Expanding Broadband Access

by Jorge Barro

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Jorge Barro, Ph.D., is a fellow in public finance at Rice University's Baker Institute of Public Policy. His research involves the development of dynamic macroeconomic models to evaluate the impact of state and federal fiscal policy. Before joining the Baker Institute, Barro was an economist at the Wharton School at the University of Pennsylvania, where he developed a large-scale macroeconomic model of the United States and helped launch the nonpartisan Penn Wharton Budget Model. Barro received his Ph.D. in economics from the University of Texas at Austin.

One of the most defining characteristics of the twenty-first century has been the introduction, expansion, and integration of the internet into nearly every dimension of human life. What began as an exclusive commodity quickly grew into an essential tool for accessing a broad range of opportunities, including education, employment prospects, and social networking. While the capabilities of the internet continue to grow and become necessary for these opportunities, access for many Texans remains out of reach.

This report summarizes the prospect of expanding broadband access in Texas and considers several aspects in the allocation of government funds and intervention. Central to this analysis is a clear understanding of the costs and benefits associated with expanding broadband access to digitally disconnected communities. Such analysis involves identifying these households and communities, understanding why private provision has fallen short, determining what broadband technologies options are feasible, and evaluating how government participation in that market could be structured in an optimal scenario.

Benefits of Broadband Access

Several studies highlight the importance of broadband access for several quality-of-life improvements, including economic gains, healthcare, and education. The corollary to quantifying these gains is a measurement of the forgone opportunities experienced by those without broadband access. To that extent, the gains experienced by broadband expansion can, in a cumulative sense, represent both the benefits of expanding access to those who do not have it and the costs of delaying access. While the full extent of the benefits of broadband access are not fully understood, several studies have measured the associated gains along several dimensions.

Economic Growth

An extensive literature on the relationship between broadband access and economic growth attempts to measure the associated economic gains from digital inclusion. The difficulty in understanding this relationship corresponds to the direction of causality. For example, a rural region might gain broadband access, which could coincide with significant economic growth. Broadband availability could enhance factors like gains in productivity or expanded access to markets. However, the possibility that broadband providers anticipated significant growth in the area, prompting the investment in local broadband infrastructure, introduces a potential ambiguity as to whether economic growth prompted broadband access or vice versa. As a result, much of this literature relies on advanced empirical techniques and focuses on explicit mechanisms driving the relationship.

One study on the relationship between broadband infrastructure and economic growth finds—after accounting for the direction of causality—that a 10-percentage point increase in broadband access raised annual economic growth per capita by 0.9-1.5 percentage points.[1] While that study focused on the impact of broadband access at the national level across OECD countries, other studies find evidence of growth at more granular geographic levels. A study from the Richmond District Federal Reserve Bank reviewed the literature on the impact of broadband access on local rural economies and found several persistent trends.[2] The first finding indicates that broadband access induces greater economic activity by drawing businesses to the location and generating employment growth. This effect was stronger for rural locations that were closer to urban areas. The second finding was that rural broadband access improved consumer variety, allowing them to shop more and save time and money. One study estimated annual economic benefits corresponding to this savings at nearly $2,000 per household.[3] The third finding highlighted gains to local businesses from improved labor market efficiency and access to both consumers and suppliers. The fourth finding summarized the improvement in home values resulting from broadband access and the corresponding potential for property tax revenue gains. Finally, the fifth finding summarized additional benefits to education and health, which are discussed in more detail in the sections below.[4]

Access to broadband can contribute to significant productivity gains across several industries. Because of the remote nature of the agricultural industry, however, broadband access remains limited, as 25% of farms still had no internet access in 2019.[5] A recent report produced by the Federal Communications Commission (FCC) measured the impact of broadband access on agricultural productivity. The report indicated that enhanced broadband connections improved crop yields and reduced operating expenses.[6] These results are consistent with previous study finding that broadband access in the agricultural industry improved farm sales, expenditures, and profits in rural communities adjacent to metropolitan counties.[7] According to the study, broadband access can improve farmers' market access (both suppliers and customers), accelerate

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[1] Czernick, Falck, Kretschmer, and Woessmann, "Broadband Infrastructure and Economic Growth," The Economic Journal, 121, 505-532.

[2] https://www.richmondfed.org/publications/community_development/community_scope/2020/comm_scope_vol8_no1

[3] Ariv Nevo, John L. Turner, and Jonathan W. Williams, "Usage-based pricing and Demand for Residential Broadband," Econometrica, Vol. 84, No. 2 (March 2016), 411-443.

