare access are vital for economic stability, as a healthier population is more productive and capable of sustaining economic growth.

Events like the GigaZone Gaming Championship and TechXpo (a Paul Bunyan Communications event) not only showcase the region's advanced broadband capabilities but also serve as a gateway for young people to explore technology and technology careers in a fun and competitive environment. The GigaZone Gaming Championship is one of the biggest rural gaming events in the country. The connection between the GigaZone Gaming Competition and the burgeoning esports team at Bemidji High School is a prime example. By supporting these initiatives, Paul Bunyan Communications is helping to cultivate a new generation of tech-savvy students who are exposed to tech at an early age.

This early exposure is crucial, as it can inspire students to pursue careers in tech or tech-related fields that pay well and contribute to economic growth in the region. The GigaZone TechXpo, held in tandem with the GigaZone Gaming Competition, is a key event for the region, drawing a growing audience to explore technological innovation and discover pathways toward tech careers. This event provides startups and companies with a platform to showcase their technologies to a wider audience and help build connections with potential employees. It also offers educators and educational institutions a valuable opportunity to promote their technology training programs, further strengthening the region's tech ecosystem. The TechXpo highlights the diversity of tech skills and solutions available in the region, featuring events like the gaming competition, the NORTHSTARTup pitch competition, and more. The connection to tech workforce development was not a simple byproduct of the GigaZone Gaming Competition, but the result of forward thinking and purposeful action on the part of Paul Bunyan Communications. As Gary Johnson said,



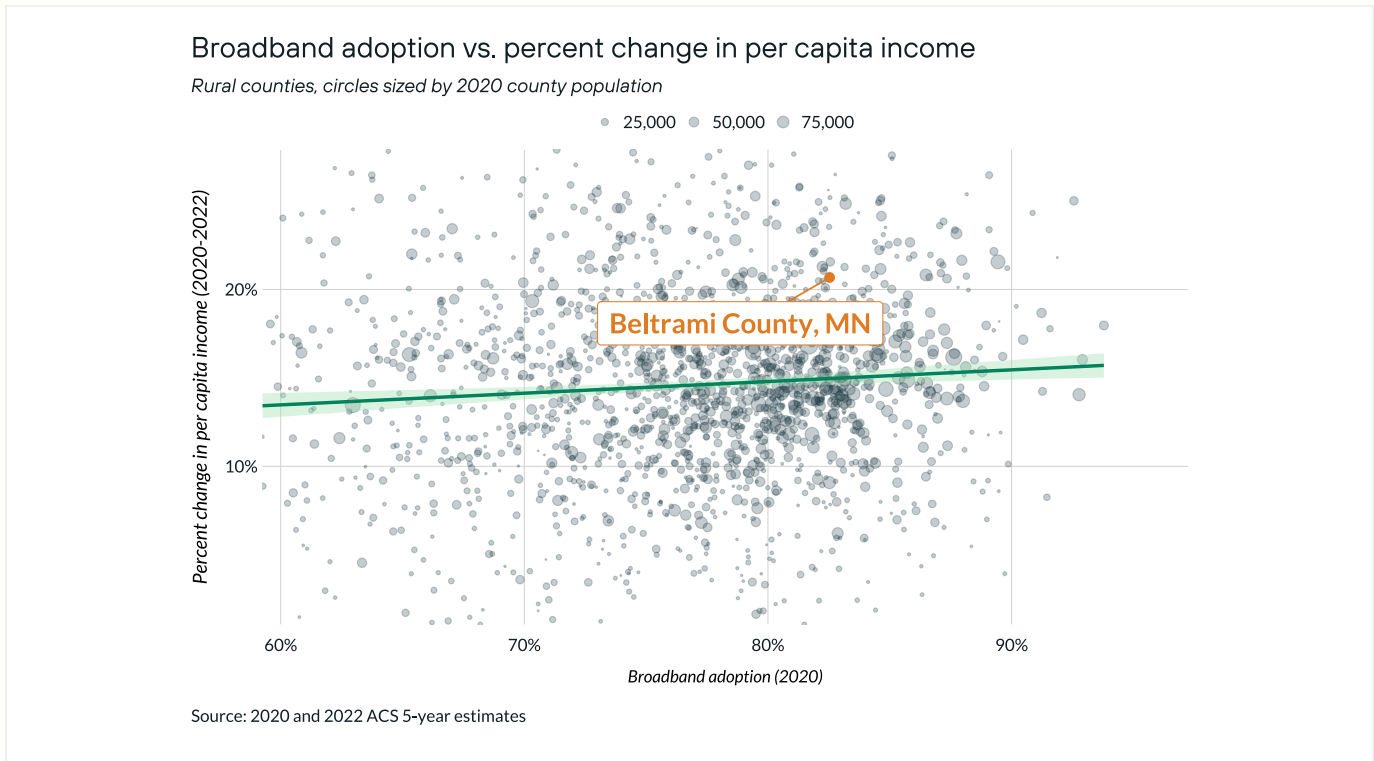
“Why not get those folks exposed to employers right in our area that would love to hire them, and schools right in our area that would love to add to their technical skills and offer them training programs? Again, right at their back door.”

