CLOSING THE BROADBAND INFRASTRUCTURE GAP: STATE GRANT FUNDS AND THE DIGITAL DIVIDE

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INTRODUCTION

Increasing reliance on high-capacity and reliable broadband Internet access for everyday activities makes disparities in the availability of broadband infrastructure a growing concern. Closing the digital divide is a collective effort, and research suggests that state funding can play an important role.[1] This report examines data collected by The Pew Charitable Trusts on state broadband grants awarded across 17 states from 2014-2020. It explores characteristics common among awarded projects, the criteria for grant allocation, and if funds reach communities less likely to be served by broadband - rural, sparsely populated and those with high poverty. What lessons can be learned from how states have allocated broadband funds in the past? As states are now receiving funds from the Broadband Equity, Access and Deployment (BEAD) Program, this analysis of historical state broadband program data will shed light on the different strategies, policies and goals in the distribution of state grants.

This report provides insights on the specific types of projects, grantees, providers and technologies that were funded, and explores how grant distribution is impacted by demographic, socioeconomic, market and policy factors. The pandemic has spurred a shift from coverage-focused broadband policy to a broader definition of access that recognizes the demographic and socioeconomic elements of the digital divide[2]. We explore how state broadband programs addressed 1) market challenges, by expanding coverage in rural, low-density and low-income areas, and 2) digital equity, by funding communities that lag behind in terms of access and adoption (rural, poor, minority or lower educational attainment). We also explore the impact of state broadband program design and broadband regulation. Implications for state broadband program design and broadband policy are provided.

BACKGROUND

The digital divide

Millions of Americans remain without access to high-speed Internet. The "digital divide" is a multilayered issue, including access to high-speed and reliable broadband service, adoption and service affordability,[3] which have been linked to geographic, socio-economic, policy and technology disparities.[4,5] Rural areas suffer from lack of competition due to low population density and remoteness, with construction costs rising as networks spread across long distances to reach more users.[6] Government subsidies have played a role in encouraging investment in upgrades to faster and more reliable technologies.[7] In addition to rural consumers, research has also found that low-income and minority groups have also been found to lag behind in terms of access[8] and adoption.[9] Inability to afford broadband Internet service, and lack of digital literacy can also prevent potential consumers from adopting broadband service.[10]

Broadband policy and the local supply of broadband infrastructure were impacted by the COVID-19 pandemic, which shifted many essential activities online and highlighted disparities in broadband access.[11] While research has primarily focused on federal broadband policy, states play a key role in 1) providing public funds to ease some of the costs of expanding and upgrading infrastructure in unserved areas,[12] and 2) easing the regulatory barriers that might slow the deployment or entry of new providers.[13] This report explores how state broadband grants are supporting infrastructure deployment, especially in high-cost, low-density and high-poverty areas.

The role of state funding

While federal funding is important, many states have launched their own programs to expand broadband access. Learning from these state level programs can help guide future policy design, especially the BEAD Program. State program eligibility requirements and priorities, as well as state law, impact the availability of specific broadband technologies, speeds, provider types and the degree of public and private involvement. The Pew Charitable Trusts (2021) outlines some of the aspects in which state programs vary, such as their eligibility requirements and funding requirements.[14] We list them below.

Eligibility requirements

- **Technology.** Most state programs follow a "technology neutrality" policy that prevents any broadband technology being prioritized over another, so as not to discourage entry in unserved areas. As long as technologies could deliver the minimum speed required, they would be able to compete for grants. Not all broadband technologies are equal, and some states are no longer supporting older technologies increasingly perceived as slower and less reliable, such as DSL or satellite projects.[15]
- **Speed definitions.** When the minimum speed requirement is low (less than the federal definition of 25/3 Mbps), communities served by such slow, unreliable and outdated technologies become ineligible for state funding – as they are considered "served." Some states provide incentives for fiber deployment and higher speeds.
- **Provider type.** Some states prioritize or restrict eligibility to specific provider types, such as private telecommunications companies, or require that projects are public-private partnerships. States can also have more than one program targeting different provider types. For example, in Massachusetts, the Last Mile Infrastructure Grant program is oriented towards a publicly owned networks, and the Flexible Grant Program funds private Internet Service Providers.
- **Middle mile versus last mile deployment.** States primarily fund last mile projects, which provide connectivity to end users (such as households). However, some states allow funds to be used for middle mile networks, which connect the last mile segment to the core network and provide service to anchor institutions – government buildings, schools, libraries, hospitals, etc.[16] Middle mile buildout is critical for rural locations, which can be far from the nearest Internet point of presence (POP)[17]. When the middle mile network is open access, multiple Internet Service Providers may lease the infrastructure and deliver last mile service[18].
- **Demographic and socioeconomic factors.** Some states use thresholds (minimum or maximum population, percentage of unserved, poverty level) to target areas in need and ensure state funds reach low-income, low-density areas.
- **Federal funding.** In some states, communities may become ineligible for state funding if they have already used federal funding for broadband. For example, in Missouri, projects that were already awarded federal funding (that did not contain a match requirement) were ineligible for state funding[19]. In North Carolina, counties that used American Rescue Plan (ARPA) funds for broadband infrastructure, outside of the state's GREAT or CAB broadband programs, were ineligible as locations for GREAT-funded projects[20].

Funding requirements

- **Maximum grant amount.** Grant funds available for distribution vary across states. This affects the maximum grant amount a project may receive.
- **Required match percentages.** Many state programs require grantees to pay for a percentage of the project costs[21]. Matching funds may be provided by the local government, the provider, or the federal government (federal grant funds). A high required match could become a barrier for communities with less resources and capacity.

Post-pandemic opportunities to address digital inequity: ARPA and BEAD

The **American Rescue Plan Act (ARPA)** allocated $350 billion to the State and Local Fiscal Recovery Funds to assist states, counties and cities with pandemic relief[22], and $10 billion to the Capital Projects Fund (CPF), to support broadband infrastructure projects, device acquisition and facilities for education and health monitoring. CPF funds also can be used for project planning, capital improvements and efforts to increase adoption and digital literacy.[23] Some states are taking advantage of CPF's flexible grant requirements to expand service in unserved areas, build libraries that will provide Internet access to the public, and increase connectivity in affordable housing.[24]

The **2021 Infrastructure Investment and Jobs Act (IIJA)** allocated $65 billion to various broadband programs[25], including $42.45 billion to the Broadband Equity, Access and Deployment (BEAD) Program, $1 billion to the Enabling Middle Mile Broadband Infrastructure Program, $2 billion to the Tribal Broadband Connectivity Program and $2.75 billion to the Digital Equity Act Programs.

BEAD represents an important shift in federal broadband policy, which was traditionally neutral regarding technology and provider eligibility. Technology neutrality meant that, projects offering fiber optic (high speed and high capacity, but expensive to build) could not be prioritized over slower, less reliable (but less expensive to deploy) technologies based on the technology alone.[26] Eligibility requirements largely favored for-profit private providers, did not provide enough support for cooperatives, and restricted opportunities for municipal providers.[27] With BEAD, the federal government now aims to 1) support projects with a speed of 100/20 Mbps, and 2) encourage "non-traditional" broadband providers to apply for federal funding – including cooperatives, utilities, municipalities and non-profit organizations.[28] BEAD also aims to support fiber connectivity. Finally, areas with access to reliable broadband service must have access to Internet service of at least 100/20 Mbps download/upload speeds, be it fiber optic networks, cable modem, fixed wireless or DSL.[29]

Still, some concerns remain. States have their own definitions and policies. For example, some states continue to define unserved areas as those without access to 25/3 Mbps, and rely on inaccurate data from the FCC's Form 477 maps.[30,31] Municipal broadband is restricted (to varying degrees) in 16 states and faces challenges in another three.[32] Finally, BEAD will require recipients to match at least 25% of project costs, except in "high cost" areas. High-cost areas are defined by remoteness, low population density, topography and poverty level, among other factors.[33] Since the cost of installing fiber technology is high - if awardees must match 25% per mile, this might deter applicants with limited resources.[34]

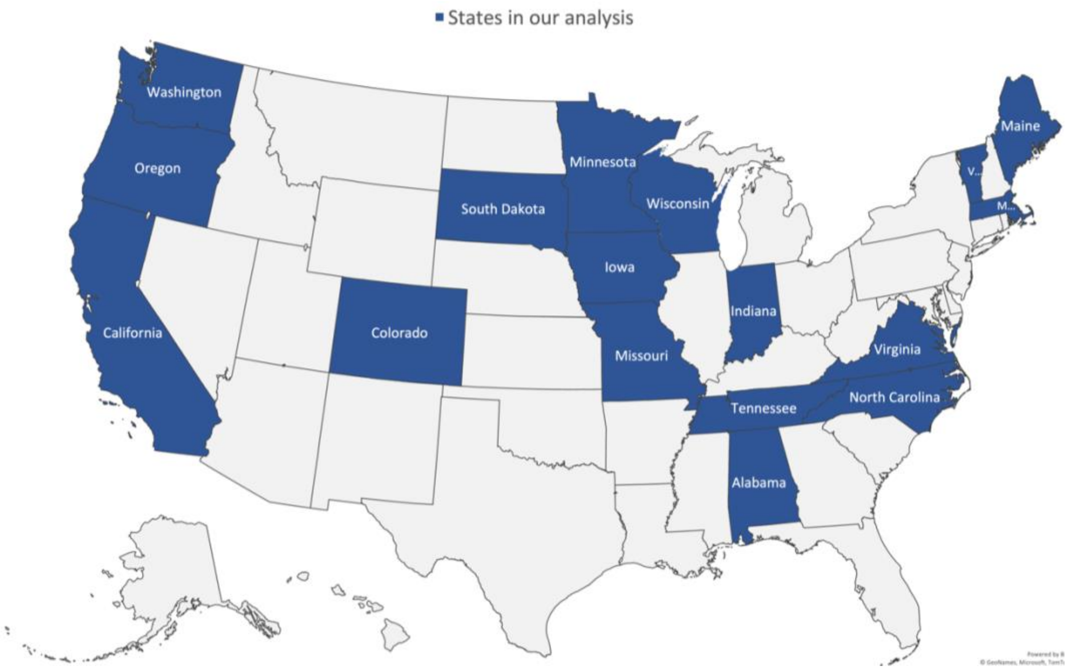
These new federal programs address technology, speed, partner and match requirements. Prior state funding programs show a diversity in policy design. Analysis of these state programs can provide important insights for new federal and state policy design, given the heightened interest in broadband investment, especially for underserved communities.