[4] This article also mentions economic multiplier estimates in the range of 3-4, indicating that every dollar spent in broadband infrastructure would return $3-4 in economic benefits to the region. Although this may be true at small amounts of investment, the estimates are likely highly nonlinear and unlikely to hold for all levels and types of investments.

[5] https://downloads.usda.library.cornell.edu/usda-esmis/files/h128nd689/8910k592p/qz20t442b/fmpc0819.pdf

[6] https://docs.fcc.gov/public/attachments/DOC-368773A1.pdf

[7] Kandilov, Amy MG, Ivan T. Kandilov, Xiangping Liu, and Mitch Renkow. "The impact of broadband on US Agriculture: An evaluation of the USDA broadband loan program." Applied Economic Perspectives and Policy 39, no. 4 (2017): 635-661.

technological adoption, and improve real-time information corresponding to weather outlook and pricing information for both inputs and outputs.

Healthcare

Access to broadband has improved the provision of healthcare in several different ways. On the demand side, broadband offers several direct benefits, ranging from better health information through patient research to direct healthcare provision through telemedicine services. Telehealth services can also reduce costs to both the patient, through time and travel costs, and providers, by reducing overhead costs. Virtual visits can also reduce the financial costs to patients, reducing barriers to accessing care. According to estimates from the Covid-19 Healthcare Coalition, approximately 67% of telehealth users reported lesser costs related to their telehealth visit versus an in-person visit.[8]

The growing need of healthcare provision in rural areas is largely tied to the sharp increase in rural hospital closures. According to data from the The Cecil G. Sheps Center for Health Services Research at the University of North Carolina, Texas experienced 21 rural hospital closures over the last decade, leading the nation in closures.[9,10] These closures accelerated following the passage of the Affordable Care Act, which transitioned towards patient-based financing (through Medicaid expansion), rather than provider-based financing. Having chosen not to expand Medicaid, Texas experienced the adverse consequence of reduced federal funding for these hospitals without the benefit of federally subsidized payments offered through Medicaid expansion.[11] That transition placed a strain on rural hospitals, reducing access to care in those areas, and placing a higher value on access through telemedicine.

The benefits of telehealth through broadband access are not limited to rural areas, but also any underserved households who may be limited in available time and access. Since the start of the Covid-19 pandemic, telehealth utilization rates increased by several orders of magnitude. Estimates indicate that telehealth usage spiked to 78-fold in the immediate aftermath of the pandemic before settling at around 38 times higher by early 2021.[12] Estimates for evaluation and management visits, however, highlight the continued disparities in rural versus urban access. In urban counties, these telehealth visits rose from 4.1 visits per thousand total visits before the pandemic to 132 visits per thousand in late 2020, while in rural communities, that value rose

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[8] https://c19hcc.org/static/catalog-resources/telehealth-patient-survey-analysis-c19hcc.pdf
[9] https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/
[10] https://www.beckershospitalreview.com/finance/why-rural-hospital-closures-hit-a-record-high-in-2020.html
[11] https://www.washingtonpost.com/national/health-science/rural-hospitals-beset-by-financial-problems-struggle-to-survive/2015/03/15/d81af3ac-c9b2-11e4-b2a1-bed1aaea2816_story.html
[12] https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality

from 2.8 visits per thousand to 86 visits per thousand.[13] Low-income households, which are generally less likely to have access to broadband, are also more likely to be insured by Medicaid. At the onset of the pandemic, the Center for Medicare and Medicaid Services took measures to expand availability and coverage of virtual care.[14] Many of these services require broadband access, further increasing the benefits associated with broadband expansion.

With significant growth and proliferation in the telehealth industry, technology and efficiency are also likely to improve. These improvements will increase the value of broadband access, as a larger share of households will be able to access health services, particularly as rural hospital closures continue. Conditional on having broadband access, telehealth services are likely to reduce existing physical and financial barriers to healthcare access for both rural and low-income households, adding to the associated economic and social benefits.

Education

For younger educational cohorts, lack of broadband access and appropriate technology, like computers, could limit the ability of students to complete homework or access supplemental at-home learning resources. Before the Covid-19 pandemic, estimates indicated that nearly one in every five school-age children could not complete their homework resulting from lack of access to computers or reliable internet connection.[15] The digital divide in primary and secondary education, sometimes known as the "homework gap," disproportionately affects groups that often lack broadband access—particularly low-income and rural households.

