ADVANCING POLE ATTACHMENT POLICIES TO ACCELERATE NATIONAL BROADBAND BUILDOUT

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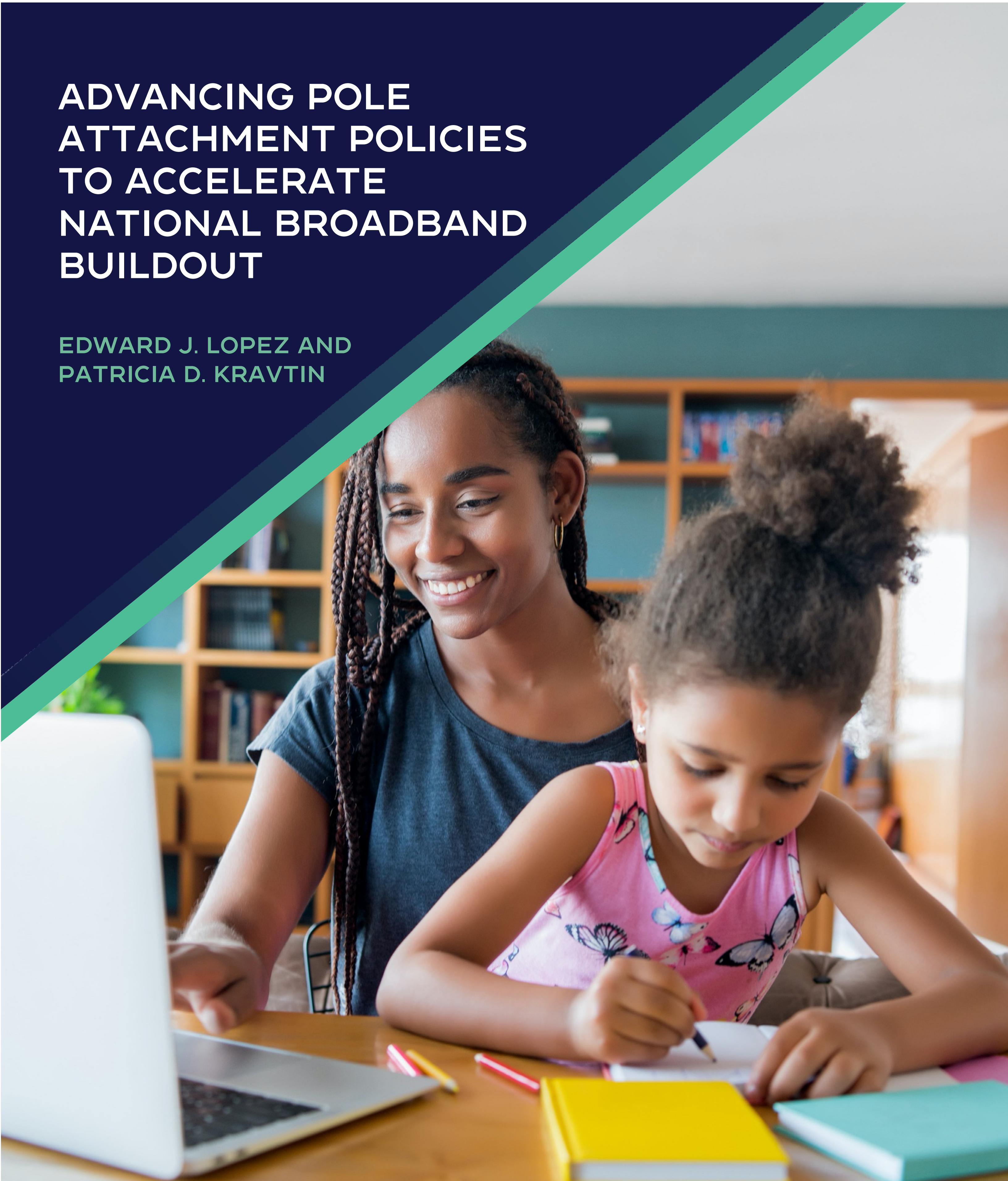

CONNECT THE FUTURE

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EXECUTIVE SUMMARY

Between 14 to 42 million Americans currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $83 billion to $314 billion of new economic gains to America's homes and small businesses. This estimated gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in America.

Today, broadband deployment is being inhibited or outright stopped due to the lack of effective pole policy to address problematic behavior of certain utility pole owners affecting broadband provider access to utility poles. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In economics this is known as the *hold up problem*[1], an inefficient concentration of *market power* that harms the *public interest*.

When pole owners hold up the process, the result is foregone economic gains to Americans. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Americans between $491 million and $1.86 billion.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures now to recapture this economic value by revising and modifying state and federal pole policies to mitigate pole owner *market power* in order to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Americans
> **$491M – $1.86B**
> *every month*
> it delays expansion.

INTRODUCTION AND OVERVIEW

Too many American homes and small businesses still lack access to reliable, high-speed, low-latency internet connections. While recent private and public investments at the national, state, and local levels are playing a significant role in helping to bridge America's digital divide, policies to remove remaining barriers to infrastructure deployment are now needed to maximize the social return on public and private broadband investments.[2] In this paper, we demonstrate that the economic gains to full broadband expansion are quite substantial, yet state and federal policies governing pole attachment processes require modification before the digital divide can be fully bridged and those economic gains realized. (See below Appendix A, *Elements of a Model Pole Policy*, for details of these required modifications.)

According to the Federal Communications Commission (FCC), more than 14 million Americans still lack access to reliable, high-speed, low-latency broadband, including nearly 20% of rural households (FCC 2021). An estimate by BroadbandNow suggests that over 42 million Americans still lack access.[3] In this paper, we estimate that connecting these currently unserved populations would create as much as $314 billion of new economic gains to America's homes and small businesses, calculated as additional *willingness-to-pay* (WTP) in net present value over 25 years, or the lower end of average utility pole life, at 5% discount rate.[4] This estimated economic gain represents the potential return on private and public broadband investments, namely the productive, commercial, educational, health, civic, and other social benefits that could be realized by achieving full broadband expansion.

To achieve these economic and social gains requires cost efficient and timely attachment of broadband wires to existing utility pole networks. Deployment of broadband networks into unserved rural areas of the country requires attachment of broadband infrastructure to thousands and thousands of poles. Placement of broadband infrastructure underground isn't feasible or cost efficient in most unserved areas of the country.

Existing pole policies across the country, however, allow electric utility pole owners – i.e., investor-owned electric utilities ("IOUs"), as well as municipal and cooperatively owned utilities ("Muni and Coop") – to exercise significant market power over pole attachment rates, terms, and conditions. Pole owners frequently impose onerous timetables, unfeasible permitting fees, and various pre- and post-construction requirements, including full pole replacements ahead of scheduled replacement, as part of "make-ready" procedures required prior to the actual attachment to the pole. Pole owners sometimes limit the number of pole-attachment applications considered at any given time, and certain pole owners have refused to consider any applications at all. Furthermore, increasing numbers of Muni and Coop owners have themselves become market participants in providing broadband service (Beard et al. 2021).