Moreover, these events don't just impact young people; they also affect parents and the wider community, raising awareness about the opportunities in the tech sector. Research has shown that having children in the home is associated with higher rates of broadband adoption.⁴⁶ As students develop their skills and interests, their families are introduced to the possibilities that tech careers can offer, further embedding technology into the community's fabric. This comprehensive approach is integral to building a robust entrepreneurial tech ecosystem, where a skilled workforce is the foundation for long-term economic prosperity. Paul Bunyan Communications' efforts, including their support for numerous scholarships, are helping to ensure that the region's residents are not just participants but leaders in the growing tech economy.

⁴⁵ Ibid.

⁴⁶ Clements, Michael E. and Abramowitz, Amy, The Deployment and Adoption of Broadband Service: A Household-Level Analysis (August 15, 2006). TPRC 2006, Available at SSRN: <https://ssrn.com/abstract=2118320>

Figure 12: Beltrami County stands out for the impact of broadband access helping to increase prosperity in the community



As more residents gain access to these resources, new opportunities open up and they can pursue careers or launch businesses that were previously out of reach due to geographical and infrastructure limitations. This access not only improves individual financial outcomes but also contributes to the overall economic vitality of the region. The growth in per capita income, as shown in Figure 12 reflects this positive trend. As the county continues to leverage its strong broadband infrastructure and support for innovation, it is witnessing a steady increase in per capita income. Beltrami County stands out as a rural community helping to build prosperity for its residents by effectively utilizing and leveraging fiber optic broadband technology

Bemidji stands as a powerful example of what's possible when a community comes together to invest in its future. With the right infrastructure, community partnerships, and commitment to innovation, rural regions like Beltrami County can find themselves on the path to thriving.



6. Conclusion

Effectively leveraging broadband infrastructure as a transformative tool for rural economic development and resilience requires a collaborative effort between local broadband service providers and communities. This approach should not only focus on expanding access but also on promoting digital literacy, fostering local entrepreneurship, and actively engaging with community members.

The additional services offered by broadband service providers that help leverage broadband infrastructure and increase broadband adoption rates can take many forms. Community WiFi, like Calix SmartTown, allows people to connect to the internet through their subscription via broadband WiFi outside of their homes. Free public WiFi hotspots also provide access points and may be especially useful for residents who do not have a home wireline broadband subscription, allowing them to access high-speed internet. Many cooperative broadband service providers see their mission and their success as one that is interwoven with the success of the community and its residents. As one municipal ISP manager stated, “We see our customers in the grocery store.” Small, local broadband service providers have a vested interest in providing the highest quality service and driving widespread adoption of broadband internet services. One of the ways they fulfill this mission is through the provision of additional services.