DATA AND METHODOLOGY

DESCRIPTION OF THE DATA

The Pew Charitable Trusts collected data on 19 states from 2014-2020. Location data was unavailable for projects in Nebraska and New York (93 projects), so these two states are not included in our analysis. Our analysis is based upon 724 projects in 17 states. These states are shown in dark blue in Figure 1.

Figure 1. State Broadband Programs Analyzed.



State	Grants
Alabama	35
California	44
Colorado	45
Indiana	13
Iowa	24
Maine	36
Massachusetts	15
Minnesota	139
Missouri	16
North Carolina	21
Oregon	3
South Dakota	8
Tennessee	39
Vermont	28
Virginia	40
Washington	8
Wisconsin	210
Total	*724*

Data Source: Pew Charitable Trusts State Broadband Grants, 2014-2020

State Broadband Grant Data

The data include grants awarded between 2014 and 2020. For each grant, there is data on: the project's county location, total grant amount, total match, number of premises passed, provider type and size, grantee type, technology type, whether the project included middle mile infrastructure or was connected to a previous planning grant, and metro status (See Box 1). These data were combined with data on state broadband program requirements and policies, including required match (See Box 2). County-level socio demographic data was included to assess if grants reached low income and underserved communities (see Box 3).

BOX 1: STATE BROADBAND GRANT DATA (N = 724 grants or awarded projects, excluding NY and NE)	
County	Location of the project. Projects may serve a single location or multiple locations (up to 8).[A] There is no data available on what percentage of the population in each location is served by the project.
Grant Amount ($)	Total amount of money received by the grantee.
Total Match ($)	Total amount of match money provided for the project from all sources, including provider match, federal match and local government match. We use total match in our analysis due to the lower number of missing values.
Provider Match ($)	Amount of money provided to the project by the provider.
Federal Match ($)	Amount of money provided to the project through federal programs.
Local Government Match ($)	Amount of money local government provides for the project.
Premises Passed (#)	Number of premises passed by the project, according to the grant application.
Provider Type	1 = for-profit telephone company; 2 = for-profit cable company; 3 = telephone cooperative, or a subsidiary; 4 = electric cooperative, or a subsidiary; 5 = municipality or a municipal utility; 6 = wireless ISP; 7 = another category.
Provider Size	1 = Provider is active in only one local region; 2 = Provider is active nationwide or in multiple regions.
Grantee Type	1 = private (either for-profit or non-profit) provider applying alone; 2 = public-private partnership; 3 = municipality (including counties) or municipal utility applying without a private-sector partner; 4 = special district or regional entity comprised of multiple local governments.
Technology	Grant Funds only: 1 = fiber optic infrastructure; 2 = cable infrastructure; 3 = DSL infrastructure; 4 = fixed wireless infrastructure; 5 = another technology (e.g., satellite); 6 = combination of technologies.
Middle mile	0 = Grant-funded infrastructure does not include middle mile; 1 = Grant-funded infrastructure includes middle mile.
Planning	0 = Grant is a planning grant; 1 = Grant is not a planning grant.
Rural Code	2013 USDA Rural-Urban Continuum Codes (RUCC), ranging from 1 to 9. Codes 1, 2 and 3 are metro areas, 4, 6 and 8 are nonmetro areas adjacent to metro, and 5, 7, and 9 are nonmetro areas nonadjacent to metro.[35]

State Broadband Program Data

State program scoring criteria differ by a number of elements. These include: required match, grant size, technology neutrality, speed, definitions of what constitutes a "served" community. Data on these are included in the Pew Data base and described in Box 2 below.

[A] Thirteen locations were Indian tribes, reservations or tribal lands: in Minnesota (06), Iowa (01), Washington (04) and Wisconsin (02). These locations were included in our analysis of 724 projects.

BOX 2: STATE BROADBAND PROGRAM DATA (N = 20 broadband programs, 17 states[B])	
Required Match (%)	Percent of project funding that each state requires recipients to provide, ranging from zero to eighty-five percent across the 17 states analyzed. Grant funds might be matched using funds from the local government, the project's provider or federal funds.
Maximum Grant Amount	Some states will cap the maximum amount of funds they will grant to a project, ranging from $75,000 to $5,000,000 across the 17 states analyzed.
Technology Neutrality	Most state programs follow a technology neutrality policy. Some programs exclude satellite.
Definitions of unserved and underserved	States have their own definitions of what constitutes 'unserved' and 'underserved' areas. These are related to the minimum eligible broadband download/upload speeds they will fund (ranging from 10/1 Mbps to 25/3 Mbps), the types of broadband technology regarded as adequate, and the existing number of providers (expected to be one or two) offering broadband service at state standards.
Minimum eligible upload and download speeds	State thresholds in Pew's database for eligible minimum download/upload speeds for new projects vary between 10/1 Mbps and 25/3 Mbps, with the exception of Washington state[C]. Since 2015, the speed threshold for the Federal Communications Commission has been 25/3 Mbps.[36] Currently, the US Department of Agriculture considers projects proposing service at 10/1 Mbps ineligible for ReConnect funds.[37]
Scoring criteria	Scoring criteria vary across states. They include whether the project 1) is scalable to higher speeds; 2) is a public-private partnership; 3) is connected to a local planning process; 4) includes plans to increase broadband adoption, 5) is open access, and 6) connects community anchor institutions. States also might consider the degree of community support or the potential social and economic impact of the project.
Challenge process	Some states have a formal challenge process by which providers can challenge grant awards.
Area eligibility and federal funding	In some states, communities may become ineligible for state funding if they have already received federal funding. Eligible applicants also may be barred from using federal funds to meet state match requirements.

[B] Colorado, Massachusetts and Virginia each have two programs included in our study. Colorado has the Department of Local Affairs Broadband Program and the Department of Regulatory Agencies Broadband Fund. Massachusetts has the Last Mile Infrastructure Grant and the Broadband Extension Program. Virginia has the Virginia Telecommunication Initiative (VATI) and the Tobacco Region Revitalization Commission Last Mile Broadband Program.

[C] Washington state's CERB Rural Broadband Program has individual minimum eligible infrastructure and minimum speed requirements for different broadband technologies. See Washington State's Department of Commerce website: https://www.commerce.wa.gov/building-infrastructure/community-economic-revitalization-board/rural-broadband/

Additional data incorporated

To study the impact of factors related to socioeconomic and demographic characteristics and broadband coverage, we added the following data to the county-level database (see Box 3).

BOX 3: SOCIO-ECONOMIC AND BROADBAND COVERAGE DATA (N = 1,167 counties, 17 states)	
Socio-economic data	Drawn from the U.S. Census Bureau's American Community Survey (ACS; 2020, 5-year estimates (2015-20)). These variables are at the county-level and include: total population, population density, percent of the population over the age of 25 with a bachelor's degree or more, percentage of the population that is Non-Hispanic White, the poverty rate, the Gini coefficient of income inequality, and the percentage of households with a broadband internet subscription. The total population and population density variables were natural logged because of their positive skew, to fit the assumptions of subsequent statistical modeling.
Metro status	We use 2013 Rural-Urban Continuum Codes (RUCC) from the USDA. In Part I, we assess how grants were allocated between metro counties (RUCC = 1, 2, 3), metro-adjacent nonmetro (rural) counties (RUCC = 4, 6, 8) and non-adjacent nonmetro (rural) counties (RUCC = 5, 7, 9). In Part II, we develop separate models for metro counties (RUCC = 1, 2, 3) and nonmetro (rural) counties (RUCC = 4, 5, 6, 7, 8, 9).
Residential broadband Internet Service providers	December 2020 data on providers by census tract was drawn from the Federal Communications Commission (FCC) "Fixed Broadband Deployment Data from FCC Form 477." Data manipulation was necessary to make a comparable county level variable. For each state, a dataset of broadband providers by census block was downloaded and aggregated upwards to the county level. For each county in the dataset this is a count of unique providers present within their borders. While the FCC's broadband deployment data has received criticism for its inaccuracies,[38] federal and state programs have used it as a reference to determine which areas are unserved[39,40] and are thus eligible for grants. Previous research has used home broadband Internet subscription rates as an alternative measure of broadband access to FCC data.[41] We also include data on the percentage of households with broadband Internet subscriptions.
State policy	We control for state-level policy factors, such as: 1) grant match requirements, drawn from the state broadband program data collected by The Pew Charitable Trusts, and 2) municipal broadband restrictions, drawn from Temple University's Center for Public Health Law Research Data on State Preemption Laws.

METHODOLOGY

First, we used descriptive statistics to analyze project characteristics and identify common patterns across the 724 projects in the 17 states in the 2014-20 time period. We explored how state grant funds were allocated across all states, in terms of provider and grantee type, technology and other aspects of state policy design, and grant allocation by socio-economic and metro status.

Next, we used a T-test comparison of means to assess funded versus unfunded counties across all 1,167 counties in the 17 states for the 6-year period. This showed which counties were more likely to be funded, and the relation to 1) socioeconomic and demographic community characteristics and 2) number of residential Internet Service Providers.

Next, we used regression models to explore how the following factors were related to the number of grants received by each county. We explored which counties were more likely to receive more grants by: 1) socioeconomic and demographic community characteristics, 2) rurality, 3) state municipal broadband restrictions, 4) state required match percentage, and 5) available data on residential Internet Service Providers.

Together, these analyses enable us to assess whether state grant funds are reaching low-density, rural and high-poverty areas, supporting nontraditional providers (who often have less funding and financing resources available), and supporting the construction of high-capacity and high-speed last mile and middle mile infrastructure (which connects anchor institutions and offsets costs for last mile providers in rural areas).

PART I: WHICH PROJECTS WERE FUNDED?