In the study of economics, this form of market power is known as the *hold up problem*, and it causes delayed or foregone expansion of broadband to currently unserved populations. This inefficient and inequitable advantage, in the absence of effective pole policies, enables certain pole owners to impose economically unfeasible rates, terms, and conditions that harm the *public interest* by holding up broadband deployment. We estimate that every month of delayed expansion due to pole owner market power costs Americans between $491 million and $1.86 billion in foregone economic gain, known in economics as *deadweight loss* (DWL).[5] The economic methodology for this study was initially developed in an earlier paper that focused on North Carolina.[6] That study calculated economic gains that would be realized with full broadband expansion in North Carolina under just one federal program, the Rural Development Opportunity Fund (RDOF), which launched in February, 2020, with a total $20 billion of rural broadband investment across the country.[7]

The need for a nationwide examination is now all the more relevant given the recent passage of the Infrastructure Investment and Jobs Act of 2021 ("IIJA") and its massive $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to deploy broadband in all 50 states is unprecedented. Therefore, in this study we enhance and expand the analysis beyond North Carolina and the funding being supplied by RDOF. Results in this paper include estimates of economic gain of full broadband expansion for all 50 States, while also including a more granular analysis for five focus states (Florida, Kentucky, Missouri, Texas, and Wisconsin).

The analysis in this paper concludes that if the economic gains from broadband deployment are to be fully realized, policymakers need to facilitate the streamlining of equitable access and cost-sharing arrangements between broadband attachers and pole owners. These improved arrangements, among others, would factor the age and net book value of replaced poles, thus eliminating a common barrier in which broadband providers are too often inequitably (and contrary to sound economic policy) required by pole owners to bear the full monetary burden of pole replacements ahead of scheduled replacement. These and other key elements of a model pole policy that best promote broadband expansion are presented in Appendix A.

This barrier to full broadband expansion arises because in most instances the only practical and economically feasible means for a broadband provider to connect its service to a household or small business location is to attach its wires to the existing network of utility poles. Building underground is unrealistic given the prohibitively higher costs as compared to aerial installations along with the host of other practical, environmental, and topographical barriers associated with underground construction. And the notion that broadband providers could build their own standalone pole networks would not only be a waste of social resources and aesthetically undesirable, in many if not most instances would be effectively prohibited under zoning rules, environmental regulations and other laws and ordinances.

CRITICAL BACKGROUND AND METHODOLOGY

In this paper, we expand and enhance our earlier analysis for North Carolina.[8] First, we expand our calculations beyond RDOF and to all 50 states. Nationally, RDOF auction participants were awarded over $9 billion to connect 5.22 million locations, or approximately 2 million people.[9] Yet, RDOF is a relatively small program compared to the FCC's estimated 14 million households currently unserved by broadband, and especially small relative to BroadbandNow's estimate of over 42 million unserved, and in the context of the IIJA's $42 billion commitment to broadband infrastructure. Therefore, in this paper we also report the estimated consumer gains if all FCC and BroadbandNow unserved populations become connected.[10]

Second, our North Carolina study focused only on the benefits of improved bandwidth speeds, whereas in this paper we also account for latency improvements being rolled out under current deployments. Bandwidth speed measures the megabits/gigabits of data that a connection can transmit per second (Mbps). Latency measures the milliseconds (Ms) it takes for a connection to transport a data packet between a user's computer and other servers elsewhere on the network. Greater latency degrades a customer's service quality and broadband experience. Appendix D below explains how economists have estimated consumers' WTP for both speed and latency, and how we use those empirical estimates in our calculations of aggregate economic gains.

Our underlying computation methodology begins with a representative household's estimated WTP for broadband, as provided by the Liu, Yu-Hsin, Jeffrey Price and Scott Wallsten (2018). Expressed in layman's terms, WTP is the highest price that a representative household would pay to improve from a slow mobile connection to a fixed connection at higher speeds. WTP therefore represents a dollarized measure of the value to that representative household of broadband's productive, commercial, social, educational, entertainment, health, civic and other benefits, to that household. For example, the representative household is willing to pay $111.08 per month to improve from a Mobile 4/1 Mbps connection at 60-150 Ms latency, to a Fixed 1000/100 Mbps connection at less than 10 Ms.[11]

Next, we aggregate from the household to the societal level by multiplying that monthly WTP by the number of locations becoming connected. In the case of RDOF, for example, if all 5.22 million locations become connected, that would yield an aggregate $579 million per month of new WTP. Next, we simply annualize the computed monthly gains, and then compute the annualized gains in terms of net present value over 25 years at an assumed 5% discount rate.[12] Tables 1 and 2, discussed in the next section, present the results utilizing this method.

As explained in full detail in our earlier paper, economic theory classifies utility poles as a textbook example of a *natural monopoly*, meaning that a single network of poles can supply access to all locations in an area at a lower cost to society than two or more sets of poles can. Given the construction of a network of poles, pole attachments are *non-rival in use* to a degree. For these reasons, economic theory stipulates that efficient pricing of pole attachments—including economically feasible make-ready rates, terms, and conditions—promotes full broadband expansion by resolving the *hold up problem*. This is because pricing practices consistent with economic principles create real-world conditions that facilitate the timely access to high-speed, quality broadband services for consumers in unserved and typically higher-cost and hard-to-reach areas.

On the other hand, the unchecked exercise of market power by pole owners (IOUs, as well as Muni & Coop) enabled by the lack of consistent, efficient pole policies, will continue to impede this important *public interest* goal. This exercise of market power includes the practice of shifting to broadband providers the total cost of new poles, even in cases when pole owners did not otherwise plan to replace poles in their course of operations. Economic theory therefore classifies *hold up problems* as socially harmful concentrations of market power that result in sizeable lost consumer value and reduction in societal welfare, including delayed or denied broadband expansion to unserved communities.

FINDINGS AND ANALYSIS

TABLE #1: ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION ACHIEVES BROADBAND ACCESS

	All Unserved RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	$82.96B	$88.71B	$265.56B
300/100 Mbps at <10 Ms	$91.90B	$98.27B	$294.17B
1000/100 Mbps at <10 Ms	$98.07B	$104.87B	$313.92B

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate.

In Tables 1 above and 2 below, we present our main nationwide findings. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed and latency thresholds are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $98.07 billion of new economic gains nationwide. But if all 14 million persons estimated by the FCC that lack broadband get similarly connected, that gain would be $104.87 billion. And connecting all 42 million unserved persons as estimated by BroadbandNow would yield $313.92 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

Focusing on Table 2 below, this same computation methodology demonstrates the foregone economic gains, known in economics as *deadweight loss*, due to the pole owner *hold up problem*. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, aggregated across the fifty states, we compute the magnitude of potential losses to be in the range of $491 million to $1.86 billion per month of delay.

In Appendix D below, we present alternative estimates for different sets of assumptions. And in the state-specific modules below, we report the state-specific estimates equivalent to Table 1 and 2 for our five focus states.

TABLE #2:
MONTHLY FOREGONE ECONOMIC GAINS (DEADWEIGHT LOSSES) DUE TO POLE ATTACHMENT HOLD UP

	All RDOF Locations Gain Access	All FCC Estimated Population Gains Access	All BroadbandNow Estimated Population Gains Access
150/25 Mbps at <10 Ms	$0.491B	$0.524B	$1.57B
300/100 Mbps at <10 Ms	$0.543B	$0.581B	$1.74B
1000/100 Mbps at <10 Ms	$0.579B	$0.620B	$1.86B

Note: Table entries are monthly aggregate foregone economic gains.