What began as a barrier to homework completion turned into a barrier to educational attainment at the onset of the Covid-19 pandemic. In an effort to implement social distancing, several schools quickly switched to remote format, exacerbating gaps in educational attainment caused by broadband access and proper technology. Learning loss from school closures and the transition to remote instruction alone reduced estimated lifetime income by at least 3% for all affected students.[16] For disadvantaged households, that figure grows to nearly 5%.[17] Still, those numbers are not explicitly conditional on broadband availability and access, indicating that lifetime earnings losses for these households would likely exceed 5% once accounting for lack of broadband access. While education has mostly returned to in-person instruction, a significant share of at-home learning still requires online access, highlighting the persistent gap in educational attainment resulting from limited broadband access.

[13] https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/covid-19-and-rural-communities-protecting-rural-lives-and-health
[14] https://www.medicaid.gov/medicaid/benefits/telemedicine/index.html
[15] https://www.pewresearch.org/fact-tank/2018/10/26/nearly-one-in-five-teens-cant-always-finish-their-homework-because-of-the-digital-divide/
[16] https://www.oecd.org/education/The-economic-impacts-of-coronavirus-covid-19-learning-losses.pdf
[17] https://budgetmodel.wharton.upenn.edu/issues/2021/10/27/covid-19-learning-loss-long-run-macro-effects

Postsecondary online educational attainment has also grown increasingly prominent throughout the United States. More than 7 million students were enrolled in distance education courses at degree-granting postsecondary institutions in fall 2019, accounting for 37.2% of all students enrolled at postsecondary institutions.[18] Attaining a college degree can significantly increase lifetime earnings—a measure that can increase even more for graduate degree attainment. The estimated increase in earnings over a 50-year career subsequent to college attainment is at least $600,000, and that figure increases to nearly $800,000 for graduate degree attainment.[19] While the estimated value of postsecondary education could vary based on several factors, including geographical variables corresponding to population density and family income (i.e., the variables affecting the likelihood of broadband access), they highlight the potential gains corresponding to improvements in postsecondary education though broadband access.

Even if broadband expansion efforts are largely successful and other technological divides are closed, gaps remain in people's ability to make productive use of these resources. This ability, known formally as digital literacy, is necessary to safely experience the gains associated with broadband access by helping to protect digital consumers—particularly children—from online risks and teaching them how to derive the benefits of digital connectivity. These deficiencies became increasingly detrimental at the onset of the pandemic, as an estimated 30% of adults have low "tech readiness," characterized by needing assistance with connectivity (devices or otherwise) or lacking confidence to do complete necessary online tasks.[20] While adult outreach can help bridge the digital literacy gap, school programs can also improve digital literacy, leading to large returns corresponding to a broad range of benefits.

Other Factors

While education, health, and economic opportunities gained through broadband access offer quantifiable benefits, digital inclusion can offer several additional nonquantifiable benefits. For example, broadband access can improve social interaction, which was particularly important for people in rural communities and many during the Covid-19 pandemic. Such interactions can reduce social isolation, leading to improvements in mental health. It can also improve civic engagement and help in the proliferation of emergency messages from local public safety officials. Many of these are known benefits and contribute to the value of broadband access.[21]

By combining the quantifiable and nonquantifiable benefits of broadband, policymakers and other stakeholders can begin to assess the marginal value of programs designed to improve

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[18] https://nces.ed.gov/fastfacts/display.asp?id=80
[19] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4534330/
[20] https://www.pewresearch.org/internet/2021/09/01/navigating-technological-challenges/
[21] https://www.brookings.edu/research/digital-prosperity-how-broadband-can-deliver-health-and-equity-to-all-communities/

broadband access. Simultaneously, the benefits of broadband also provide an indication of the opportunity cost of forgoing the efforts to expand access. Despite an extensive literature on the topic, however, the full extent of the benefits of broadband access remains unknown.