In addition to access, other services include the creation and support of events and facilities, like Paul Bunyan Communications’ Gigazone Gaming Championship and TechXpo, and Greater Bemidji’s LaunchPad, a business incubator. These provide valuable exposure to broadband and the growing tech economy. Facilities like the LaunchPad also have the potential to serve as places where residents can both access the internet and learn skills through digital navigator programs and other tech-related programming, which can help to foster increased adoption, in addition to LaunchPad’s entrepreneurship support services.

Our findings underscore the critical role of broadband in fostering business growth, entrepreneurship, and improved economic outcomes for rural communities. Counties that effectively utilize broadband are seeing marked improvements in local economic dynamism, suggesting that broadband can help mitigate the economic disadvantages often faced by rural areas. In contrast, areas with low broadband utilization continue to experience economic stagnation, highlighting the urgency of addressing the digital divide.

Using a propensity score matching approach, we find that compared to otherwise similar counties, rural counties in the high broadband utilization group have

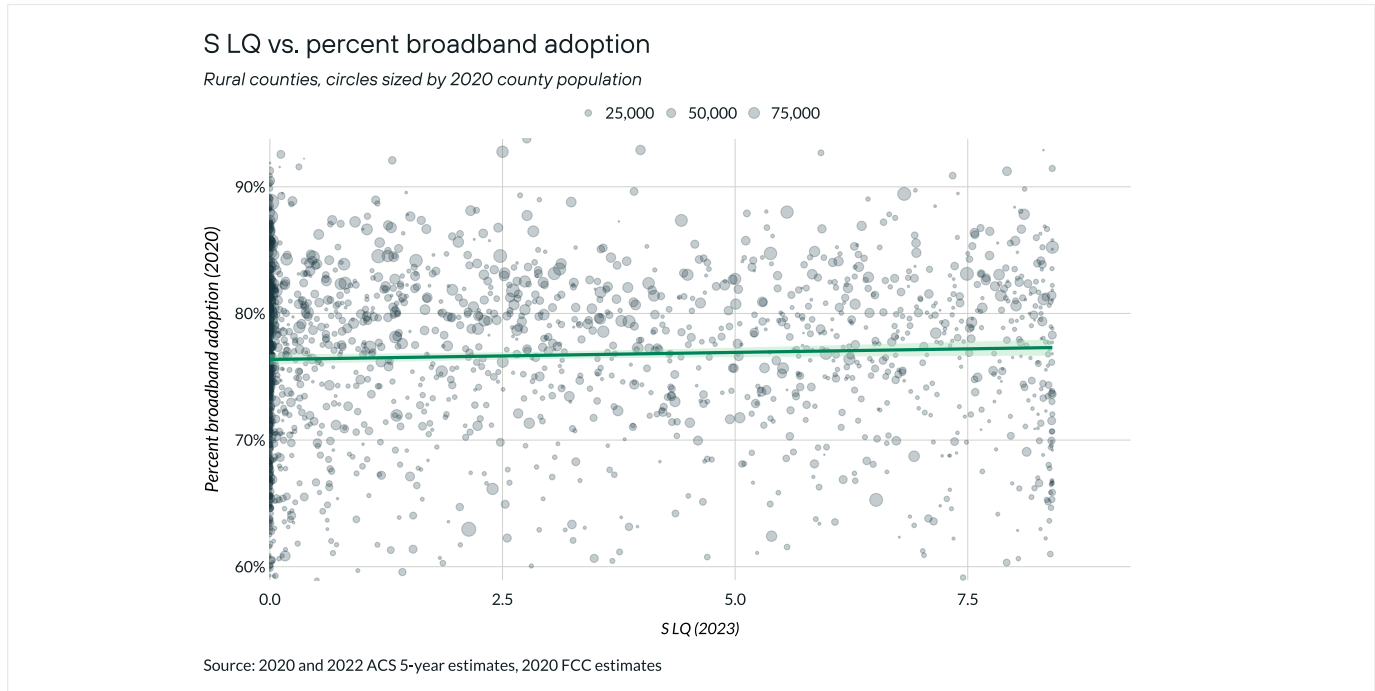
- **Business growth rates that are 213% higher**
- **Self-employment (opportunity entrepreneur) growth rates that are 10% higher**
- **Per capita income growth rates that are 18% higher**
- **GDP growth rates that are 44% higher**