We emphasize that these national and state-specific estimates are conservative in magnitude because the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the higher broadband speeds scheduled for deployment under ongoing expansion plans. As cited in Lopez and Kravtin 2021, the Broadband Internet Technical Advisory Group reports that upload demand rose by 60% from March to December 2020, and the RDOF program was structured to incentivize deployment at high speeds including 1000 Mbps download (BITAG 2021). For these reasons, the true economic gains nationwide of full broadband expansion are likely exceed the estimates shown in Table 1 above.

The magnitude of total consumer value that could be realized with unimpeded access to utility poles by broadband providers highlights the potential magnitude of the public's return on its broadband investment that would be made possible if policies aimed at the hold up power of pole owners were implemented and the full range of productive, commercial, educational, health, civic, and other social benefits widely associated with full broadband expansion could be achieved. The next section of the paper further explores the policy implications and prescriptions for full broadband expansion introduced in our earlier paper.

POLICY IMPLICATIONS AND PRESCRIPTIONS

As described in Lopez and Kravtin 2021, there are a number of key reasons for the current disconnect between existing utility pole practices, especially those involving pole replacement as part of the make-ready process, and those aligned with economic principles that best promote the *public interest*. These include the economic reality that pole owners, regardless of whether the pole is actually identified by the utility as needing replacement, enjoy operational, strategic, revenue-enhancing, capital cost, and tax savings benefits from pole replacements.[13]

When attachers such as broadband providers are forced to bear 100% of the cost responsibility of replacing partially depreciated utility poles, it results in fewer or delayed broadband infrastructure investments and reduced service availability to the great detriment of unserved areas throughout the nation. This practice disincentivizes broadband deployment for attachers and gifts the utility a significant, windfall economic benefit to the detriment of consumers and the broader economy as a whole.

To ensure consumers benefit from broadband services in a timely and equitable manner, and the economy enjoys as much growth and development gains as possible, public policy should expressly prohibit utilities from requiring an attacher to pay the full replacement cost of a prematurely retired pole, and instead adopt regulations that promote a more economically optimal and equitable approach — e.g., by making attachers only responsible for the remaining un-depreciated value of the replaced pole. In addition, pole owners should be prohibited from exercising hold up power by imposing unreasonable timelines and/or engaging in delay tactics. This approach would avoid the imposition of substantial and unreasonable costs on pole attachers and would ultimately benefit the country's existing—and new—consumers of high-speed broadband services in the form of cost-efficient broadband connectivity.

Pole owners historically have enjoyed unilateral control of most aspects of the make-ready process. Indeed, opportunities exist for pole owners to exert hold up power by raising the expected stream of ongoing costs incurred by broadband providers through the recurring pole attachment rental rates that pole owners charge attachers—even in jurisdictions that have adopted effective recurring pole rate regulation for cooperative and municipal pole owning utilities such as North Carolina, the subject of our earlier paper, or in Kentucky, one of the states we examine in more detail in our current analysis. For example, pole owners can harm the *public interest* by failing to give proper written notice of recurring pole attachment rate increases, thereby diminishing or entirely precluding the attacher from effectively challenging the increase and the right to a just and reasonable rate.

CONCLUSION AND KEY TAKEAWAYS

Pole owner behaviors and the set of unjust and unreasonable make-ready rates, terms and conditions imposed on broadband providers create substantial lost economic gains for residents and small businesses, especially those in hard-to-reach rural unserved areas. Allowing these behaviors to go unchecked is contrary to any reasonable notion of the economic *public interest*. As federal and state resources are increasingly used to support broadband expansion into unserved areas, the *public interest* in supporting a cost-efficient and timely pole attachment process is only heightened. Some believe that the fair outcome is to allow pole owners, especially the smaller local ones, to charge broadband providers higher fees for access to a vital input necessary to reach American consumers. However, as demonstrated in the analysis presented here, this is a much more harmful outcome from an objective overall societal welfare standpoint, because it reduces or delays consumer access to broadband service, resulting in substantial lost value to consumers.

In the context of achieving full broadband access for residents and small businesses in unserved areas, both theoretical economics and common sense align to create a pressing and justified *public interest* case for policy makers to check the *market power* of pole owners by adopting consistent, efficient policies for poles, including fair and equitable policies around make-ready and pole replacement cost sharing.[14] A number of such legislative and regulatory initiatives are underway across the country, but the ability of pole owning utilities to hold up broadband expansion is going largely unchecked. One of the first of such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas legislature in the spring of this year. The Texas law, further detailed in the Texas chapter of this paper, incorporates a number of the key elements of a model pole policy presented in Appendix A below required to mitigate pole owner impediments to full broadband expansion.

There are always tradeoffs to consider in economics and public policy. Given the pressing need to close the digital divide, there is greater risk to consumers from the current inefficient make-ready and pole replacement cost allocation practices than there is from enacting rules and policies that may have the byproduct of reducing nominal flows of monies to pole owners. This is especially the case in unserved areas as those customers stand to gain substantially as potential users of high-quality broadband, including the impact of full broadband access on economic growth and job creation throughout all areas of our nation.

APPENDICES

A. ELEMENTS OF A MODEL POLE POLICY

B. GLOSSARY OF TECHNICAL TERMS

C. LISTS OF WORKS CITED

D. EMPIRICAL METHODOLOGY AND COMPLETE RESULTS: BASELINE/ALTERNATIVE ASSUMPTIONS

APPENDIX A: ELEMENTS OF A MODEL POLE POLICY

Two foundational principles necessary for the success of broadband deployment in unserved areas are: 1) changing the cost equation for the intermediate pole input in order to encourage infrastructure investment in hard-to-reach areas of the country; and 2) the removal of other regulatory or market impediments to the vital pole input that might jeopardize the cost-efficient nature of that infrastructure investment and deployment. These two principles are at the forefront of the effort to achieve full broadband access in unserved rural areas of our country. The first policy priority is being addressed by federal and state programs that seek to support the cost-efficient deployment of broadband in hard to serve areas of the country; however, the second priority requires additional policies, including policies to ensure an economically efficient and fair cost allocation of pole costs that would help to moderate a pole owners' ability to exercise anti-competitive, anti-consumer market power in an otherwise competitive ecosystem.

Key elements of urgently needed broadband deployment promoting policies include:

- Creation of a pole replacement fund or grant program to promote the efficient use of available state and federal infrastructure funding dollars in support of the buildout of utility pole infrastructure into unserved areas, and in conjunction, ensure pole owners provide nondiscriminatory, just and reasonable non-recurring and recurring rates, terms, and conditions of access to broadband providers (consistent with those detailed below);
- Definitions for make-ready related pole replacements that distinguish make-ready pole replacements from those related to the utility's own inevitable electric (or broadband related) infrastructure upgrade costs;
- Terms that require the pole owner to pay the entire cost of pole replacement when due to safety or reliability as a result of normal wear and tear or other natural causes; or the pole has recorded conditions or defects that would reasonably be expected to endanger human life or property and which should be promptly corrected (whether or not officially "red tagged" for replacement);
- Terms that provide for the economically efficient and equitable sharing of costs of pole replacements tied to the age and/or net book value of the utility poles to be replaced that would preclude, as precondition of access, new attachers from having to bear the full cost of replacing aging poles. This would preclude the utility seeking from attachers the full recovery of poles that the utility would have to replace at its own cost in the near future in the absence of the new attachment or overlash;
- Terms that prevent the utility from seeking any cost recovery from attachers associated with pole replacements unrelated to the need to accommodate a new attachment terms that facilitate the efficient use of federal and state grant funding;

- Detailed make-ready related invoices;
- Specify workable time frames for pole permit application, survey timeframes, pre- and post- construction requirements;
- Shorter timelines for make-ready work;
- Longer timelines for assessing new attacher One Touch Make-Ready ("OTMR") requests versus existing attachers whose facilities are slated for OTMR;
- Audit process and costs;
- Reasonable notice-only policy for overlashing;
- Terms that preclude as precondition of access prior to overlashing, requirement for permitting or fixing of preexisting violations;
- Expedited dispute resolution under the auspices of the state utility commission or through the courts subject to applicable law;
- Charges for non-recurring charges, including pole replacement, must be based on actual, reasonable costs, objectively determined (i.e., based on accepted economic cost allocation criteria); and
- Recurring rental rates set based on the widely used FCC cable rate formula.