Project-level analysis

N = 724 funded projects, 17 states

THEME 1: EXPANDING THE MARKET AND RAISING THE STANDARDS

1.1. Promoting the regional market: Regional, for-profit telephone companies were the most commonly funded.

There has been some criticism over the large amounts of federal broadband subsidies received by large telecommunications providers.[42] Ten of the largest telecommunications carriers – "price cap" carriers such as CenturyLink, AT&T, Frontier and Verizon – were the main beneficiaries of the Phase II of the Connect America Fund (CAF-II, 2015-2021).[43,44] Smaller and rural telephone companies (including telephone cooperatives) serving low-density populations have a program of their own – the Alternative Connect America Cost Model (A-CAM).[45] The history and structure of federal programs may affect the type of broadband providers available to apply to state programs.

Problems with delivery on coverage and speed promises after receiving public funding has made some states cautious about relying on large telecommunications companies to close the digital divide.[46,47] State broadband programs can play a key role complementing federal efforts, by targeting providers that are less likely to benefit from federal funding programs. The Pew Charitable Trusts collected data on the size of providers that were awarded state grants between 2014 and 2020, dividing them in two groups: 1) Providers that were active in only one region, and 2) Providers that were active nationwide or in multiple regions.

The data suggest that states have made a concerted effort to expand beyond the traditional reliance on large telecoms to close the digital divide. We found that only 18% of grants were awarded to providers that were active in multiple regions or nationwide – i.e., primarily for-profit telephone (8%) and cable companies (9%) such as CenturyLink, Charter Communications, Comcast, Frontier and Verizon Communications (see Table 1, below). Additionally, out of 129 grants awarded to large telecommunications companies, 74 grants were awarded to projects in metro areas, 36 in metro-adjacent rural areas and 19 in non-adjacent rural areas. Additional county-level demographic and socioeconomic is needed to assess whether funds are being channeled to populations disproportionately impacted by the digital divide. These results suggest that most state grants awarded to large telecoms will serve metro and metro-adjacent rural areas, and thus will not drive broadband deployment in remote (non-adjacent) rural areas.

Between 2014 and 2020, states primarily funded providers that were active in only one region, amounting to 74% of awarded providers. This percentage is due, in part, to the percentage of providers that are local – cooperatives and municipalities. Table 1 (below) shows the various types of regional providers (active in only one region) that were awarded state funds: "Traditional" providers, such as for-profit telephone companies (26%), telephone cooperatives (14%) and wireless Internet Service Providers (11%), received the majority of grants. "Non-traditional" providers received a smaller number, including electric cooperatives (8%) and municipal providers (3%). We discuss the limited role of municipalities as providers under Theme 2.

Table 1. Projects (%) by Provider Type

	Provider Size						Total	
	Active in only one local region		Active nationwide or in multiple regions		Unknown			
Provider Type	N	(%)	N	(%)	N	(%)	**N**	**(%)**
Provider is a for-profit telephone company	188	(26%)	59	(8%)	0		**247**	**(34%)**
Provider is a for-profit cable company	12	(2%)	64	(9%)	0		**76**	**(10%)**
Provider is a telephone cooperative, or a subsidiary	102	(14%)	0		0		**102**	**(14%)**
Provider is an electric cooperative, or a subsidiary	57	(8%)	0		0		**57**	**(8%)**
Provider is a municipality or a municipal utility	23	(3%)	0		0		**23**	**(3%)**
Provider is a wireless ISP	80	(11%)	0		0		**80**	**(11%)**
Provider falls into another category	73	(10%)	6	(1%)	0		**79**	**(11%)**
Unknown	0		0		60	(8%)	**60**	**(8%)**
Total	**535**	**(74%)**	**129**	**(18%)**	**60**	**(8%)**	**724**	**(100%)**

Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

Regional providers and rurality. We found that more grants to regional providers were located in metro-adjacent nonmetro areas (31%) and metro areas (26%), rather than non-adjacent nonmetro areas (16%). **Table 2** (below) shows this is the case for all provider types, including telephone and electric cooperatives.

Table 2. Projects by Provider Type and Metro Status.										
	Metro Status								**Total**	
	Metro		Nonmetro, metro-adjacent		Nonmetro, not metro-adjacent		Unknown			
Provider Type	N	(%)	N	(%)	N	(%)	N	(%)	**N**	**(%)**
Provider is a for-profit telephone company	101	(14%)	95	(13%)	51	(7%)			**247**	**(34%)**
Provider is a for-profit cable company	43	(6%)	23	(3%)	10	(1%)			**76**	**(10%)**
Provider is a telephone cooperative, or a subsidiary	20	(3%)	62	(9%)	18	(2%)	2	(0%)	**102**	**(14%)**
Provider is an electric cooperative, or a subsidiary	29	4%	13	(2%)	15	(2%)			**57**	**(8%)**
Provider is a municipality or a municipal utility	3	0%	13	(2%)	2	(0%)	5	(1%)	**23**	**(3%)**
Provider is a wireless ISP	28	4%	31	(4%)	18	(2%)	3	(0%)	**80**	**(11%)**
Provider falls into another category	36	5%	24	(3%)	19	(3%)			**79**	**(11%)**
Unknown	10	1%	8	(1%)	41	(6%)	1	(0%)	**60**	**(8%)**
Total	**270**	**(37%)**	**269**	**(37%)**	**174**	**(24%)**	**11**	**(2%)**	**724**	**(100%)**

Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

Policy Implications

The data show regional telecoms were funded in metro and metro-adjacent nonmetro markets. Future research should assess the extent to which this might be an outcome of providers' risk-averse investment choices, or the result of state program design. In metro and metro-adjacent rural areas, the customer base is likely to be larger, and the costs of deployment lower, than in non-adjacent rural areas. In areas with low population density, deployment costs are likely to be higher because networks must expand over long distances to reach as many customers as possible.[48] If regional providers lack the capacity to bear the financial risk of building and operating networks in remote areas, then meeting costly expectations related to technology, speed, affordability and grant requirements could further discourage build out in remote rural areas.

The pandemic shed light on the critical role of local broadband providers in addressing disparities in connectivity. With customers unable to pay for Internet service at risk of being disconnected, the FCC Chairman asked providers to take the Keep Americans Connected Pledge. Providers were asked to continue providing Internet access to customers, even after they were unable to keep paying for the service; to waive late fees, and to grant access to their wi-fi hotspots. Companies were also encouraged to adopt or expand their programs targeting low-income families.[49] In addition, to encourage more local broadband providers to serve remote areas, ongoing federal and state broadband funding will be a critical source of support. State broadband programs could benefit from tailoring their policies and approaches to complement the federal approach, and addressing potential barriers in the application process for non-traditional providers. These include small, local, independent and rural providers, telephone and electric cooperatives, municipal providers, etc. For example, Wisconsin has addressed potential barriers for small providers by making applications and reporting requirements easier to navigate.[50]

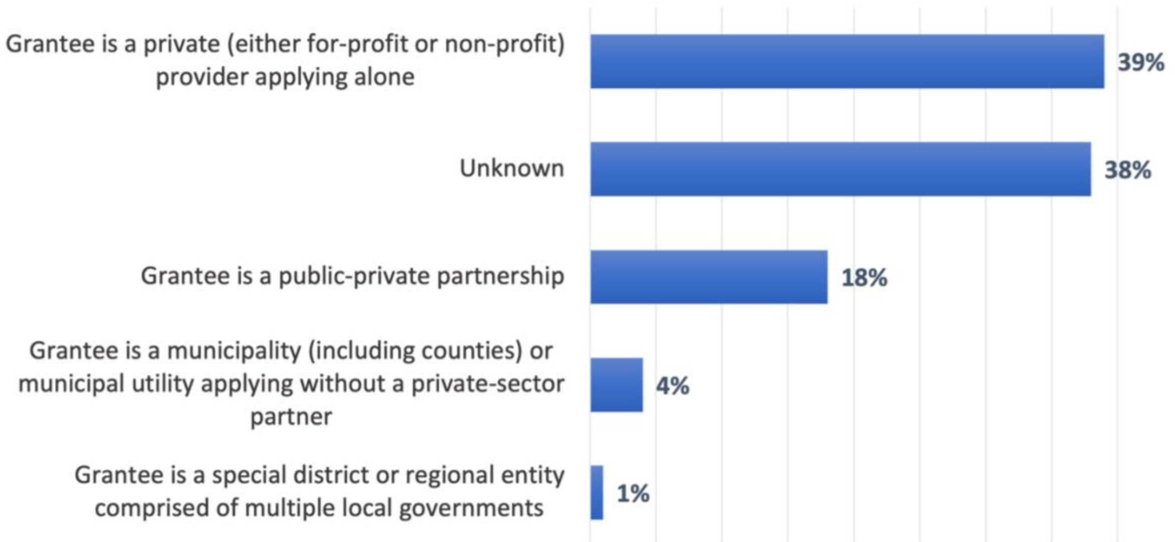
1.2. States are encouraging public-private partnerships.

Different state programs have their own policies regarding the types of providers and grantees eligible for state funding. Most programs tend to fund private Internet Service Providers or, aim to support projects that are public-private partnerships (such as the Virginia Telecommunications Initiative[51]). Some programs, like the Colorado Department of Local Affairs Broadband Program, provide support to local governments with funding for planning and middle mile infrastructure.[52]

The Pew Charitable Trusts collected data on four types of grantees: 1) Private providers applying without a local government, 2) Public-private partnerships, 3) Municipalities or municipal utilities applying without a private sector partner, and 4) Special district or regional entity comprised of multiple local governments. A grantee will not necessarily assume the role of provider. In a traditional public-private partnership, the municipal role can be limited to procuring funding, and the private provider is the owner of the infrastructure and responsible for the construction, operation and maintenance of the network. Thus, in states where municipalities are forbidden to own, build or operate a network and provide Internet Service, they are still eligible to receive state funds. Where there are no regulatory roadblocks, local governments could procure funding and build and retain ownership of the network while their private sector partner would be in charge of operation and maintenance. This can be an attractive option for underserved areas where there is little incentive for incumbents to upgrade their services or lower prices.[53]

As Figure 2 (below) shows, private providers applying alone (without a public sector partner) accounted for 39% of grantees. These private providers were mostly for-profit telephone companies (15%), for-profit cable companies (6%), telephone cooperatives (6%), electric cooperative (6%), wireless ISP (3%) and others (4%). While this was consistent with our expectations, we were interested in the local government role as well.

Figure 2. Types of Grantees Funded.



Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

Local governments received more grants when part of a public-private partnership (18% of 724 projects), instead of applying alone (4%). Public-private partnerships (P3) were more commonly funded in states that gave weight to P3 or required grantees to be P3,[D] such as, Virginia (where all projects were P3), Maine (78% of projects), Washington (63% of projects), Minnesota (26% of projects) and Wisconsin (8% of projects)., In Virginia, where grantees are required to be public-private partnerships, local governments apply for grants, and their private sector partner owns and operates the network.[54] Local government involvement is facilitated with a generous state match provided by the Virginia Telecommunications Initiative, which can match up to 80% of project costs[55].

Public-private partnerships largely involved providers that were active in only one region (79% of 130 P3 projects). These P3s were mostly for-profit telephone companies (28%). Grants allocated to P3's primarily support fiber optic infrastructure (45%), and these P3 grantees were evenly distributed across metro (38%), metro-adjacent nonmetro (33%) and non-adjacent nonmetro areas (27%). In contrast, projects with private providers applying alone (32 projects) were overwhelmingly located in nonmetro areas - metro-adjacent (34%) and non-adjacent (34%). The high percentage of public-private broadband partnerships in nonmetro (rural) areas suggests that encouraging P3s where local governments take a more proactive role can help promote investment in broadband infrastructure for rural areas.

[D] Grantees are required to be P3 in Virginia and Washington. Source: Pew Charitable Trusts State Broadband Program Data.

1.3 Raising the standards: Fiber is the most funded technology.

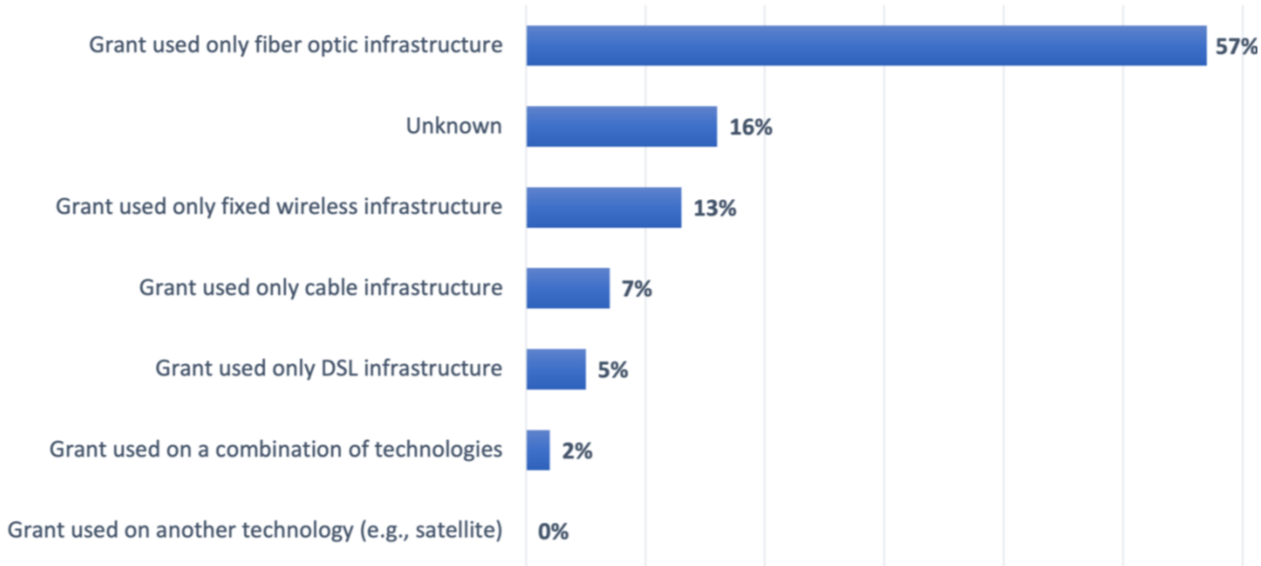
In the past, technology neutrality was the norm for federal and state broadband programs. No broadband technology was to be prioritized over another as long as it could fulfill the program's minimum speed, scalability and reliability requirements. Thus, over the years, federal and state funds have been used to deploy a wide range of broadband technologies, including: fiber optic, coaxial cable, Digital Subscriber Line (DSL), fixed wireless, satellite, or a combination of these technologies. Not all broadband technologies are equal, and older technologies that are less expensive and/or faster to deploy (such as DSL and satellite) also are slower, less reliable and less capable of sustaining increasing traffic. With the FCC raising the minimum broadband speed definition from 10/1 Mbps to 25/3 Mbps, some of these technologies have become obsolete and potentially ineligible for broadband funding.

While fiber optic technology is regarded as the gold standard of broadband technologies in terms of speed, reliability and scalability, it is not always a viable choice for rural and low-density areas due of the high costs of deployment.[56] Keeping the service affordable can be a challenge for rural providers.[57] While federal and state funding can assist with construction costs, rural providers may still struggle to attract the number of subscriptions to justify the high costs of deployment. Thus, despite the benefits of fiber, states might choose to support the deployment of less expensive technologies to address the rural digital divide.

Contrary to these expectations, we find that a high percentage of funded projects (57%) were fiber optic (see Figure 3). These projects also received larger grants,[E] which could be attributed to fiber's high cost of deployment. While twelve states in our study maintained a technology neutrality policy and six states funded projects with a download/upload speeds minimum of 10/1 Mbps, the data suggest that states have made an effort to prioritize higher speed, capacity and scalability over cost.

[E] We used a two-sample t-test to compare the mean 'Grant Amount/Premise Passed' ($) of fiber optic versus non-fiber optic projects. We observed a statistically significant difference ($p<.05$) between the average amount received by fiber optic projects ($3,366) versus non-fiber optic projects ($1,921). This analysis was limited to 614 grants for which we had data on Grant Amount and Number of Premises Passed. Missing values are coded as 0 (other) to preserve the sample size (N=614).

Figure 3. Types of Technology Funded.



Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

While last mile service includes various technologies, fiber is often the technology of choice for middle-mile infrastructure.[58] Middle-mile network technologies can be terrestrial (such as fiber) or wireless.[59] Table 3 (below) shows, the majority of awarded fiber projects were located in metro-adjacent nonmetro areas (23%) and metro areas (20%).

Table 3. Projects by Technology and Metro Status.										
	Metro Status								**Total**	
	Metro		Nonmetro, metro-adjacent		Nonmetro, not metro-adjacent		Unknown			
Technology	N	(%)	N	(%)	N	(%)	N	(%)	**N**	**(%)**
Grant used only on fiber optic infrastructure	148	(20%)	167	(23%)	90	(12%)	6	(1%)	**411**	**(57%)**
Grant used only on cable infrastructure	31	(4%)	11	(2%)	10	(1%)		(0%)	**52**	**(7%)**
Grant used only on DSL infrastructure	18	(2%)	5	(1%)	12	(2%)		(0%)	**35**	**(5%)**
Grant used only on fixed wireless infrastructure	33	(5%)	35	(5%)	20	(3%)	5	(1%)	**93**	**(13%)**
Grant used on another technology (e.g., satellite)			2	(0%)				(0%)	**2**	**(0%)**
Grant used on a combination of technologies	5	(1%)	2	(0%)	10	(1%)		(0%)	**17**	**(2%)**
Unknown	35	(5%)	47	(6%)	32	(4%)		(0%)	**114**	**(16%)**
Total	**270**	**(37%)**	**269**	**(37%)**	**174**	**(24%)**	**11**	**(2%)**	**724**	**(100%)**

Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

Support of fixed wireless infrastructure (13%) is also relatively common. Research finds that fixed wireless is less expensive to deploy than fiber, yet the speed and reliability of its service will largely depend on the capacity of the middle mile network (ideally fiber), and the availability of cell towers.[60] To allow for higher speeds and accommodate more traffic, more cell towers will need to be deployed, and antennas attached. Upgrading fixed wireless equipment is costly due to its short life, with antennas needing to be replaced as the technology evolves.[61] Signal interference from foliage, weather, buildings and metallic structures is a key concern with fixed wireless technology.[62] Thus, fixed wireless is more likely to be deployed in areas where antennas can be deployed in close proximity and where the customer base is large enough to make deployment financially viable.[63] Indeed, state grants supporting fixed wireless were more common in metro (5%) and metro-adjacent nonmetro areas (5%), than in non-adjacent nonmetro areas (3%) as seen in Table 3.

Finally, the data show little to no support of older technologies, such as cable (7%), DSL (5%) and other technologies. While these technologies are less expensive than fiber, they can still require a significant investment in low density areas and across long distances.[64]

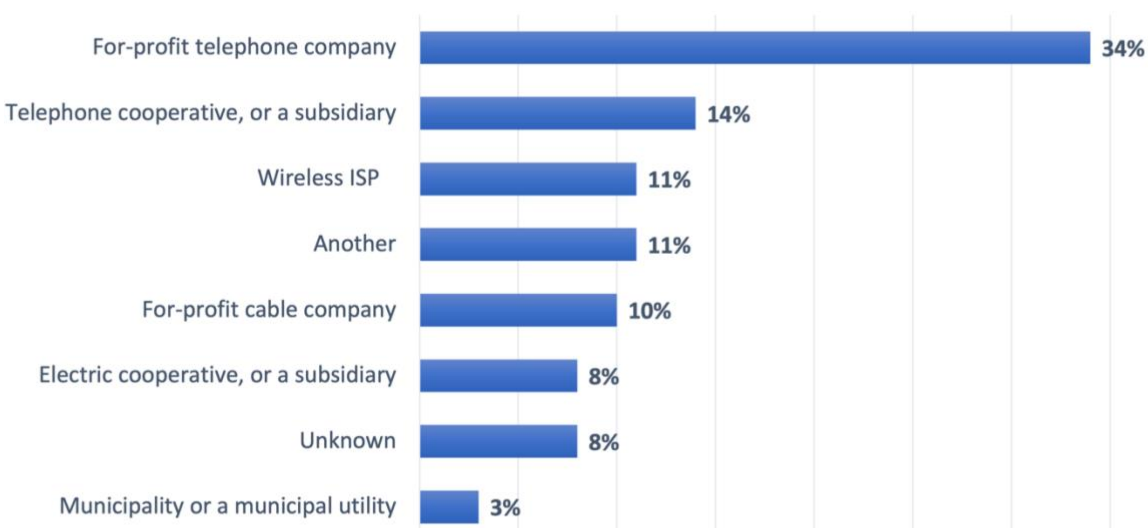
THEME 2: STATES ARE SUPPORTING TRADITIONAL PROVIDERS AND LAST MILE SERVICE

2.1 Limited role of non-traditional providers and possible barriers to entry

The National Telecommunications and Information Administration (NTIA) defines as "non-traditional" Internet Service Providers the following provider and grantee types: public-private partnerships, electric cooperatives, public or investor-owned utilities, local governments, non-profit organizations and tribal entities.[65] These providers can play a key role in closing the infrastructure gap in rural, low density and unserved areas. Electric utilities, in particular, have some unique advantages that could facilitate their expansion into broadband, as they are already deploying fiber to upgrade their smart grid technology,[66] and have direct access to poles and easements.[67,68,69] While more than 200 electric cooperatives are deploying or plan to deploy broadband,[70] they face financial and regulatory challenges.[71,72]

As noted under Theme 1, the role of non-traditional providers was limited. Out of 724 awarded projects, 8% were electric cooperatives, and 3% were municipalities or municipal utilities (see Figure 4).