Conversely, communities with lower rates of broadband utilization experience negative effects. Businesses shutter at higher rates and unemployment and underemployment are also higher. Lower broadband utilization leads to population loss, hollowing out communities and severing important social ties as people move away.

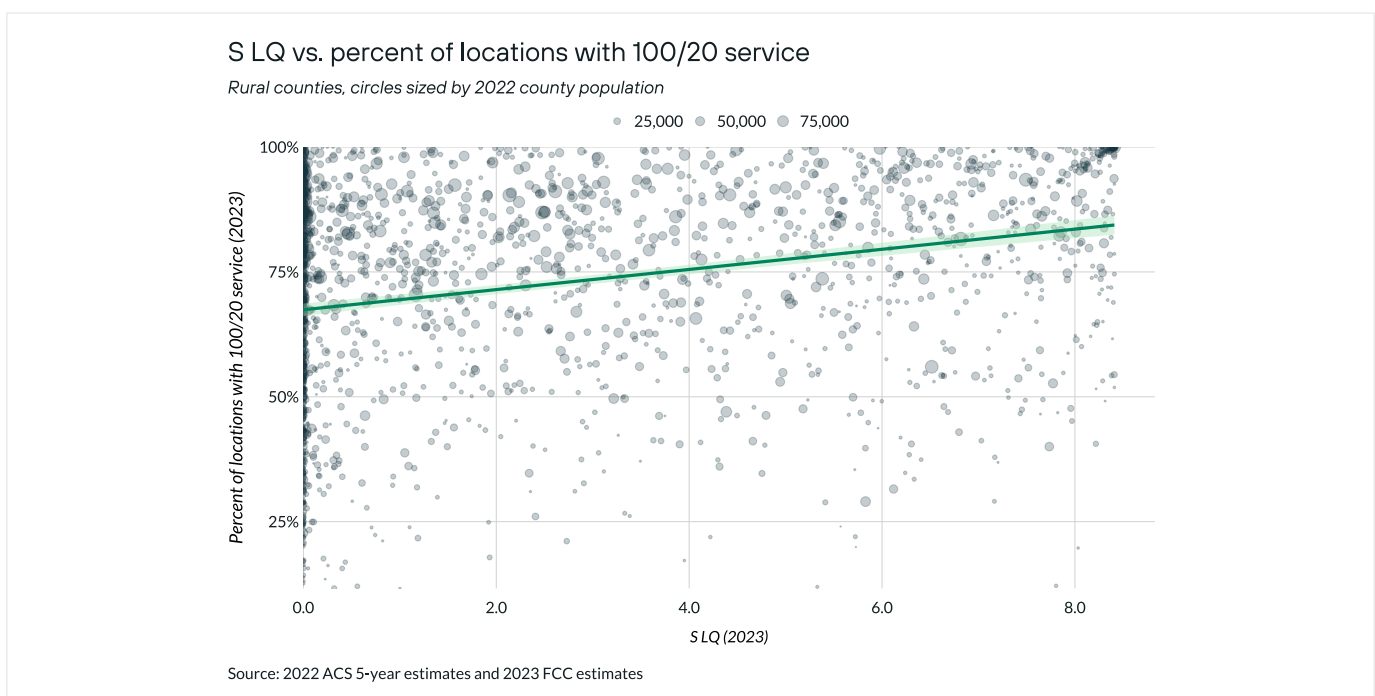
Effectively leveraging broadband is a crucial step in helping rural areas build resilience and close the long-standing gap between rural and nonrural places. Successful rural broadband initiatives show that with strategic investments and strong community engagement, rural America can fully engage in the 21st-century digital economy. Expanding and utilizing broadband access remains essential for ensuring economic opportunity and prosperity for all rural residents, as widespread broadband adoption holds significant economic and social promise, fostering both local connections and global opportunities.