APPENDIX B: GLOSSARY OF TECHNICAL TERMS

Barriers to Entry – "Factors that increase the cost to new firms of entering an industry" (Cowen & Tabarrok 2021)

Deadweight Loss – "the reduction in total [consumer] surplus caused by a market distortion or inefficiency" (Cowen & Tabarrok 2021)
Example: If a household would gain $100 of WTP, but it remains unconnected because of the hold up problem, then the deadweight loss is equal to the foregone economic gain of $100.

Economic Efficiency – "Productive efficiency concerns the utilization of resources to achieve the highest possible level of production of a desired mix of goods and services [and] distribution of goods and services in an economy to maximize social welfare." (Cole & Grossman 2005, p.10)

Hold Up Problem – the use of market power "to extract by a threat to destroy value" that impedes other's ongoing investments (Cooter & Uhlen 2004, p.271)

Natural Monopoly – "a situation when a single firm can supply the entire market at a lower cost than two or more firms" (Cowen & Tabarrok 2021)

Non-Rival in Use – "when one person's consumption of the good does not limit another person's consumption" (Cowen & Tabarrok 2021)

Public Interest – "the efficient quantity is the quantity that maximizes social surplus" (Cowen & Tabarrok 2021)

Willingness-to-Pay (WTP) – "the economic value of something is how much someone is willing to pay for it" (Posner 1992, p.12). Also, "the maximum price a consumer will pay for a good; also called the reservation price" (Mateer & Coppock 2020, p.152) Example: If a currently unserved household was willing to pay $100 to improve from a low-quality connection at slow speeds to a high-quality broadband connection at high speeds, then we say that the household values this broadband improvement as much as it values $100 of other goods & services.

APPENDIX C: LIST OF WORKS CITED

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APPENDIX D: EMPIRICAL METHODOLOGY AND COMPLETE RESULTS: BASELINE/ALTERNATIVE ASSUMPTIONS

The estimates presented in this paper are based on the methodology developed in our earlier paper, Lopez and Kravtin 2021. In Appendix B of that earlier paper, we provide full details on the method underlying the computations in this paper, specifically how we calculate economic gains of broadband expansion as aggregate *willingness-to-pay* (WTP), which is a standard textbook measurement tool in economic theory.

Our calculations in this paper begin with a representative household's monthly WTP for broadband access. The source of our underlying WTP estimates is the peer-reviewed study by Liu, Prince, and Wallsten 2018. The authors employ a discrete choice experimental design to elicit consumers' responses to various broadband price and plan options. The experimental design collects responses in a survey format that is designed to simulate the myriad of realistic choices and possible combinations of actual, realistic options of household and small business internet plans.

From the survey results, the authors utilize conditional logit maximum likelihood estimation to derive econometric estimates of a typical household's WTP for broadband access. Specifically, the authors estimate WTP at various speed thresholds and for various improvements in latency. Table D1 below reproduces select estimates from the Liu et al. study. The dollar amounts in this table represent the amount that a representative household is willing to pay for download speed, upload speed, and latency improvements, relative to a Mobile 5/1 connection. Our methodology adapts these estimates from the Liu et al. study to calculate statewide aggregate figures.

TABLE D1:
SELECT WILLINGNESS-TO-PAY ESTIMATES FROM LIU, PRINCE, AND WALLSTEN

Download Speeds	Estimated WTP for Improvement from 4 Mbps Down
150 Mbps	$71.37
300 Mbps	$75.60
1000 Mbps	$82.59

Upload Speeds	Estimated WTP for Improvement from 1 Mbps Up
25 Mbps	$18.57
100 Mbps	$24.46

Latency Improvements	Estimated WTP for Improvement to Less than 10 Ms
From 60-150 Ms	$4.03

Table D2 below reports our calculations of WTP for three speed thresholds and improvement from 60-150 Ms to less than 10 Ms latency. For example, our calculation of $93.97 combines the Liu et al. estimated WTP of $71.37 for 150 Mbps download, plus the separately estimated $18.57 for 25 Mbps upload speed, plus the separately estimated $4.03 for improvement to <10 Ms, yielding a combined WTP of $93.97 = $71.37 + $18.57 + $4.03. The other estimates of monthly WTP in Table D2 below are calculated the same way.

TABLE D2:

SPEED AND LATENCY THRESHOLDS UTILIZED IN THIS PAPER

	Speeds (download/ upload)	Household Monthly WTP for Improved Speed and Latency	Household Monthly WTP for Improved Speed Only
150/25 Mbps	105/25 Mbps	$93.97	$89.94
300/100 Mbps	300/100 Mbps	$104.09	$100.06
1000/100 Mbps	1000/100 Mbps	$111.08	$107.05

Continuing from the monthly gains estimates in Table D2, we next multiply by 12 to calculate the annualized estimated gain to a typical household. We then multiply the household annualized gain by the number of locations in a state to arrive at annualized aggregate economic gain for that state. Finally, we calculate the net present value of annualized gains over 25 years at an assumed 5% discount rate. For complete details about this computation methodology, see Appendix B of Lopez and Kravtin 2021.

Converting from population to number of locations requires a further assumption in our FCC and BroadbandNow estimates. Both sources, the FCC and BroadbandNow estimates, are provided in terms of unserved *population*. To convert from population to locations, we use the U.S. Census Bureau's American Community Survey, average persons per household 2014-2018 (https://www.indexmundi.com/facts/united-states/quick-facts/all-states/average-household-size#table).

For example, in Texas the FCC's estimated unserved population is 1.23 million, and the persons per household is 2.86, yielding a converted number of FCC locations at 430,070 = 1.23 million persons / 2.86 persons per household. Equivalently for the BroadbandNow estimates, in Texas the BroadbandNow estimated unserved population is 4.39 million, yielding an assumed number of BroadbandNow locations at 1,537,349 = 4.39 million persons / 2.86 persons per household. For the RDOF estimates, we simply use the number of locations reported in the 904 auction results.