Figure 4. Types of Providers funded.



Data: Pew Charitable Trusts State Broadband Grants 2014-20, N= 724 funded projects in 17 states

The limited role of non-traditional providers could be attributed to various factors, including backlash from large telecommunications companies, which have tried to prevent non-traditional providers entering underserved areas; [73,74] and state regulation that imposes roadblocks or prohibits municipal entities from owning, financing and delivering broadband service.[75]

Incumbents argue that entry by non-traditional providers to underserved markets can oversaturate the market. More competition is not necessarily viable in the long term, if the optimal number of firms is low due to limited market size and high costs of deployment. When aiming to provide affordable service, publicly subsidized broadband providers might drive prices below the average cost and use cross-subsidization to cover their losses.[76] Incumbents might try to discourage new entry by investing in upgrades or, depending on the cost of upgrades and the size of the market, they might choose not to invest to diminish loss.[77] However, without competition, there is little incentive for incumbents to upgrade or make services more affordable. Research finds faster Internet service has been associated with competitive markets (two or more providers), in comparison to areas with a single provider.[78]

Electric cooperatives are interesting because our data show that they received significantly larger grant amounts per premise[F] passed ($5230) in comparison to other provider types ($2593).[G] This may be due to the fact that most funded electric cooperatives were using state funds to deploy fiber (86%, not shown).

Municipal broadband

State regulation that limits or bans the role of non-traditional providers in broadband delivery can have a negative impact on Internet availability. Research has documented this with municipal broadband[79] which, as of 2023, is explicitly restricted or faces barriers in sixteen states, and faces barriers in another three.[80] Some of these laws include: 1) Prohibiting cross-subsidization to fund broadband service; 2) Only allowing locations with municipal electric utilities to offer broadband; 3) Preventing service delivery outside of the public entity boundaries; 4) Requiring a specific minimum percentage of referendum approval; and 5) Restricting service to "unserved areas," with the public entity bearing the burden of proving that the area is indeed unserved and would not be served by a private provider.

Figure 5 (below) shows that 10 of the 17 states in our study had explicit restrictions or barriers on municipal broadband between 2014 and 2020.[81] These states were Alabama, Colorado, Iowa, Minnesota,

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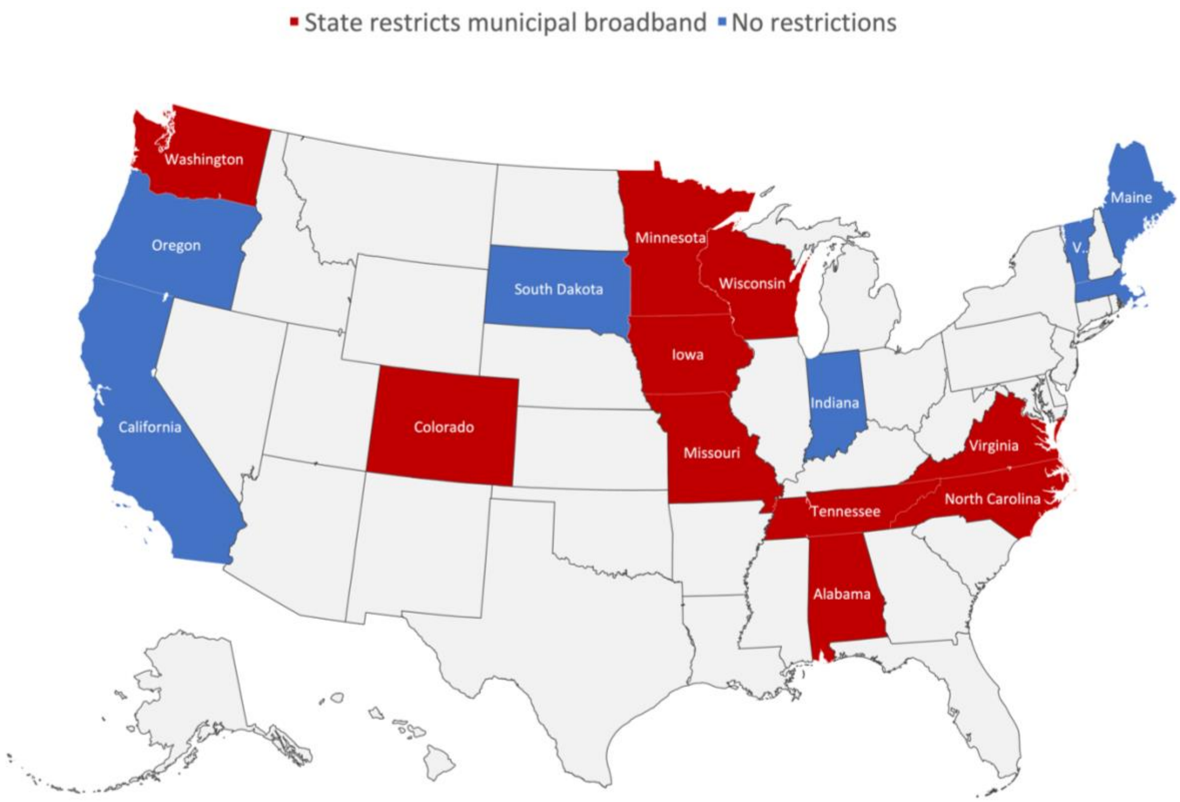
[F] Number of premises passed by the project, according to the grant application. It can include residences, businesses and other building types.

[G] We used two-sample t-tests to compare the mean 'Grant Amount/Premise Passed' ($) of each provider type. We only observed a statistically significant difference ($p<.05$) with electric cooperatives, which had larger grants per premise passed by the project, compared to other provider types. This analysis was limited to 614 grants for which we had data on Grant Amount and Number of Premises Passed. Missing values are coded as 0 (other) to preserve the sample size (N=614).

Missouri, North Carolina, Tennessee, Virginia, Washington and Wisconsin. As of 2023, Washington no longer restricts municipal broadband,[82] and Colorado eliminated the referendum requirement for municipalities seeking to deliver broadband by themselves or with an Internet Service Provider partner.[83]

Figure 5. Which states in our study restricted municipal broadband between 2014-2020?



Note: This map only features municipal broadband restrictions and barriers in the sample group of 17 states, effective between 2014 and 2020. As of 2023, Colorado and Washington have removed restrictions.
Data sources: (1) The Pew Charitable Trusts 2021 State Broadband Preemption Data, and (2) Temple University Center for Public Health Law Research Data on State Preemption Laws

Non-traditional providers and rurality

While non-traditional providers could play a key role in closing the digital divide in remote areas, the data show that most grants awarded to electric cooperatives were in metro areas, and those awarded to telephone cooperatives and municipal providers were primarily in metro-adjacent nonmetro areas. Proximity to metro areas can be a key determinant of entry for non-traditional providers,[84] as the costs of deployment will be lower, in part because connecting to middle-mile infrastructure will not be as expensive when the nearest aggregation point is close.[85] Thus, as with traditional providers, non-traditional providers might find it more profitable (lower construction costs, higher capacity) to serve metro-adjacent areas first.

2.2 Limited funding for middle mile infrastructure and planning processes

Middle mile infrastructure

Eleven states give weight to projects providing service to anchor institutions, but only 12% of funded projects included middle mile infrastructure. These were mainly located in non-adjacent rural areas and metro areas. Several states have allocated funds to statewide and regional middle-mile networks, which will support last mile service providers.[86] In addition, our data show grant amounts were significantly larger for projects including middle mile infrastructure ($7,601 vs $2,226 per premise passed).[H] This suggests that state funds are being used to offset the costs of providing service to anchor institutions or deploying middle mile broadband infrastructure in rural areas.

Local planning processes

States also encourage local planning processes, in which communities assess their connectivity needs and goals. Planning grants are used to support the development of community broadband plans, in which communities assess their goals and needs with respect to Internet availability and adoption. The number of awarded projects connected to a previous planning process was small (4%), yet the grant amounts were significantly larger ($15,782 vs $2,202 per premise passed).[I] The majority of these grants were awarded by the California Broadband Infrastructure Grant Account.

[H] We used a two-sample t-test to compare the mean 'Grant Amount/Premise Passed' ($) of projects including middle mile infrastructure versus projects that did not, and observed a statistically significant difference (p<.05). This analysis was limited to 614 grants for which we had data on Grant Amount and Number of Premises Passed.

[I] We used a two-sample t-test to compare the mean 'Grant Amount/Premise Passed' ($) of projects connected to a local planning process versus projects that were not, and observed a statistically significant difference (p<.05). This analysis was limited to 614 grants for which we had data on Grant Amount and Number of Premises Passed.

PART II: WHERE HAVE GRANT FUNDS BEEN ALLOCATED?

County-level analysis

N = 1,167 counties, 17 states

Which counties received funds?