Appendix A

A higher small broadband service provider location quotient (S LQ) is associated with slightly higher broadband adoption rates (an increase in S LQ by 1 is associated with a 0.1 percentage point increase in the broadband adoption rate with a p-value equal to 0.091 and a t-statistic equal to 1.692).



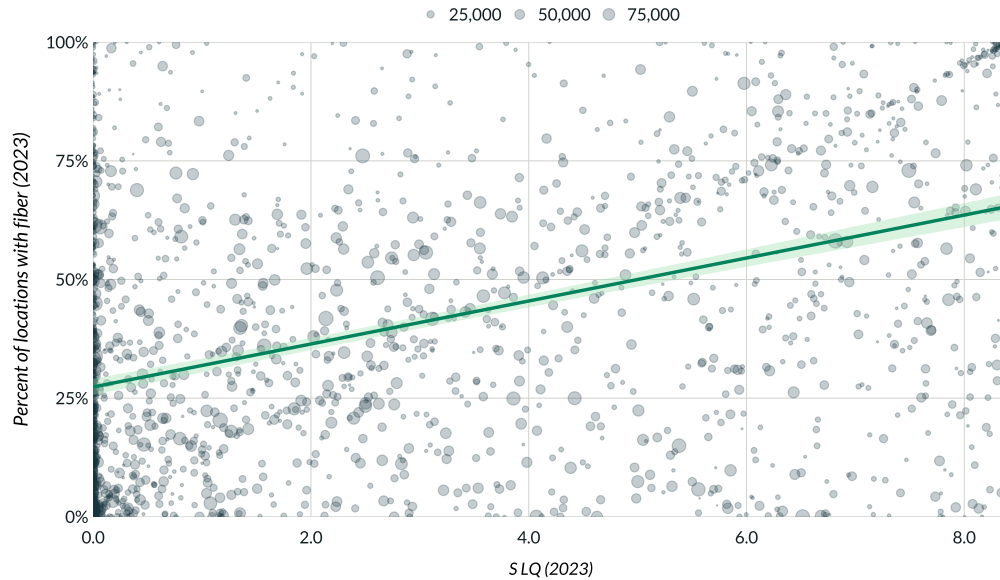
A higher small broadband service provider location quotient (S LQ) is associated with a statistically significant higher share of locations (households, businesses, and other organizations) with access to faster broadband, 100/20 Mbps speed (an increase in S LQ by 1 is associated with a 2.3 percentage point increase in the share of locations with access to 100/20 Mbps with a p-value less than 0.0001).



A higher small broadband service provider location quotient (S LQ) is associated with a statistically significant increase in the share of locations (households, businesses, and other organizations) with access to fiber broadband (an increase in S LQ by 1 is associated with a 4.5 percentage point increase in the share of locations with fiber broadband access with a p-value less than 0.0001).

S LQ vs. percent of locations with fiber service

Rural counties, circles sized by 2022 county population



Source: 2022 ACS 5-year estimates and 2023 FCC estimates



Appendix B

Descriptive statistics for high and low broadband utilization groups

Descriptive statistics show that rural counties with higher broadband utilization have higher growth in entrepreneurship than the counties in neither group which have higher growth in entrepreneurship than the low treatment group (measured by either the firm growth rate or the establishment growth rate 2020-2021). Rural counties with higher broadband utilization also have higher job growth, increases in the ratio of employment to population, increases in industry diversity (as measured by a drop in the industry concentration using the Herfindahl-Hirschman Index), higher per capita income growth, and higher GDP growth between 2020 and 2022.