In Table D3 below, we present aggregate economic gains for three speed thresholds under three sets of assumptions for all 50 states including our five focus states. The selected speeds (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table D3 represent a range of possibilities. For example, in Alabama, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $3.69 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $4.48 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $8.86 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

TABLE D3:
50-STATE ESTIMATES OF STATEWIDE ECONOMIC GAINS (WTP)

State	Speed and Latency Improvements	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
Alabama	150/25 Mbps at <10 Ms	$3.12b	$3.79b	$7.50b
	300/100 Mbps at <10 Ms	$3.46b	$4.20b	$8.30b
	1000/100 Mbps at <10 Ms	$3.69b	$4.48b	$8.86b

Alaska	150/25 Mbps at <10 Ms	$0.00b	$0.61b	$1.34b
	300/100 Mbps at <10 Ms	$0.00b	$0.68b	$1.49b
	1000/100 Mbps at <10 Ms	$0.00b	$0.72b	$1.59b
Arizona	150/25 Mbps at <10 Ms	$3.19b	$2.38b	$5.37b
	300/100 Mbps at <10 Ms	$3.53b	$2.63b	$5.95b
	1000/100 Mbps at <10 Ms	$3.77b	$2.81b	$6.35b
Arkansas	150/25 Mbps at <10 Ms	$2.06b	$3.39b	$5.97b
	300/100 Mbps at <10 Ms	$2.28b	$3.76b	$6.61b
	1000/100 Mbps at <10 Ms	$2.43b	$4.01b	$7.06b
California	150/25 Mbps at <10 Ms	$5.80b	$3.19b	$20.88b
	300/100 Mbps at <10 Ms	$6.42b	$3.53b	$23.13b
	1000/100 Mbps at <10 Ms	$6.85b	$3.77b	$24.68b
Colorado	150/25 Mbps at <10 Ms	$1.21b	$1.00b	$4.19b
	300/100 Mbps at <10 Ms	$1.34b	$1.11b	$4.64b
	1000/100 Mbps at <10 Ms	$1.43b	$1.18b	$4.95b
Connecticut	150/25 Mbps at <10 Ms	$0.05b	$0.17b	$2.42b
	300/100 Mbps at <10 Ms	$0.05b	$0.19b	$2.68b
	1000/100 Mbps at <10 Ms	$0.05b	$0.20b	$2.86b
Delaware	150/25 Mbps at <10 Ms	$0.12b	$0.14b	$0.27b
	300/100 Mbps at <10 Ms	$0.14b	$0.15b	$0.30b
	1000/100 Mbps at <10 Ms	$0.15b	$0.16b	$0.32b
Florida	150/25 Mbps at <10 Ms	$2.25b	$4.82b	$14.24b
	300/100 Mbps at <10 Ms	$2.49b	$5.34b	$15.77b
	1000/100 Mbps at <10 Ms	$2.66b	$5.69b	$16.83b
Georgia	150/25 Mbps at <10 Ms	$2.85b	$3.84b	$10.84b
	300/100 Mbps at <10 Ms	$3.16b	$4.25b	$12.01b
	1000/100 Mbps at <10 Ms	$3.37b	$4.53b	$12.81b
Hawaii	150/25 Mbps at <10 Ms	$0.13b	$0.16b	$3.44b
	300/100 Mbps at <10 Ms	$0.14b	$0.17b	$3.81b
	1000/100 Mbps at <10 Ms	$0.15b	$0.19b	$4.07b
Idaho	150/25 Mbps at <10 Ms	$0.65b	$0.49b	$1.51b
	300/100 Mbps at <10 Ms	$0.72b	$0.55b	$1.68b
	1000/100 Mbps at <10 Ms	$0.76b	$0.58b	$1.79b
Illinois	150/25 Mbps at <10 Ms	$2.54b	$1.59b	$7.53b
	300/100 Mbps at <10 Ms	$2.82b	$1.76b	$8.34b
	1000/100 Mbps at <10 Ms	$3.01b	$1.88b	$8.90b
Indiana	150/25 Mbps at <10 Ms	$2.43b	$1.64b	$5.59b
	300/100 Mbps at <10 Ms	$2.69b	$1.82b	$6.19b
	1000/100 Mbps at <10 Ms	$2.87b	$1.94b	$6.61b
Iowa	150/25 Mbps at <10 Ms	$0.86b	$0.84b	$2.55b
	300/100 Mbps at <10 Ms	$0.95b	$0.93b	$2.83b
	1000/100 Mbps at <10 Ms	$1.01b	$0.99b	$3.02b
Kansas	150/25 Mbps at <10 Ms	$0.74b	$0.79b	$2.16b

	300/100 Mbps at <10 Ms	$0.82b	$0.87b	$2.39b
	1000/100 Mbps at <10 Ms	$0.88b	$0.93b	$2.55b
Kentucky	150/25 Mbps at <10 Ms	$1.57b	$1.64b	$5.31b
	300/100 Mbps at <10 Ms	$1.74b	$1.82b	$5.89b
	1000/100 Mbps at <10 Ms	$1.85b	$1.94b	$6.28b
Louisiana	150/25 Mbps at <10 Ms	$2.79b	$3.28b	$7.02b
	300/100 Mbps at <10 Ms	$3.09b	$3.63b	$7.78b
	1000/100 Mbps at <10 Ms	$3.30b	$3.87b	$8.30b
Maine	150/25 Mbps at <10 Ms	$0.44b	$0.31b	$2.03b
	300/100 Mbps at <10 Ms	$0.49b	$0.35b	$2.25b
	1000/100 Mbps at <10 Ms	$0.52b	$0.37b	$2.40b
Maryland	150/25 Mbps at <10 Ms	$0.60b	$0.90b	$1.33b
	300/100 Mbps at <10 Ms	$0.66b	$1.00b	$1.47b
	1000/100 Mbps at <10 Ms	$0.71b	$1.07b	$1.57b
Massachusetts	150/25 Mbps at <10 Ms	$0.40b	$0.88b	$1.12b
	300/100 Mbps at <10 Ms	$0.45b	$0.97b	$1.25b
	1000/100 Mbps at <10 Ms	$0.48b	$1.04b	$1.33b
Michigan	150/25 Mbps at <10 Ms	$3.96b	$2.69b	$8.41b
	300/100 Mbps at <10 Ms	$4.39b	$2.98b	$9.32b
	1000/100 Mbps at <10 Ms	$4.68b	$3.18b	$9.94b
Minnesota	150/25 Mbps at <10 Ms	$2.27b	$0.89b	$5.62b
	300/100 Mbps at <10 Ms	$2.51b	$0.98b	$6.22b
	1000/100 Mbps at <10 Ms	$2.68b	$1.05b	$6.64b
Mississippi	150/25 Mbps at <10 Ms	$3.48b	$3.56b	$7.13b
	300/100 Mbps at <10 Ms	$3.86b	$3.94b	$7.90b
	1000/100 Mbps at <10 Ms	$4.11b	$4.21b	$8.43b
Missouri	150/25 Mbps at <10 Ms	$3.16b	$2.72b	$6.81b
	300/100 Mbps at <10 Ms	$3.51b	$3.01b	$7.54b
	1000/100 Mbps at <10 Ms	$3.74b	$3.21b	$8.05b
Montana	150/25 Mbps at <10 Ms	$0.73b	$0.94b	$1.72b
	300/100 Mbps at <10 Ms	$0.81b	$1.05b	$1.91b
	1000/100 Mbps at <10 Ms	$0.86b	$1.12b	$2.03b
Nebraska	150/25 Mbps at <10 Ms	$0.69b	$0.46b	$1.19b
	300/100 Mbps at <10 Ms	$0.76b	$0.51b	$1.32b
	1000/100 Mbps at <10 Ms	$0.82b	$0.54b	$1.41b
Nevada	150/25 Mbps at <10 Ms	$0.49b	$0.52b	$0.83b
	300/100 Mbps at <10 Ms	$0.54b	$0.58b	$0.91b
	1000/100 Mbps at <10 Ms	$0.57b	$0.62b	$0.98b
New Hampshire	150/25 Mbps at <10 Ms	$0.28b	$0.28b	$1.60b
	300/100 Mbps at <10 Ms	$0.31b	$0.31b	$1.77b
	1000/100 Mbps at <10 Ms	$0.33b	$0.34b	$1.89b
New Jersey	150/25 Mbps at <10 Ms	$0.14b	$0.76b	$2.42b