Texas Access to Broadband

Evaluating the prospect of government intervention aimed at enhancing broadband access starts with identifying which households and communities in Texas lack internet access. Overall, a large share of households in Texas has internet access at home, and that value has improved significantly over the last decade. Figure 1 shows that 80.4% of households in Texas had access to the internet at home in 2013. By 2019, that value had improved more than ten percentage points to 91.4% of Texas households. With an estimated 9.9 million households in Texas collectively generating a total population of 29 million people, this figure indicates that approximately 852,000 households, or roughly 2.5 million people still do not have access to internet at home.[22]

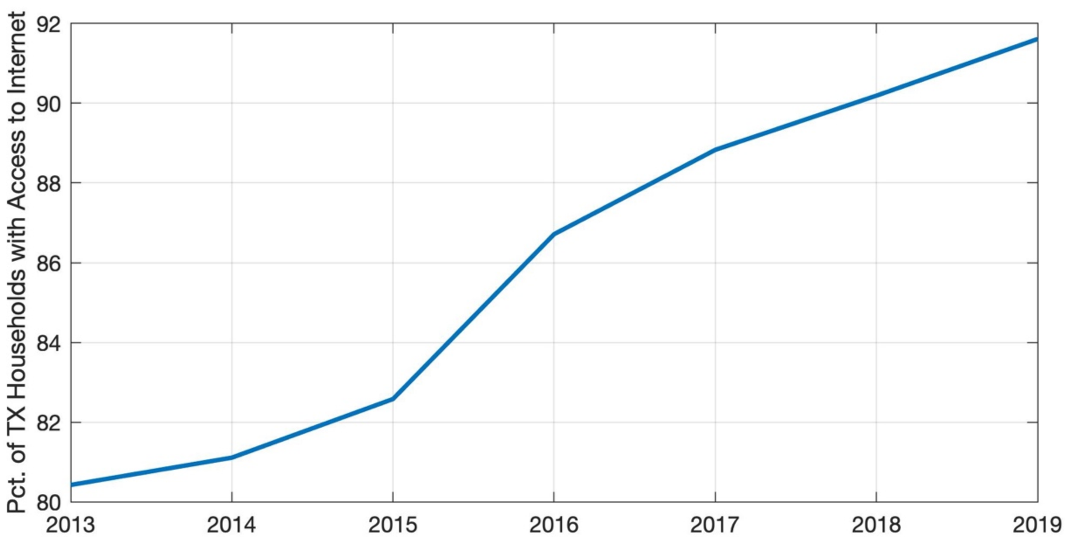

Figure 1: Access to Internet by Texas Households (Source: ACS via IPUMS)

Although the proliferation of internet access across Texas households has improved over time, the quality of such access remains another threshold to achieve. For example, *high speed* internet access, which is generally the defining characteristic of broadband, is only available to 79.2% of Texas households, according to estimates from 2019 data from the American Community Survey.[23] Broadband internet includes high speed services, such as cable, fiber optic, or digital subscriber line (DSL) service.

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[22] (Total population estimates) https://www.census.gov/quickfacts/TX

[23] Note that different definitions of broadband access can lead to different estimates. For example, the Census Bureau estimates that from 2015-2019, the share of Texas households with broadband access was 81.9%.

Without broadband access to these households, several services remain limited. The FCC characterizes broadband service as having a download speed of 25 Mbps and an upload speed of 3 Mbps. In choosing this benchmark, the FCC determines this measure to satisfy *"advanced telecommunications capabilities"* defined by statute, or services that *"enable users to originate and receive high-quality voice, data, graphics, and video telecommunications."*[24] As a result, internet services below this benchmark would fall short of providing standard access to the benefits of digital connectivity.

Much of the literature on broadband access focuses on two partially overlapping groups that lack broadband access—those living in rural communities that experience limitations in broadband availability and households whose incomes are prohibitively low to afford such access. Econometric analysis was performed on data from the 2019 American Community Survey to measure the extent of this pattern in Texas. Estimates presented in Appendix 1 summarize the results of the analysis. The estimates confirm that lower income and lower population density both reduce the likelihood that a household has broadband internet at home. To gain an understanding of how much income and population density mattered for broadband internet at home, an estimate of the likelihood at the median values (i.e., 50th percentile) of each was compared the likelihood at the bottom quartile (i.e., 25th percentile). A reduction in household income from the median value for Texas in 2019 of $68,000, to the bottom quartile, or $36,000, reduced the likelihood of having broadband internet at home by 2.9 percentage points. Similarly, living in an area of Texas that was in the 25th percentile of population density, relative to an area of median density, reduced the likelihood of having broadband internet at home by 3.2 percentage points. These results confirm the results of existing studies and provide magnitudes of this relationship.

Improving Affordability

The two partially overlapping groups most likely to lack broadband access are low-income and rural households. For low-income households that cannot afford broadband access, but could otherwise access it, most policy alternatives to close the gap involve improving affordability. For those who lack reasonable access, solutions involve exploring technological alternatives, including investment in broadband infrastructure. This section focuses on issues related to affordability of broadband access.