STATISTIC	HIGH TREATMENT	NEITHER TREATMENT	LOW TREATMENT
Broadband Adoption	83.44	76.34	63.65
Source: ACS (2020) 5-yr average	(2.79)	(6.70)	(6.05)
Small BSP Location Quotient	6.26	2.55	0.14
Source: Calculations using FCC Data	(1.62)	(2.81)	(0.25)
Firm Growth Rate	0.36	-0.28	-1.79
Source: BDS 2020-2021	(4.30)	(3.91)	(4.22)
Establishment Growth Rate	0.33	-0.28	-1.79
Source: BDS 2020-2021	(4.14)	(3.82)	(4.23)
Self-Employment Growth Rate	10.34	9.65	10.81
Source: BEA 2020-2022	(4.93)	(5.10)	(6.67)
Employment Growth Rate	5.88	4.99	4.41
Source: BEA 2020-2022	(8.85)	(4.45)	(4.57)
Employment: Population Change	5.31	2.64	2.49
Source: BEA 2020-2022	(34.55)	(3.24)	(3.19)
Per Capita Income Growth Rate	11.68	9.89	8.04
Source: BEA 2020-2022	(9.46)	(8.31)	(6.80)
GDP Growth Rate	4.61	3.23	0.47
Source: BEA 2020-2022	(11.03)	(12.03)	(11.19)
Population Growth Rate	0.23	0.04	-0.91
Source: BEA 2020-2022	(2.80)	(2.43)	(2.37)
Population Share Bachelor or Higher	23.80	19.61	14.41
Source: ACS (2020) 5-yr average	(7.96)	(6.96)	(4.29)
Per Capita Income	53,318	47,278	40,080
Source: BEA 2020	(13,269)	(12,730)	(7,205)
Observations (counties)	252	1,492	199

Note: Standard errors in parentheses



Appendix C

Logit model predicting the likelihood of high or low broadband utilization

VARIABLE	HIGH BROADBAND TREATMENT	LOW BROADBAND TREATMENT
Bachelors population share	2.890**	-14.059***
Source: ACS 2017 5-yr average	(1.406)	(3.172)
Change in bachelor share	-4.122	1.651
Source: ACS 2017 and 2012 5-yr average	(3.026)	(3.929)
ln(Per capita income)	0.327	-2.095***
Source: BEA 2017	(0.533)	(0.713)
Per capita income growth	-0.634	0.469
Source: BEA 2012 and 2017	(0.670)	(0.675)
Poverty rate	-13.846***	3.180*
Source: ACH 2017 5-yr average	(2.206)	(1.674)
ln(Population)	0.422***	-0.234
Source: BEA 2017	(0.145)	(0.190)
Population growth	2.580	-7.090***
Source: BEA 2012 to 2017	(1.813)	(2.360)
Establishments	0.0001	-0.001
Source: BDS 2017	(0.0002)	(0.001)
Self-employment	-1.896	2.686
Source: BEA 2017	(1.455)	(1.667)
Median age	-0.031*	0.051**
Source: ACS 2017 5-yr average	(0.016)	(0.022)
BIPOC population share	-3.793***	3.602***
Source: ACS 2017 5-yr average	(0.986)	(0.508)
ln(Distance to metro)	0.636***	-0.162
Source: Tiger Line	(0.158)	(0.204)
Constant	-12.998**	21.857***
	(6.436)	(8.373)
Observations	1,943	1,943
Pseudo R-squared	0.169	0.296

Note: Standard errors in parentheses

*p<0.1; **p<0.05; ***p<0.01

Appendix D

Robustness check with regression results for nonmetropolitan counties with state fixed effects show that as broadband adoption rates increase and as the small broadband service provider location quotient increases, the firm growth rate and the establishment growth rate increase. The results show that a 10 percentage point increase in broadband adoption is associated with 0.4 percentage point increase in the number of businesses in rural communities. After controlling for the broadband adoption rate, an increase in the small broadband service provider location quotient of 1 is associated with a 0.1 percentage point increase in the number of businesses.