	300/100 Mbps at <10 Ms	$0.15b	$0.84b	$2.69b
	1000/100 Mbps at <10 Ms	$0.16b	$0.89b	$2.87b
New Mexico	150/25 Mbps at <10 Ms	$1.02b	$1.63b	$2.90b
	300/100 Mbps at <10 Ms	$1.13b	$1.80b	$3.22b
	1000/100 Mbps at <10 Ms	$1.21b	$1.92b	$3.43b
New York	150/25 Mbps at <10 Ms	$0.74b	$1.53b	$7.69b
	300/100 Mbps at <10 Ms	$0.82b	$1.69b	$8.52b
	1000/100 Mbps at <10 Ms	$0.88b	$1.81b	$9.09b
North Carolina	150/25 Mbps at <10 Ms	$2.47b	$2.98b	$9.88b
	300/100 Mbps at <10 Ms	$2.73b	$3.30b	$10.95b
	1000/100 Mbps at <10 Ms	$2.91b	$3.52b	$11.68b
North Dakota	150/25 Mbps at <10 Ms	$0.04b	$0.17b	$0.84b
	300/100 Mbps at <10 Ms	$0.05b	$0.18b	$0.93b
	1000/100 Mbps at <10 Ms	$0.05b	$0.20b	$1.00b
Ohio	150/25 Mbps at <10 Ms	$3.04b	$2.14b	$9.19b
	300/100 Mbps at <10 Ms	$3.36b	$2.38b	$10.17b
	1000/100 Mbps at <10 Ms	$3.59b	$2.54b	$10.87b
Oklahoma	150/25 Mbps at <10 Ms	$2.00b	$2.96b	$5.74b
	300/100 Mbps at <10 Ms	$2.22b	$3.28b	$6.36b
	1000/100 Mbps at <10 Ms	$2.37b	$3.50b	$6.79b
Oregon	150/25 Mbps at <10 Ms	$1.30b	$1.37b	$4.35b
	300/100 Mbps at <10 Ms	$1.44b	$1.51b	$4.82b
	1000/100 Mbps at <10 Ms	$1.53b	$1.62b	$5.14b
Pennsylvania	150/25 Mbps at <10 Ms	$2.93b	$3.39b	$7.91b
	300/100 Mbps at <10 Ms	$3.25b	$3.76b	$8.76b
	1000/100 Mbps at <10 Ms	$3.47b	$4.01b	$9.35b
Rhode Island	150/25 Mbps at <10 Ms	$0.06b	$0.10b	$0.21b
	300/100 Mbps at <10 Ms	$0.06b	$0.11b	$0.23b
	1000/100 Mbps at <10 Ms	$0.07b	$0.11b	$0.25b
South Carolina	150/25 Mbps at <10 Ms	$1.73b	$2.82b	$7.46b
	300/100 Mbps at <10 Ms	$1.92b	$3.13b	$8.27b
	1000/100 Mbps at <10 Ms	$2.04b	$3.34b	$8.82b
South Dakota	150/25 Mbps at <10 Ms	$0.16b	$0.29b	$0.94b
	300/100 Mbps at <10 Ms	$0.18b	$0.33b	$1.04b
	1000/100 Mbps at <10 Ms	$0.19b	$0.35b	$1.11b
Tennessee	150/25 Mbps at <10 Ms	$2.47b	$2.72b	$7.98b
	300/100 Mbps at <10 Ms	$2.73b	$3.01b	$8.84b
	1000/100 Mbps at <10 Ms	$2.92b	$3.22b	$9.43b
Texas	150/25 Mbps at <10 Ms	$4.94b	$6.84b	$24.43b
	300/100 Mbps at <10 Ms	$5.47b	$7.57b	$27.06b
	1000/100 Mbps at <10 Ms	$5.84b	$8.08b	$28.88b
Utah	150/25 Mbps at <10 Ms	$0.16b	$0.70b	$1.12b
	300/100 Mbps at <10 Ms	$0.18b	$0.78b	$1.25b

	1000/100 Mbps at <10 Ms	$0.19b	$0.83b	$1.33b
Vermont	150/25 Mbps at <10 Ms	$2.96b	$0.26b	$1.11b
	300/100 Mbps at <10 Ms	$3.28b	$0.29b	$1.23b
	1000/100 Mbps at <10 Ms	$3.50b	$0.31b	$1.31b
Virginia	150/25 Mbps at <10 Ms	$0.31b	$3.43b	$6.44b
	300/100 Mbps at <10 Ms	$0.34b	$3.80b	$7.13b
	1000/100 Mbps at <10 Ms	$0.36b	$4.05b	$7.61b
Washington	150/25 Mbps at <10 Ms	$1.60b	$1.76b	$8.01b
	300/100 Mbps at <10 Ms	$1.77b	$1.95b	$8.87b
	1000/100 Mbps at <10 Ms	$1.89b	$2.08b	$9.47b
West Virginia	150/25 Mbps at <10 Ms	$1.90b	$2.09b	$5.91b
	300/100 Mbps at <10 Ms	$2.10b	$2.32b	$6.55b
	1000/100 Mbps at <10 Ms	$2.24b	$2.48b	$6.99b
Wisconsin	150/25 Mbps at <10 Ms	$3.82b	$2.61b	$4.44b
	300/100 Mbps at <10 Ms	$4.23b	$2.89b	$4.92b
	1000/100 Mbps at <10 Ms	$4.52b	$3.08b	$5.25b
Wyoming	150/25 Mbps at <10 Ms	$0.30b	$0.27b	$0.65b
	300/100 Mbps at <10 Ms	$0.33b	$0.30b	$0.72b
	1000/100 Mbps at <10 Ms	$0.36b	$0.32b	$0.77b

Moving to Table D4 below, this same computation methodology demonstrates the foregone economic gains, known in economics as *deadweight loss*, due to delayed or denied broadband expansion under the pole owner *hold up problem*. As our analysis in Lopez and Kravtin 2021 demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. In Alabama, for example, each month of delayed expansion causes DWL in the range of $18.46 million to $52.40, per month, under alternative assumptions.