Both the monthly broadband rates and household start-up costs of broadband vary significantly across urban geographies. The average monthly rate in U.S. cities in 2020 was nearly $70, and

[24] https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2020-broadband-deployment-report

the start-up costs in many cases were close to the monthly rate.[25] Variation in plans allow for optional equipment rental, which lower the start-up cost, but increase the monthly total cost.

Several programs currently exist to help low-income households afford broadband and corresponding technology in places where broadband is otherwise reasonably accessible. In particular, the federal government offers limited discounts for broadband access through the Lifeline program. The program offers a discount of $9.25 per month off the cost of telephone service (additional $25 for consumers in Tribal areas), qualifying broadband internet service, or bundled services (wireline or wireless).[26] Because of the limited value of the discounts, the Lifeline program induces limited participation, and Texas has one of the lowest estimated take-up rates at only 10% of eligible households, servicing approximately 261,000 households.[27]

In response to the Covid-19 pandemic, the Emergency Broadband Benefit program provided low-income households an additional discount of up to $50 towards broadband service (additional $25 for consumers in Tribal areas) and a one-time discount of up to $100 on the purchase of a laptop, desktop computer, or tablet.[28] The program was converted into the Affordable Connectivity Program, which extends its duration. Under current programs, low-income consumers can cover a large share of the costs associated with broadband access (wherever available). Given such low take-up rates of the current Lifeline program, Texas might best serve low-income households by improving outreach to expand its availability to these consumers. Texas policymakers should evaluate the success of the existing programs and explore the effectiveness of improving affordability of broadband access at the state level.

Another ongoing issue at the federal level impacting affordability is the possible lack of competition in the broadband market leading to unusually high prices. A forthcoming paper by Thomas Philippon shows a negative relationship between the number of pro-competition reforms and the price of broadband in OECD countries, with the U.S. having one of the highest broadband prices and the lowest number of pro-competition reforms.[29] By promoting greater competition, the results indicate that the U.S. might be able to reduce broadband prices for all households, making high-speed internet more accessible to low-income households. While such efforts would likely require reforms at the federal level, Texas can still explore opportunities to enhance state-level competition and encourage Congressional representatives to enact federal-level legislation to do the same.

[25] https://www.newamerica.org/oti/reports/cost-connectivity-2020/global-findings/
[26] https://www.fcc.gov/sites/default/files/lifeline_support_for_affordable_communications.pdf
[27] https://www.usac.org/lifeline/resources/program-data/
[28] https://www.fcc.gov/broadbandbenefit
[29] Philippon, Thomas, How Expensive Are U.S. Broadband and Wireless Services? (April 29, 2021). NYU Stern School of Business Forthcoming, Available at SSRN: https://ssrn.com/abstract=3836281 or http://dx.doi.org/10.2139/ssrn.3836281

Improving Rural Access

Solutions to resolve accessibility of broadband in rural areas is complicated by several factors corresponding to limited profitability of private companies serving those areas. Unlike in urban areas where efficiency of broadband networks has been established, there is significant variability and financial risk corresponding to different technology for rural customers. This makes policy solutions unique to the local market.

Determining the best option for a particular region often depends on several factors, including proximity to existing technology, capacity of local infrastructure, and the prospect of emergent technologies, like low-orbit satellite provision. Moreover, the value delivered by certain government-incentivized technologies depends on the benefits corresponding to the region. This section evaluates these issues, taking the variability of circumstances into consideration.

Land-based technologies

For rural communities with accessible land-based internet, service might be available though one or more types of providers, including telephone companies, cable companies, electric cooperatives, fiber providers, and fixed wireless providers.[30] Each of these options play an important role in the rural broadband ecosystem, with variability in the prospect of expanding access to rural households.

Telephone companies currently provide DSL internet at broadband speeds to many rural customers that have telephone access, but the internet quality can be prohibitively slow for more remote customers.[31] The benefit of access through telephone companies is the existence of established infrastructure. However, DSL technology transmits data over copper wires that were designed for narrow-band voice communication and not the delivery of broadband data.[32] As a result, the value of upgrading existing infrastructure is likely dominated by implementing alternative technologies.