The availability of state funding is only one of the various geographic, economic and regulatory variables that will impact providers' decisions to enter the market, and many of these are also determinants of Internet access and adoption.[87,88] Using 2014-2020 data from The Pew Charitable Trusts on state broadband grants awarded to 724 projects in 17 states, we assess where state broadband grant funds were allocated, and whether there was an identifiable pattern in grant distribution related to county and state-level factors. Given the ongoing socioeconomic disparities linked to the digital divide, we were especially interested in whether state grants reached communities that often lag behind in terms of infrastructure availability, access and adoption, including rural, low-density and high-poverty areas, those with less educational attainment and a higher percentage of minority population[89,90,91]. This has important implications for future broadband policy. While states broadband programs have primarily focused on supporting infrastructure deployment in unserved areas,[92] we were interested in their role in addressing broader notions of access and digital equity. We also explore whether state grants reached counties with limited local capacity, which could impact broadband expansion.

Our approach

We built a county-level database by matching Pew's project-level data with county-level data from the American Community Survey (ACS), the FCC and the USDA, and state-level data from Temple University Center for Public Health Law Research Center and the Pew Charitable Trusts. We analyzed the impact of multiple factors in the allocation of state grant funds – including 1) socioeconomic and demographic characteristics; 2) rurality; 3) available retail broadband providers; 4) required grantee match, and 5) municipal broadband restrictions. We assess if any of these socioeconomic, geographic, market, policy and regulatory factors operate as potential barriers for state funding to address digital equity.

Table 4 shows the list of variables that were matched with Pew's data on grants. For two of our county-level analyses, we grouped metro counties into one group (RUCC 1,2,3 = 1) and nonmetro counties (RUCC 4,5,6,7,8,9 = 0) into another group for comparison.

Table 4. Analysis variables.			
Variable	**Type**	**Description**	**Source**
State		State in which the grant is awarded.	The Pew Charitable Trusts State Broadband Grants 2014-2020
County		County where the awarded project is located. Some project areas span more than one county.	
Funded/Unfunded	Binary	0 = County was not "funded" (did not have a funded project) 1 = County was "funded" (had at least 1 funded project)	
Grant count	Count	Total number of state broadband grants allocated to each county. For grants that covered multiple locations, we added 1 grant to each location.	
Grant Amount ($)		Total amount of state broadband grant funds received by the county.	
Total population		Total Population	American Community Survey 2020 (5-Year Estimates) Tables from Social Explorer 2023[93] http://www.socialexplorer.com
Population density		Population Density (Per Sq. Mile), based on Total Population/Area (Land)	
Bachelor's degree or higher	%	Based on Population 25 Years and Over	
Non-Hispanic White Population	%	Based on the Total Population: White Alone	
Population over age 65	%	Based on the Total Population: More than 65	
Poverty	%	Based on Population for Whom Poverty Status is Determined	
Income Inequality	[0,1]	Gini Index of Income Inequality, ranging from 0 (complete equality) to 1 (complete inequality)	
HH with broadband Internet subscriptions	%	Based on Total Households: Household with an Internet Subscription, Broadband of Any Type	
Metro/Nonmetro	Binary	0 = Nonmetro county (RUCC 4,5,6,7,8,9) 1 = Metro county (RUCC 1,2,3)	USDA 2013 Rural-Urban Continuum Code (RUCC)[94] http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx
# Retail broadband providers	Count	Number of retail broadband providers per county. Based on each retail provider's unique ID number and the census block code of the area in which they operate.	FCC Form 477 Broadband Deployment Data (2020)[95] http://www.fcc.gov/form-477-broadband-deployment-data-december-2020
Required grant match	%	Percentage of the grant amount that states require grantees to match. • Three states did not have required match data (Maine, Massachusetts and Oregon), so we used zero (0%). • Two states had more than one broadband program (Colorado and Virginia), so we used the lowest required match percentage.	The Pew Charitable Trusts State Broadband Program Data
Municipal broadband restrictions	Binary	Municipal broadband restrictions that were effective during the study period (2014-20).	Temple University Center for Public Health Law Research Data on State Preemption Laws[96] http://www.lawatlas.org/datasets/preemption-project

Our universe consists of 1,167 counties, 405 funded and 762 unfunded, across 17 states. We develop two analyses in this section: First, we use t-test comparison of means between funded and unfunded counties, to assess whether they can be differentiated in terms of their capacity and market characteristics. Second, we build a statistical model to predict the number of grants received by metro and nonmetro counties, using county-level capacity and market variables and controlling for state-level policy variables. We also assess whether our findings hold when using the total amount of state funds received by funded counties as the outcome variable. In the second analysis we divide the sample by metro (464 counties, of which 158 (34%) were funded) and nonmetro (703 counties, of which 247 (35%) were funded). While the proportion of metro counties and nonmetro counties that were funded was similar, the majority of state grants (61%) went to nonmetro areas because these are the majority of counties (703 of 1167 counties, see Appendix 1). We wondered if other factors differed between funded metro and nonmetro counties, so we separated the sample into metro and nonmetro subsamples for the regression analysis in section 3.2. See Appendix 1 for the number of funded/unfunded, metro/nonmetro counties by state in our study.

THEME 3: DO STATE PROGRAMS ADDRESS DISPARITIES?

3.1 Counties funded at least once had lower population density, lower poverty rates and a lower percentage of minority population.

We conducted t-tests (comparison of subgroup means) to compare counties that had *at least one funded project* ("funded counties" henceforth) and counties that did not ("unfunded counties"), to see if there were statistically significant differences in terms of demographic and socioeconomic characteristics, and provider availability. Our analysis includes all 1,167 counties across 17 states for the entire 2014-20 period. Table 5 (below) shows the results of our analysis.

Table 5. Socioeconomic differences between unfunded and funded counties, t-test comparison of means

Variable	**Unfunded[1] (N = 762)**	**Funded[1] (N = 405)**	**P-value (Significance)**
Total population[2]	102,753.2	113,774.3	NS
Population density[2]	350.08	111.2	***
% Bachelor's degree or higher[2]	23.93	24.12	NS
% Non-Hispanic White[2]	78.28	81.77	***
% Population over age 65[2]	19.38	19.74	NS
% Poverty[2]	13.96	12.83	***
Income inequality (Gini coefficient) [2]	0.442	0.437	**
% HH with broadband Internet subscriptions[2]	79.44	80.04	NS
# Retail broadband providers[3]	13.64	14.94	***

Significant at the 0.01 (***), 0.05 (**) and 0.1 (*) level. NS = Not significant.
N = 1,167 counties (funded and unfunded), 17 states, t-test comparison of means
Data sources: (1) The Pew Charitable Trusts State Broadband Grants 2014-2020; (2) American Community Survey 2020 (5-Year Estimates) Tables from Social Explorer 2023; (3) Federal Communications Commission's December 2020 Fixed Broadband Deployment Data.

Results show that counties that were funded at least once between 2014 and 2020 had lower population density, a higher percentage of non-Hispanic White population, less poverty and less inequality. They also had more retail broadband providers. Differences in population size, educational attainment, age, and the percentage of households with a broadband Internet subscription were not statistically significant.

We expected population density to be negatively correlated with a county's likelihood to receive grants, and our results show that this is the case. More funded projects were located in less densely populated counties. These are areas where the costs of deploying fiber broadband and delivering high-speed, high-capacity Internet service will be higher,[97] in part because the costs of trenching and renting poles to install fiber will be impacted by the size of the service area,[98,99] in low-density areas.

We did not find that broadband Internet subscriptions were significant in differentiating which counties received at least one state grant. Disparities in Internet access and adoption have been linked to income, educational attainment, age, race, poverty level, and inequality,[100] and previous studies have found that home Internet subscriptions rates are lower among low-income households and minority populations, and linked to lower educational attainment.[101,102] Our grant recipient analysis shows counties with lower density were more likely to be funded, but other measures of capacity were less likely to be funded (minority populations, poverty, inequality and provider availability). Thus, state grants are not yet addressing all the disparities that lead to the digital divide.

Financial viability is an important consideration both for states and grantees, and this may help explain these results. One-time state grants might not be able to cover the full extent of deployment costs, and cannot be used for annual operational and maintenance costs, which can be substantial. On the other hand, projects in better off areas might have more sources of capital available, and state grants could be supplementary, rather than the primary source of funding. Additional research is needed to determine if these factors might explain the differences.

While counties funded at least once may be lower-risk and potentially more profitable markets, they also may contain underserved areas. Minority and low-income neighborhoods in urban areas tend to be underserved and struggle with unequal access (slow service and lack of upgrades)[103] and low rates of adoption (due to the cost of the service and other factors).[104] The literature argues that providers are less likely to serve these areas, as they expect adoption rates to be low.[105]

Our results show that states are addressing one key factor linked to the digital divide - low population density - but more efforts will be needed to address other measures of the digital divide (minority populations, poverty and education). Next, we explore if funded counties differ by local capacity and market characteristics.

3.2 Among funded counties, those with more capacity received more grants.

The literature argues that rural (nonmetro) areas lag behind in terms of broadband infrastructure availability and adoption,[106] and our next analysis explores differences between funded counties in metro and nonmetro areas. 405 counties received at least one grant.[J] We explore if the number of grants received by a metro or nonmetro county was affected by county-level metro status, capacity and market-characteristics and state-level policy factors (required grant match percentage and municipal broadband restrictions).

We built two statistical models (metro and nonmetro) to predict the number of grants obtained by each funded county,[K] using grant data from The Pew Charitable Trusts.[L] We included county-level data from the American Community Survey and the Federal Communications Commission, and incorporated two state policy variables in our analysis, which are controlled for in the regression at the state-level. These state policy variables include: 1) The state's broadband program required match percentage (which can range from 0% in CA, VT and WI, to 85% in IA),[M] and 2) A dummy variable that signifies if the state restricts municipal broadband (1=yes; otherwise = 0). Out of the 17 states in this study, ten states restricted municipal broadband during the study period, while seven states did not.[107]

Table 6 (below) shows the list of factors that were statistically significant in the model of number of grants received by a county. Complete model results are found in Appendix 2.

[J] Excluding NY and NE, the original grant-level database had 724 state broadband grants in 17 states. An additional 10 grants were excluded from the county-level analysis – 3 grants without location data, and 7 grants awarded to areas that were not counties. We had a total of 714 grants, distributed among 405 counties in 17 states for the analysis.

[K] For our separate analyses of funded metro and nonmetro counties, we use Poisson regressions with clustered standard errors at the State-level. We chose this method because of (1) the nature of the dependent variable (grant count) and its distribution, and (2) to control for state-level factors, which do not vary by county. See Appendix 1 for the number of funded counties by state.