VARIABLE	FIRM GROWTH RATE (2020-2021)	ESTABLISHMENT GROWTH RATE (2020-2021)
Small BSP location quotient	0.001** (0.000)	0.001** (0.000)
Broadband adoption rate (2020)	0.040* (0.021)	0.040** (0.020)
Firms (2020)	0.000 (0.000)	
Establishments (2020)		0.000 (0.000)
Self-employment share (2020)	0.025 (0.026)	0.019 (0.026)
Bachelor's population share (2020)	0.019 (0.016)	0.027 (0.017)
Ln(per capita income) - 2020	-0.014 (0.012)	-0.012 (0.012)
Ln(population) - 2020	-0.005 (0.004)	-0.004 (0.003)
Median age (2020)	0.000 (0.000)	0.000 (0.000)
Previous firm growth rate (2017-2019)	-0.014 (0.039)	
Previous establishment growth (2017-2019)		-0.022 (0.038)
Distance to metropolitan area	-0.000*** (0.000)	-0.000** (0.000)
Percent below poverty line (2020)	-0.046 (0.029)	-0.046* (0.026)
Percent foreign born (2020)	0.024 (0.022)	0.025 (0.023)
Percent BIPOC (2020)	-0.003 (0.008)	-0.005 (0.008)
STATE FIXED EFFECTS	YES	YES
Observations	1944	1944
Adjusted R-squared	0.111	0.106

Note: Standard errors in parentheses

*p<0.1; **p<0.05; ***p<0.01



Appendix E

Robustness check with the propensity score matching that does not use the small broadband service provider location quotient. The high broadband adoption group is defined as any county with broadband adoption rates greater than 80% and the low broadband adoption group defined as any county with broadband adoption rates less than 70%. The results show that the inclusion of the small broadband service provider location quotient has a stronger positive impact on entrepreneurship growth rates (for firms, establishments, and self-employment) and that high broadband adoption rates have a stronger impact on employment and population growth rates.

High broadband adoption treatment group effect

OUTCOME	TREATED	CONTROL	DIFFERENCE	PERCENT DIFFERENCE	T-STAT	P-VALUE
Firm growth rate	0.03	-0.51	0.54	106%	2.843	0.004
Establishment growth rate	.02	-0.54	0.56	104%	3.034	0.002
Self-employment growth rate	10.04	9.77	0.27	3%	1.086	0.278
Employment growth rate	6.05	4.55	1.5	33%	5.046	<0.0001
Population growth rate	0.31	-0.2	0.51	255%	4.190	<0.0001
Change in Employment: Population	4.18	2.37	1.81	76%	2.103	0.036
Per capita income growth rate	10.93	9.43	1.5	16%	3.560	0.0004
GDP growth rate	4.67	2.36	2.31	98%	4.194	<0.0001

Low broadband adoption treatment group effect

OUTCOME	TREATED	CONTROL	DIFFERENCE	PERCENT DIFFERENCE	T-STAT	P-VALUE
Firm growth rate	-0.93	-0.18	-0.75	-417%	-2.853	0.005
Establishment growth rate	-1	-0.2	-0.8	-400%	-3.149	0.002
Self-employment growth rate	10.37	9.74	0.63	6%	1.877	0.061
Employment growth rate	4.3	5.22	-0.92	-18%	-3.390	0.001
Population growth rate	-0.75	0.15	-0.9	-600%	6.308	<0.0001
Change in Employment: Population	2.45	3.1	-0.65	-21%	-1.638	0.102
Per capita income growth rate	9.01	10.15	-1.14	-11%	2.428	0.015
GDP growth rate	1.44	3.54	-2.1	-59%	3.113	0.002



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