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[30] https://www.pewtrusts.org/en/research-and-analysis/white-papers/2021/09/multiple-barriers-to-can-hinder-rural-broadband-deployment

[31] https://broadbandnow.com/guides/satellite-vs-dsl-rural-internet

[32] https://www2.itif.org/2017-rural-broadband-infrastructure.pdf

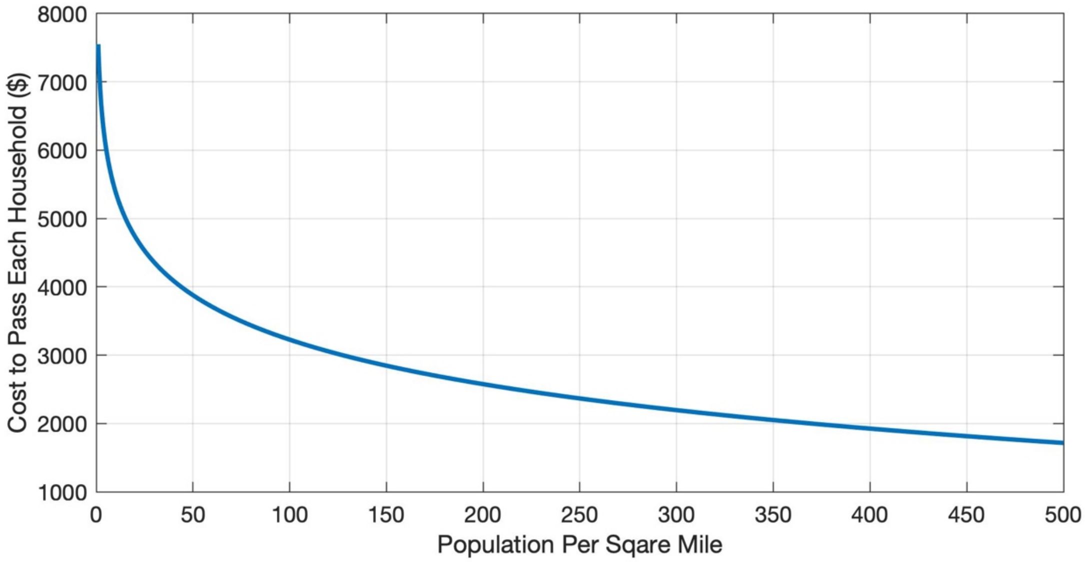

Figure 2: Costs of passing fiber networks by households by population density. (Source Fiber Broadband Association)

Cable providers and fiber-based companies provide broadband to more than 90% of the U.S., but they face high costs of expanding, making availability in rural areas extremely limited.[33] A 2019 study produced by the Fiber Broadband Association provided estimates of the costs of passing by and connecting households to a fiber network. Figure 2 shows how the cost of passing by households increases exponentially as population density declines.[34] Consequently, the viability of fiber networks as solutions for rural communities declines as population becomes sparser.

Electric cooperatives (co-ops) are potential candidates for providing broadband to a large share of rural customers at a lower cost by utilizing the existing infrastructure. What makes electric co-ops an attractive candidate as a rural broadband provider is their prevalence in delivering power to rural communities. The existing infrastructure often has fiber-optic networks used to manage electricity flow along transmission lines. Expanding access to these fiber-optic networks could allow these electric co-ops to offer broadband to their consumers at lower costs, relative to companies that might need to establish new infrastructure.[35] Some electric co-ops in Texas, like Bandera Electric Cooperative and Guadalupe Valley Electric Cooperative already offer broadband to customers in rural and underserved areas.

[33] https://www.brookings.edu/research/5-steps-to-get-the-internet-to-all-americans/
[34] Estimates provided in Figure 2 only include the costs of passing households. Connecting each household incurs additional costs.
[35] https://www.cooperative.com/programs-services/bts/Documents/Reports/Unlocking-the-Value-of-Broadband-for-Co-op-Consumer-Members_Sept_2018.pdf

Finally, fixed wireless broadband service transmits data wirelessly to households that have fixed communication equipment, like an antenna. The benefit of fixed wireless is the ability to offer broadband to a region at potentially lower costs without having to bring a line to every house individually. Unfortunately, the technology also requires "line of sight" of the transmission towers, requiring unimpeded proximity and a network of towers for covering large geographic areas. This can become an issue where the terrain becomes prohibitive because of large hills or mountains, but the technology may remain a viable option in flatter terrains, like northern parts of Texas.[36]

Satellite Technology

Perhaps the greatest concern regarding public investment to expand traditional land-based broadband technology is the possibility that emerging satellite broadband technology eventually delivers broadband-quality internet at a low cost in the coming years. If this new technology proves to be successful, large investment in terrestrial infrastructure expansion could become an inferior option. Any measurement of the long-term benefits of land-based broadband infrastructure investment in rural communities must be evaluated against the prospect of the growing satellite broadband industry.