[L] Out of the 714 grants, 95 were awarded to projects serving more than one county. We counted 1 grant for each county. For example, if the awarded project served three counties, we added one more grant to each of these counties' grant count.

[M] Data provided by The Pew Charitable Trusts. Three states did not have required match data (Maine, Massachusetts and Oregon), so we used zero. Three states had more than one broadband program (Colorado, Massachusetts and Virginia), so we used the lowest required match percentage.

Table 6. Which factors affect the number of grants received by a funded county?		
Variable	**Metro[6] N = 158 counties[1] (16 states[N])**	**Nonmetro[6] N = 247 counties[1] (17 states)**
County capacity		
Total population (ln)[2]	+ (***)	+ (***)
Population density (ln) [2]	− (***)	− (***)
% Bachelor's degree or higher[2]	NS	+ (***)
% Poverty[2]	NS	− (***)
Market characteristics		
% Non-Hispanic White Population[2]	+ (**)	+ (*)
% HH with broadband Internet subscriptions[2]	NS	− (***)
# Retail broadband providers[3]	NS	NS
State broadband policy		
% Required grant match[4]	− (***)	− (*)
Municipal broadband restrictions[5]	NS	+ (**)

Significant at the 0.01 (***), 0.05 (**) and 0.1 (*) level. NS = Not significant.
Model A: N = 158 funded metro counties (received at least 1 grant, range 1-9), 16 states, Poisson regression with standard errors clustered at the State-level
Model B: N = 247 funded nonmetro counties (received at least 1 grant, range 1-13), 17 states, Poisson regression with standard errors clustered at the State-level
Data sources: (1) The Pew Charitable Trusts State Broadband Grants 2014-2020; (2) American Community Survey 2020 (5-Year Estimates) Tables from Social Explorer 2023; (3) Federal Communications Commission's December 2020 Fixed Broadband Deployment Data, (4) The Pew Charitable Trusts State Broadband Program Data, (5) Temple University Center for Public Health Law Research Data on State Preemption Laws and (6) 2013 USDA Rural Urban Continuum Code.

Despite being low-density, counties with more capacity received more grants.

We expected states to focus on rural and low-density counties, where state broadband grants could help subsidize construction costs. We found that low density counties received more grants – in both metro and nonmetro areas. They also received a larger total amount of state funds.[O] This is consistent with our previous results, which showed that states are addressing a key aspect of the digital divide by supporting deployment in low-density areas.

We then assessed the impact of market characteristics on broadband grant receipt, using available data on retail broadband providers from the FCC and home broadband Internet subscription rates from

[N] We do not have funded metro counties from Oregon in our dataset, so we only have 16 states in this model.
[O] Using a linear regression with standard errors clustered at the State-level, we also modelled the total amount of grant funds received by 158 metro and 247 nonmetro funded counties. Those model results showed the total grant amount was higher for (1) Metro counties with low population density and that were *not* in states with municipal broadband restrictions; and (2) Nonmetro counties with large populations and low population density. All other factors were not statistically significant.

ACS. While the FCC has acknowledged that their fixed broadband deployment data is not a reflection of actual service availability,[108] we were interested in the role of FCC data as a reference for policymakers, and its potential impact on grant distribution. We found that it was not statistically significant in the distribution of state broadband grants – suggesting that states weigh other factors when distributing funds for deployment.

On the other hand, our models find that nonmetro counties with low adoption received more grants. Previous literature shows that broadband adoption is lower among rural Americans[109] and that providing Internet service that is both high-speed and affordable in rural areas can be challenging.[110] Disparities in home Internet adoption have been linked to income, race and education,[111] as well as lack of digital literacy and access to computers.[112] Even with states supporting buildout, rural broadband networks could struggle to remain financially viable without a customer base that can afford a home Internet subscription. A rural broadband strategy that simultaneously addresses gaps in infrastructure availability and adoption is key. Our data show that state grants are addressing both.

We also consider how other potential measures of county capacity (besides population density) affect grant distribution, including: population size, educational attainment and poverty level. We were interested in whether counties with more capacity (larger, less poverty, more educated) receive more grants. Our results show that both metro and nonmetro counties with larger populations and fewer minorities received more grants. However, education and poverty variables were only significant in the nonmetro (rural) model, where counties with higher educational attainment and less poverty received more grants. This is consistent with our previous results (see Table 5), which suggest that states are not yet addressing broader elements of local capacity and digital equity.

State broadband policy could aggravate disparities in grant distribution.

Lastly, we explore the impact of the state policy environment. Previous literature raises concern over the disproportionate impact of broadband grant match requirements on rural and high-poverty areas.[113,114] While required match percentages varied widely across states in our study, we found that, in states with higher match requirements, counties had a lower grant count, both for metro and nonmetro areas. Future research might focus on the relationship between capacity and match percentages, and their impact on rural, low-density and high-poverty areas in need of more state aid.

Our models found municipal broadband restrictions were not significant in metro counties, and were positively correlated with the number of grants received in nonmetro counties. This was a surprise.

Previous literature argues that municipal broadband restrictions have a negative impact on Internet availability.[115] On the other hand, research also suggests that the threat of municipal entry may discourage the entry of new private providers,[116] and that incumbents may be less inclined to invest in upgrades due to municipal competition.[117] Because municipal broadband restrictions limit the public delivery alternatives available to communities, rural areas in particular are likely to rely on state aid to attract private providers. Our model shows that nonmetro (rural) counties in states with municipal restrictions received more grants. Further research will be needed to study the impact of state broadband program design and state broadband regulation on grant distribution.

IMPLICATIONS FOR BEAD

In this section, we discuss some of the implications of our findings for how states will allocate funds from the Broadband Equity, Access and Deployment (BEAD) program. Based on how states have approached grant decision-making in their state programs in previous years, how will they tailor their definitions and policies to meet the requirements and goals of BEAD?

Technology neutrality

Our analysis of state broadband programs shows states are primarily supporting fiber. This suggests that, despite the high cost of deployment, states are looking at their broadband grants as long-term investments that will offset the costs of upgrading to higher speeds in the future. This is key, given that BEAD upgraded the definitions of “unserved” to below 25/3 Mbps download/upload speeds and “underserved” to below 100/20 Mbps. However, many state programs still have minimum speed thresholds below 10/1 Mbps, and will need to update their definitions to match BEAD requirements – which some states have already been doing: For example, in 2016, Minnesota set out to achieve statewide access to 100/20 Mbps broadband service by 2026.[118]

States also will be required to set an “Extremely High Cost Per Location Threshold” to ensure applicants will use BEAD funds for the best technology possible and meet BEAD requirements regarding coverage, affordability, speed, open access and inclusivity. States will be able to award projects using any technology other than fiber if they are able meet these requirements and manage to do so at a cost below the threshold. However, to encourage fiber deployment, the NTIA expects states to set this threshold as high as possible.

BEAD has been prioritizing fiber,[119] with critics noting that the low rate of return of fiber optic networks are leading to a slowdown in deployment.[120] Still, previous literature finds that, despite its high deployment costs, fiber is an attractive long-term investment due to its capacity, reliability and scalability.[121] BEAD rules are not expected to preempt state authority over how broadband funds are allocated and spent,[122] and our analysis provides encouraging results that states are already prioritizing fiber in their broadband programs.

Non-traditional providers

BEAD will increase pressure on states to adopt measures ensuring the participation of non-traditional providers,[123] which will be challenging for states with municipal broadband restrictions.[124]

While the number of available “non-traditional” providers varies by state, state programs will be required to justify when BEAD funds are awarded to traditional providers (for-profit telephone and cable companies) over competitive non-traditional applicants.[125]

States could ease potential application barriers impacting non-traditional providers such as: a) requirements demanding grantees partner with a private sector provider; b) a high required match percentage, which may disproportionately hurt small, rural ISPs and low-resource political subdivisions, and c) policies preventing recipients of federal funding to apply for state funding, which could affect rural ISPs that received grants or loans from the USDA. While state programs favoring public-private partnerships ensure local governments will be part of the application and planning process, this does not guarantee public ownership of the network or that it will be open access. Public-private partnerships may be challenging for political subdivisions where there are no available or interested private sector partners. At the same time, there are also concerns that BEAD requirements on financial and environmental studies could disproportionally impact small and non-traditional providers.[126]

Match requirements

BEAD recognizes the potential negative effect of a match requirement on communities with low-resources, on non-traditional providers and on efforts to keep services affordable.[127] While grantees will be required to provide the maximum feasible match for each project (no less than 25% of project costs), applicants in high-cost areas will be able to apply for a waiver. High-cost areas are defined in terms of remoteness, lack of population density, topography and poverty level, among other factors.[128] In addition, applicants will be able to match BEAD funds with federal funds from the Families First Coronavirus Response Act, the Consolidated Appropriations Act of 2021, or the American Rescue Plan Act of 2021.

Anchor institutions

While BEAD prioritizes connecting end users, funds can be used for middle mile deployment, which supports last mile service,[129] and providers serving anchor institutions, such as libraries and schools.[130] While our analysis shows state programs funded only a small percentage of projects that included middle mile infrastructure, many state programs in our analysis use scoring criteria to give weight to projects connecting anchor institutions, and BEAD funds will be eligible for this purpose.

SUMMARY OF FINDINGS AND CONCLUSION

Summary of findings

This report studied 724 state broadband grants, in 17 states, between 2014 and 2020. In the first section, we explored the characteristics of projects that received grants. In the second section, we explored whether there were patterns by county in the distribution of state grants related to (1) county-level variables such as rurality, capacity and market characteristics, and (2) state-level policy variables, such as state program requirements and state broadband regulation.

Which projects were funded?

While early federal policy first targeted nationwide providers, states largely supported regional providers – for-profit private telephone companies and telephone cooperatives. States also raised the standards of service. They funded various technologies (such as fiber, fixed wireless, cable and DSL), but more commonly funded high-capacity, high-speed and long-lasting fiber infrastructure. However, fiber projects were less likely to be funded in remote rural areas, possibly due to their investment-intensive nature. Nonmetro counties tend to be low-density, and therefore deployment becomes costlier. To prevent a prioritization of expensive (albeit high-quality) broadband technologies from negatively impacting remote rural areas, states might consider maintaining a flexible technology eligibility policy, while simultaneously aiming for the higher standards of service reliability, speed and affordability that BEAD requires.