TABLE D4:
50-STATE ESTIMATES OF FOREGONE ECONOMIC GAINS (DWL) DUE TO POLE ATTACHMENT HOLD UP

State	Speed and Latency Improvements	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
Alabama	150/25 Mbps at <10 Ms	$18.46m	$22.41m	$44.33m
	300/100 Mbps at <10 Ms	$20.45m	$24.82m	$49.11m

	1000/100 Mbps at <10 Ms	$21.82m	$26.48m	$52.40m
Alaska	150/25 Mbps at <10 Ms	$0.00m	$3.61m	$7.94m
	300/100 Mbps at <10 Ms	$0.00m	$4.00m	$8.80m
	1000/100 Mbps at <10 Ms	$0.00m	$4.27m	$9.39m
Arizona	150/25 Mbps at <10 Ms	$18.85m	$14.06m	$31.77m
	300/100 Mbps at <10 Ms	$20.88m	$15.57m	$35.19m
	1000/100 Mbps at <10 Ms	$22.28m	$16.62m	$37.55m
Arkansas	150/25 Mbps at <10 Ms	$12.16m	$20.05m	$35.30m
	300/100 Mbps at <10 Ms	$13.47m	$22.21m	$39.11m
	1000/100 Mbps at <10 Ms	$14.38m	$23.70m	$41.73m
California	150/25 Mbps at <10 Ms	$34.29m	$18.86m	$123.44m
	300/100 Mbps at <10 Ms	$37.98m	$20.89m	$136.73m
	1000/100 Mbps at <10 Ms	$40.53m	$22.29m	$145.91m
Colorado	150/25 Mbps at <10 Ms	$7.16m	$5.91m	$24.76m
	300/100 Mbps at <10 Ms	$7.93m	$6.55m	$27.42m
	1000/100 Mbps at <10 Ms	$8.47m	$6.99m	$29.26m
Connecticut	150/25 Mbps at <10 Ms	$0.27m	$1.00m	$14.31m
	300/100 Mbps at <10 Ms	$0.30m	$1.11m	$15.85m
	1000/100 Mbps at <10 Ms	$0.32m	$1.18m	$16.92m
Delaware	150/25 Mbps at <10 Ms	$0.73m	$0.80m	$1.59m
	300/100 Mbps at <10 Ms	$0.81m	$0.89m	$1.76m
	1000/100 Mbps at <10 Ms	$0.86m	$0.95m	$1.88m
Florida	150/25 Mbps at <10 Ms	$13.31m	$28.51m	$84.18m
	300/100 Mbps at <10 Ms	$14.74m	$31.58m	$93.25m
	1000/100 Mbps at <10 Ms	$15.73m	$33.70m	$99.51m
Georgia	150/25 Mbps at <10 Ms	$16.86m	$22.68m	$64.09m
	300/100 Mbps at <10 Ms	$18.68m	$25.12m	$71.00m
	1000/100 Mbps at <10 Ms	$19.93m	$26.81m	$75.76m
Hawaii	150/25 Mbps at <10 Ms	$0.76m	$0.93m	$20.36m
	300/100 Mbps at <10 Ms	$0.84m	$1.03m	$22.56m
	1000/100 Mbps at <10 Ms	$0.90m	$1.10m	$24.07m
Idaho	150/25 Mbps at <10 Ms	$3.83m	$2.91m	$8.95m
	300/100 Mbps at <10 Ms	$4.24m	$3.22m	$9.92m
	1000/100 Mbps at <10 Ms	$4.52m	$3.44m	$10.58m
Illinois	150/25 Mbps at <10 Ms	$15.03m	$9.40m	$44.51m
	300/100 Mbps at <10 Ms	$16.65m	$10.41m	$49.30m
	1000/100 Mbps at <10 Ms	$17.77m	$11.11m	$52.61m
Indiana	150/25 Mbps at <10 Ms	$14.38m	$9.69m	$33.06m
	300/100 Mbps at <10 Ms	$15.92m	$10.74m	$36.62m
	1000/100 Mbps at <10 Ms	$16.99m	$11.46m	$39.08m
Iowa	150/25 Mbps at <10 Ms	$5.06m	$4.95m	$15.10m
	300/100 Mbps at <10 Ms	$5.60m	$5.49m	$16.73m
	1000/100 Mbps at <10 Ms	$5.98m	$5.85m	$17.85m

Kansas	150/25 Mbps at <10 Ms	$4.40m	$4.66m	$12.75m
	300/100 Mbps at <10 Ms	$4.87m	$5.16m	$14.12m
	1000/100 Mbps at <10 Ms	$5.20m	$5.51m	$15.07m
Kentucky	150/25 Mbps at <10 Ms	$9.29m	$16.05m	$31.43m
	300/100 Mbps at <10 Ms	$10.29m	$17.78m	$34.81m
	1000/100 Mbps at <10 Ms	$10.98m	$18.98m	$37.15m
Louisiana	150/25 Mbps at <10 Ms	$16.51m	$19.37m	$41.50m
	300/100 Mbps at <10 Ms	$18.29m	$21.46m	$45.97m
	1000/100 Mbps at <10 Ms	$19.52m	$22.90m	$49.06m
Maine	150/25 Mbps at <10 Ms	$2.61m	$1.86m	$12.00m
	300/100 Mbps at <10 Ms	$2.89m	$2.05m	$13.29m
	1000/100 Mbps at <10 Ms	$3.08m	$2.19m	$14.19m
Maryland	150/25 Mbps at <10 Ms	$3.55m	$5.35m	$7.85m
	300/100 Mbps at <10 Ms	$3.93m	$5.93m	$8.69m
	1000/100 Mbps at <10 Ms	$4.19m	$6.32m	$9.27m
Massachusetts	150/25 Mbps at <10 Ms	$2.39m	$5.20m	$6.65m
	300/100 Mbps at <10 Ms	$2.65m	$5.76m	$7.37m
	1000/100 Mbps at <10 Ms	$2.83m	$6.15m	$7.86m
Michigan	150/25 Mbps at <10 Ms	$23.42m	$15.89m	$49.73m
	300/100 Mbps at <10 Ms	$25.95m	$17.60m	$55.09m
	1000/100 Mbps at <10 Ms	$27.69m	$18.78m	$58.79m
Minnesota	150/25 Mbps at <10 Ms	$13.42m	$5.25m	$33.21m
	300/100 Mbps at <10 Ms	$14.87m	$5.81m	$36.79m
	1000/100 Mbps at <10 Ms	$15.87m	$6.20m	$39.26m
Mississippi	150/25 Mbps at <10 Ms	$20.58m	$21.05m	$42.17m
	300/100 Mbps at <10 Ms	$22.79m	$23.32m	$46.71m
	1000/100 Mbps at <10 Ms	$24.33m	$24.89m	$49.84m
Missouri	150/25 Mbps at <10 Ms	$18.72m	$16.05m	$40.26m
	300/100 Mbps at <10 Ms	$20.73m	$17.78m	$44.59m
	1000/100 Mbps at <10 Ms	$22.13m	$18.98m	$47.59m
Montana	150/25 Mbps at <10 Ms	$4.32m	$5.58m	$10.18m
	300/100 Mbps at <10 Ms	$4.79m	$6.18m	$11.27m
	1000/100 Mbps at <10 Ms	$5.11m	$6.60m	$12.03m
Nebraska	150/25 Mbps at <10 Ms	$4.08m	$2.71m	$7.05m
	300/100 Mbps at <10 Ms	$4.52m	$3.00m	$7.81m
	1000/100 Mbps at <10 Ms	$4.82m	$3.21m	$8.34m
Nevada	150/25 Mbps at <10 Ms	$2.87m	$3.09m	$4.88m
	300/100 Mbps at <10 Ms	$3.18m	$3.42m	$5.41m
	1000/100 Mbps at <10 Ms	$3.40m	$3.65m	$5.77m
New Hampshire	150/25 Mbps at <10 Ms	$1.67m	$1.68m	$9.44m
	300/100 Mbps at <10 Ms	$1.85m	$1.86m	$10.45m
	1000/100 Mbps at <10 Ms	$1.97m	$1.99m	$11.15m