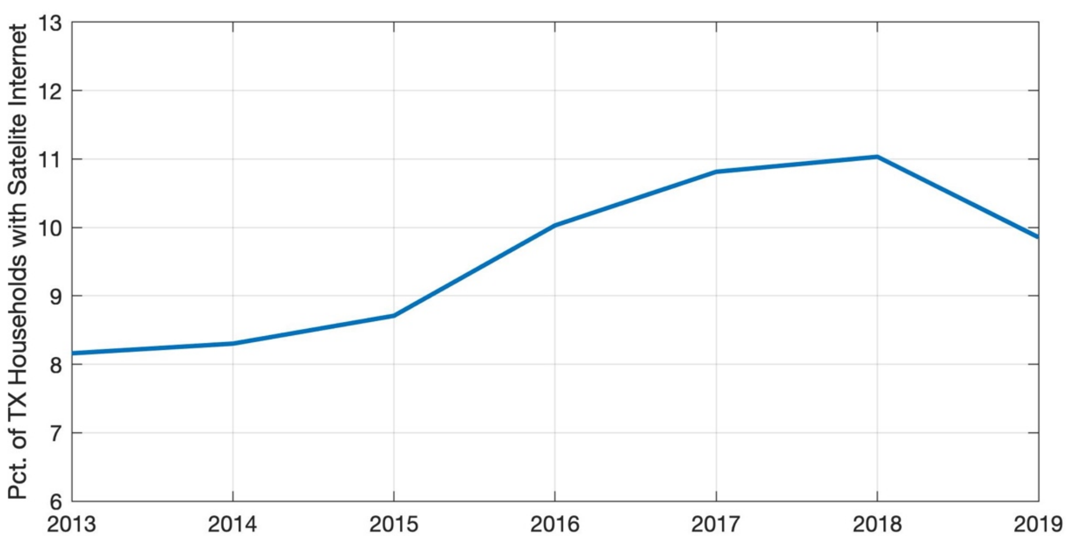

Figure 3: Share of Texas households with satellite internet. (Source: ACS via IPUMS)

Roughly 10% of households in Texas receive satellite internet service, though the quality of the service may not qualify as broadband access. Traditional satellite internet access is delivered by geostationary satellites, which are high-orbit satellites more than 22,000 miles away, while the

[36] https://comptroller.texas.gov/economy/fiscal-notes/2019/oct/divide.php

emergent low-orbit satellites are between 200 and 800 miles above Earth's surface.[37] Both technologies have the capacity to deliver internet to rural areas, but success of the low-orbit services would improve transmission speeds and latency, potentially delivering broadband-quality internet to underserved areas.

Although low-orbit satellite broadband provision could fill several gaps in broadband access, the efforts are not intended to replace traditional land-based networks currently serving more densely populated areas. Consequently, rural households that are excluded from broadband access are those most likely to benefit from emergent satellite broadband technology.

The four largest global satellite internet companies are SpaceX, Telesat, OneWeb, and Amazon.[38] Insights into SpaceX's fee structure offers a starting point for economic and policy analysis. SpaceX's internet access is provided through Starlink—a satellite internet constellation consisting of 1,740 satellites, providing internet access to 100,000 people across 14 countries.[39] This provider, which is still in a testing phase, offers service for $99 a month and requires a startup fee of $499 to for at-home receiver. With approval from the FCC to launch 12,000 satellites, the company is likely to significantly expand access in the coming years.

Because low-orbit satellite broadband provision does not require additional land-based infrastructure, like fiber-optic cables, one form of government subsidization could cover the startup fee for eligible households. For example, of the funds issued to Texas in American Rescue Plan Act, approximately $500 million was allocated to rural broadband infrastructure. That amount could cover the start-up fee for approximately 833,000 Texas households, which is roughly equal to the total number of households lacking internet in their home.

Although the emergent low-orbit satellite technology offers hope for affordable rural broadband access, the development process must still overcome several hurdles. For example, current customers may reach broadband-quality internet during the developmental phase, but internet speeds could decline significantly with broadened access. As a result, low-orbit satellite providers may need to deploy a large constellation of satellites to service a meaningful share of the rural population, leading to prohibitively high costs. While the low-orbit satellite market holds significant promise for closing the rural broadband gap, choosing this technology as the primary target for rural outreach entails near-term risk. As information regarding the costs and overall success of this industry become better understood, the value of this technology as a solution to rural broadband access will become clearer.