State funding was less commonly provided to 1) non-traditional providers, such as electric cooperatives and municipal providers; 2) projects including middle mile infrastructure, and 3) projects connected to a previous planning process. BEAD requirements encourage states to expand their support for competitive non-traditional providers, as these may be alternatives for communities that lack private provider interest.[131] However, research finds that non-traditional providers face considerable challenges as well, including concerns over their long-term financial viability, backlash from traditional providers and restrictive state law.[132]

Finally, we find that more rural projects were funded. Nonmetro (rural) areas tend to lag behind in terms of broadband availability and adoption,[133,134] but nonmetro counties received more state grants. In rural areas, investment in high-capacity middle mile infrastructure is important, as it can support last mile deployment[135] and provide service to anchor institutions (e.g. libraries and schools) that operate as alternative points of access for disadvantaged groups that lack home Internet access.[136]

Where were grants allocated?

Our county-level analysis explored disparities in the distribution of state broadband grants and how they are linked to factors such as county capacity, broadband market characteristics and the state broadband policy environment. We were interested in how these county- and state-level factors affected receipt of state broadband grants for 1) counties that could be defined as "high cost,"[137] where factors such as low population density and high poverty rate could drive up deployment costs, and 2) populations that tend to lag behind in terms of access and adoption –high-minority, low-income, with lower educational attainment and rural.[138] Because nonmetro (rural) areas, in particular, will face unique challenges due to their remoteness and low population density, we performed a separate analysis of grant count and grant amount for funded metro and nonmetro counties.

To study the impact of county capacity, we used county-level data on population size, population density, educational attainment and poverty rate. For market characteristics, we used the number of retail broadband providers in each county, the percentage of households with home Internet subscriptions and the percentage of non-Hispanic White population. Finally, to assess the impact of state policy, we used each state program's required grant match percentages and included whether the state restricted municipal broadband.

Our analysis of state broadband policies from 2014-2020 suggests the need for a broader approach to access and digital equity. In our t-test analysis (Table 5), we found that counties with at least one grant between 2014 and 2020 had lower population density, which is one indicator of need. However, funded counties also had lower minority population, less poverty and more retail broadband providers. These other indicators of need are yet to be addressed.

Next, we used regression analysis to determine which funded counties received more grants. We found that state broadband grants were supporting deployment in low-density counties (both metro and rural), and in low-adoption rural counties as well. However, rural counties with more grants were also larger, more educated and had less poverty. Future efforts will need to consider local capacity, poverty, race and age as elements of the digital divide and how state broadband grants could help address these.

We also explored the impact of state policy on grant distribution. We found that counties in states with higher required match percentages received fewer grants. By contrast, municipal broadband restrictions were not statistically significant in metro counties, and were positively correlated with the number of grants received in nonmetro counties. In states that limit the number of broadband delivery alternatives, communities are likely to rely on state aid to attract broadband providers. State broadband programs will need to be cautious about state program requirements (such as high match requirements) and municipal restrictions as these may become barriers for communities with low capacity and limited resources.

Conclusion

The digital divide is a multilayered issue linked to geographic, demographic, socio-economic and market factors, and state broadband programs can play a key role in closing the broadband infrastructure gap. This report explores how state broadband programs allocated grants in the years before the pandemic, which has implications for the distribution of BEAD funds in the future. In some respects, states have been ahead of the curve - supporting regional providers and fiber deployment, as well as low-density and low-adoption areas with more grants. However, our analysis also suggests the need for a broader approach to access and digital equity. The pandemic highlighted ongoing socioeconomic disparities in broadband access and adoption, and future state broadband policy will need to consider educational attainment, poverty and race as elements of the digital divide. In addition, prohibitive state program criteria and state broadband regulation could contribute to these disparities. State broadband programs will need to address possible barriers that prevent funds from reaching communities in need, while simultaneously continuing to meet coverage, speed and affordability goals.

APPENDIX

Appendix 1: Funded/unfunded counties by state, 17 states

Table 7. Number of funded/unfunded counties per state, 17 states.									
	State	Funded counties			Unfunded counties			Total
		Metro	Nonmetro	Total	Metro	Nonmetro	Total	
1	Alabama	17	14	31	12	24	36	67
2	California	15	13	28	22	8	30	58
3	Colorado	7	17	24	10	30	40	64
4	Indiana	11	8	19	33	40	73	92
5	Iowa	8	18	26	13	60	73	99
6	Maine	4	7	11	1	4	5	16
7	Massachusetts	4	1	5	7	2	9	14
8	Minnesota	20	46	66	7	14	21	87
9	Missouri	6	10	16	28	71	99	115
10	North Carolina	3	16	19	43	38	81	100
11	Oregon	0	3	3	13	20	33	36
12	South Dakota	2	6	8	6	52	58	66
13	Tennessee	16	27	43	26	26	52	95
14	Vermont	1	7	8	2	4	6	14
15	Virginia	17	12	29	63	41	104	133
16	Washington	3	3	6	18	15	33	39
17	Wisconsin	24	39	63	2	7	9	72
	Total	**158**	**247**	**405**	**306**	**456**	**762**	**1,167**

Data sources: (1) The Pew Charitable Trusts State Broadband Grants 2014-2020; (2) 2013 USDA Rural Urban Continuum Code.

Appendix 2: Poisson regression model results

The tables below show the results from our Poisson regression model analysis. Our dependent variable was the number of grants received by each funded county (range: 1-13). The number of observations is the 405 funded counties.

Which *Metro* Counties Received More State Broadband Grants?

Table 8. Metro counties, Summary statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Dependent variable = # of grants[1]	158	2.019	1.657	1	9
Total population (ln)[2]	158	11.319	1.295	9.071	16.122
Population density (ln)[2]	158	4.814	1.058	2.124	7.813
% Bachelor's degree or higher[2]	158	28.346	11.231	11.06	60.46
% Non-Hispanic White Population[2]	158	79.706	17.346	10.186	96.672
% Poverty[2]	158	11.156	4.441	3.184	23.455
% HH with broadband Internet subscriptions[2]	158	83.382	6.514	52.789	96.671
# Retail broadband providers (FCC)[3]	158	16.12	5.957	7	43
% Required grant match[4]	158	31.013	26.323	0	85
Municipal broadband restrictions[5]	158	.766	.425	0	1

Table 9. Metro counties, Poisson regression with standard errors clustered at the State-level

Variable	Coeff.	Robust. Stand. Error.	z	P>z	Sig.
Dependent variable = # of grants[1]					
Total population (ln)[2]	0.388	.101	3.86	0	***
Population density (ln)[2]	-.43	.076	-5.62	0	***
% Bachelor's degree or higher[2]	.007	.009	0.81	.418	
% Non-Hispanic White Population[2]	.01	.005	2.05	.04	**
% Poverty[2]	.012	.017	0.68	.493	
% HH with broadband Internet subscriptions[2]	-.008	.021	-0.36	.717	
# Retail broadband providers (FCC)[3]	.007	.02	0.34	.732	
% Required grant match[4]	-.009	.003	-2.73	.006	***
Municipal broadband restrictions[5]	.303	.263	1.15	.25	
Constant	-2.267	1.936	-1.17	.242	

N = 158 funded metro[6] counties (received at least 1 grant) across 16 states. Sig: *** *p<.01*, ** *p<.05*, * *p<.1*

Data sources: (1) The Pew Charitable Trusts State Broadband Grants 2014-2020; (2) American Community Survey 2020 (5-Year Estimates) Tables from Social Explorer 2023; (3) Federal Communications Commission's December 2020 Fixed Broadband Deployment Data, (4) The Pew Charitable Trusts State Broadband Program Data, (5) Temple University Center for Public Health Law Research Data on State Preemption Laws, and (6) 2013 USDA Rural Urban Continuum Code.

Which *Nonmetro* Counties Received More State Broadband Grants?

Table 10. Nonmetro counties, Summary statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Dependent variable = # of grants[1]	247	2.162	1.991	1	13
Total population (ln)[2]	247	9.986	.813	6.661	11.821
Population density (ln)[2]	247	3.361	.969	-.358	5.277
% Bachelor's degree or higher[2]	247	21.42	8.012	8.65	61.17
% Non-Hispanic White Population[2]	247	83.084	15.957	9.549	97.466
% Poverty[2]	247	13.895	4.934	5.343	35.027
% HH with broadband Internet subscriptions[2]	247	77.9	6.532	54.618	92.686
# Retail broadband providers (FCC)[3]	247	14.186	3.944	5	29
% Required grant match[4]	247	33.806	26.251	0	85
Municipal broadband restrictions	247	.818	.387	0	1

Table 11. Nonmetro counties, Poisson regression with standard errors clustered at the State-level

Variable	Coeff.	Robust. Stand. Error.	z	P>z	Sig.
Dependent variable = # of grants[1]					
Total population (ln)[2]	.537	.177	3.03	.002	***
Population density (ln)[2]	-.317	.121	-2.61	.009	***
% Bachelor's degree or higher[2]	.025	.009	2.91	.004	***
% Non-Hispanic White Population[2]	.011	.005	1.93	.054	*
% Poverty[2]	-.051	.016	-3.12	.002	***
% HH with broadband Internet subscriptions[2]	-.035	.01	-3.54	0	***
# Retail broadband providers (FCC)[3]	.014	.012	1.13	.259	
% Required grant match[4]	-.006	.004	-1.75	.081	*
Municipal broadband restrictions[5]	.458	.186	2.47	.014	**
Constant	-2.022	1.156	-1.75	.08	*

N = 247 funded nonmetro counties (received at least 1 grant) across 17 states. Sig: *** *p<.01*, ** *p<.05*, * *p<.1*

Data sources: (1) The Pew Charitable Trusts State Broadband Grants 2014-2020; (2) American Community Survey 2020 (5-Year Estimates) Tables from Social Explorer 2023; (3) Federal Communications Commission's December 2020 Fixed Broadband Deployment Data, (4) The Pew Charitable Trusts State Broadband Program Data, (5) Temple University Center for Public Health Law Research Data on State Preemption Laws, and (6) 2013 USDA Rural Urban Continuum Code.

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