[37] https://www.pewtrusts.org/en/research-and-analysis/articles/2021/09/08/a-primer-on-rural-broadband-deployment

[38] https://news.mit.edu/2021/study-compares-internet-meganetworks-0610

[39] https://www.cnbc.com/2021/09/01/elon-musk-jeff-bezos-job-is-legal-actions-against-spacex-starlink.html

Evaluating Options

Finding the right solution for government involvement in enhancing broadband outreach involves careful consideration of both the local costs and the local benefits of expanding access. Moreover, the decision should not be considered on a static basis—long-term estimates of maintenance costs and the prospect of emergent technology must be included in any value measurements. In evaluating these long-term implications, consideration must also be given to behavioral responses, including moral hazard in the private market and the potential for rural population growth resulting from improved broadband access.

With greater proximity to metropolitan areas comes larger overall benefits of broadband access. This relationship was shown to be particularly relevant for businesses and employees that benefited from enhanced networks. Moreover, the costs of expanding broadband access to these areas is certain to be lower, compared to more remote rural areas. For these reasons, expanding provision of terrestrial broadband technology, like cable or fiber optic lines, to these rural areas closer to metropolitan areas could deliver greater social value.

As distance grows between rural areas and metropolitan areas and as density declines, cable and fiber optic networks may become increasingly inefficient as a rural broadband delivery method. Other options, including fixed wireless may prove to be financially viable in permissible topographies. These areas may also benefit from electric co-op partnerships in the form of fiber optic broadband service.

For the most remote rural areas or consumers in areas whose topography makes fixed wireless and other terrestrial access challenging, low-orbit satellite remains a viable possibility. Although significant uncertainty remains regarding the prospect of this industry for rural broadband provision, the outlook should become increasingly clear within the next few years. Such a wait may not even be an option, as fiber optic providers experience severe supply shortages.[40] As a result, temporarily delaying a decision might be the best option for helping these consumers in the most efficient way possible.

Financing Alternatives

Different methods for efficiently allocating government resources to enhance rural broadband access can make sense for different technologies. For land-based technologies, government incentives can reduce the fixed cost of expanding into rural areas. These incentives can come in the form of tax credits, subsidies, grants, low-interest loans, and public-private partnerships. For satellite technology (pending the success of the industry), solutions on the demand side, such as

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[40] https://arstechnica.com/information-technology/2021/08/att-delays-500000-fiber-to-the-home-builds-due-to-severe-fiber-shortage/

consumer subsidies and rebates, could prove to be an efficient allocation of government resources to expand broadband access.

Ideal financing depends extensively on the cost structure of the provider. With large fixed costs of establishing infrastructure, grants and tax policy could incentivize expansion in the most efficient way. Tax deductions often come in the form of accelerated depreciation, which could translate into large tax incentives for capital intensive investments at the federal level. Prospects for tax policy in Texas would involve incentives through the corporate franchise tax, since Texas does not levy a corporate income tax. Often, a large expense for providers is getting the home connected to the network, generally referenced as going the "last mile." Subsidies for these connections could also create an efficient incentive for broadband providers.

Conclusion

Both the federal and state governments recognize the importance of expanding broadband access to low-income and rural households. With significant government resources allocated to broadband expansion, several issues remain—particularly, understanding which technology best serves the underserved group and determining the best form of government involvement. This report shows that no one-size-fits-all approach exists to expanding broadband to underserved households. Rather, the best solutions involve understanding the unique circumstances of the individual market and considering a broad range of solutions.

Appendix: Econometric Estimation of Broadband Access

The data is derived from the 2019 ACS (accessed via IPUMS). Observations whose FIPS did not equal 48 were removed to limit the data set to Texas households. The variables included in the estimation were CISPEED for broadband indicator (all high-speed sources included), HHINCOME for household income, and DENSITY for population density. The resulting data set included 465870 observations that were weighted using the corresponding HHWT variable.

The econometric model is specified as a probit: $P(Y = 1) = \phi(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3)$, where the dependent variable is the probability of the household having broadband access, the first independent variable is household income, the second independent variable is population density, and the third independent variable is an interaction term comprised of the product of the other two independent variables. The results of the estimation are displayed in the table below. Each of the variables is both statistically and economically significant.

	Estimate	SE	t-Stat
(Intercept)	0.43509	0.00051318	847.83
Household Income	2.14E-06	4.72E-09	452.57

Density	3.10E-05	1.66E-07	187.09
(Interaction)	4.67E-10	1.78E-12	262.77