New Jersey	150/25 Mbps at <10 Ms	$0.82m	$4.47m	$14.34m
	300/100 Mbps at <10 Ms	$0.90m	$4.95m	$15.88m
	1000/100 Mbps at <10 Ms	$0.96m	$5.29m	$16.95m
New Mexico	150/25 Mbps at <10 Ms	$6.03m	$9.61m	$17.17m
	300/100 Mbps at <10 Ms	$6.68m	$10.65m	$19.02m
	1000/100 Mbps at <10 Ms	$7.13m	$11.36m	$20.30m
New York	150/25 Mbps at <10 Ms	$4.38m	$9.04m	$45.49m
	300/100 Mbps at <10 Ms	$4.86m	$10.01m	$50.39m
	1000/100 Mbps at <10 Ms	$5.18m	$10.68m	$53.77m
North Carolina	150/25 Mbps at <10 Ms	$14.58m	$17.60m	$58.44m
	300/100 Mbps at <10 Ms	$16.15m	$19.50m	$64.73m
	1000/100 Mbps at <10 Ms	$17.23m	$20.81m	$69.08m
North Dakota	150/25 Mbps at <10 Ms	$0.26m	$0.98m	$4.99m
	300/100 Mbps at <10 Ms	$0.29m	$1.08m	$5.52m
	1000/100 Mbps at <10 Ms	$0.31m	$1.15m	$5.89m
Ohio	150/25 Mbps at <10 Ms	$17.96m	$12.68m	$54.31m
	300/100 Mbps at <10 Ms	$19.89m	$14.05m	$60.16m
	1000/100 Mbps at <10 Ms	$21.23m	$14.99m	$64.20m
Oklahoma	150/25 Mbps at <10 Ms	$11.85m	$17.52m	$33.94m
	300/100 Mbps at <10 Ms	$13.13m	$19.41m	$37.59m
	1000/100 Mbps at <10 Ms	$14.01m	$20.71m	$40.12m
Oregon	150/25 Mbps at <10 Ms	$7.67m	$8.09m	$25.71m
	300/100 Mbps at <10 Ms	$8.50m	$8.96m	$28.48m
	1000/100 Mbps at <10 Ms	$9.07m	$9.56m	$30.40m
Pennsylvania	150/25 Mbps at <10 Ms	$17.34m	$20.05m	$46.77m
	300/100 Mbps at <10 Ms	$19.21m	$22.21m	$51.80m
	1000/100 Mbps at <10 Ms	$20.49m	$23.71m	$55.28m
Rhode Island	150/25 Mbps at <10 Ms	$0.35m	$0.57m	$1.23m
	300/100 Mbps at <10 Ms	$0.38m	$0.63m	$1.37m
	1000/100 Mbps at <10 Ms	$0.41m	$0.67m	$1.46m
South Carolina	150/25 Mbps at <10 Ms	$10.23m	$16.69m	$44.13m
	300/100 Mbps at <10 Ms	$11.33m	$18.48m	$48.88m
	1000/100 Mbps at <10 Ms	$12.09m	$19.72m	$52.16m
South Dakota	150/25 Mbps at <10 Ms	$0.94m	$1.74m	$5.53m
	300/100 Mbps at <10 Ms	$1.05m	$1.93m	$6.13m
	1000/100 Mbps at <10 Ms	$1.12m	$2.06m	$6.54m
Tennessee	150/25 Mbps at <10 Ms	$14.59m	$16.08m	$47.19m
	300/100 Mbps at <10 Ms	$16.16m	$17.81m	$52.27m
	1000/100 Mbps at <10 Ms	$17.24m	$19.01m	$55.78m
Texas	150/25 Mbps at <10 Ms	$29.22m	$40.41m	$144.46m
	300/100 Mbps at <10 Ms	$32.37m	$44.76m	$160.02m
	1000/100 Mbps at <10 Ms	$34.54m	$47.78m	$170.77m
Utah	150/25 Mbps at <10 Ms	$0.97m	$4.14m	$6.65m

	300/100 Mbps at <10 Ms	$1.08m	$4.59m	$7.36m
	1000/100 Mbps at <10 Ms	$1.15m	$4.90m	$7.86m
Vermont	150/25 Mbps at <10 Ms	$17.52m	$1.55m	$6.55m
	300/100 Mbps at <10 Ms	$19.41m	$1.71m	$7.26m
	1000/100 Mbps at <10 Ms	$20.71m	$1.83m	$7.75m
Virginia	150/25 Mbps at <10 Ms	$1.82m	$20.26m	$38.08m
	300/100 Mbps at <10 Ms	$2.01m	$22.44m	$42.19m
	1000/100 Mbps at <10 Ms	$2.15m	$23.95m	$45.02m
Washington	150/25 Mbps at <10 Ms	$9.44m	$10.43m	$47.36m
	300/100 Mbps at <10 Ms	$10.45m	$11.55m	$52.46m
	1000/100 Mbps at <10 Ms	$11.15m	$12.33m	$55.98m
West Virginia	150/25 Mbps at <10 Ms	$11.21m	$12.39m	$34.95m
	300/100 Mbps at <10 Ms	$12.41m	$13.72m	$38.71m
	1000/100 Mbps at <10 Ms	$13.25m	$14.64m	$41.31m
Wisconsin	150/25 Mbps at <10 Ms	$22.60m	$15.43m	$26.25m
	300/100 Mbps at <10 Ms	$25.04m	$17.08m	$29.08m
	1000/100 Mbps at <10 Ms	$26.72m	$18.24m	$31.04m
Wyoming	150/25 Mbps at <10 Ms	$1.78m	$1.60m	$3.87m
	300/100 Mbps at <10 Ms	$1.97m	$1.78m	$4.28m
	1000/100 Mbps at <10 Ms	$2.11m	$1.90m	$4.57m

Finally, in Tables D5 through D9 below, we present our main findings for the five focus states under alternative assumptions. First, we consider the magnitude of economic gains (WTP) and losses (DWL) without latency improvements. These estimates appear in Tables D5 through D9 in parentheses and correspond to the estimates and assumptions made in our earlier study, Lopez and Kravtin 2021. We also consider a more conservative set of estimates, appearing in brackets, that assume only 60% deployment. As Tables D5 through D9 show, even if only 60% of currently unserved locations are connected, the economic gains are still quite substantial, ranging from $1.35 to $10.09 billion in Florida alone, for example. Likewise, the delay costs remain substantial even under the 60% deployment assumption.

TABLE D5:
FLORIDA ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
150/25 Mbps	$2.25b ($2.15b) [$1.35b]	$4.82b ($4.62b) [$2.89b]	$14.24b ($13.62b) [$8.54b]
300/100 Mbps	$2.49b ($2.39b) [$1.49b]	$5.34b ($5.13b) [$3.20b]	$15.77b ($15.16b) [$9.46b]
1000/100 Mbps	$2.66b ($2.56b) [$1.59b]	$5.69b ($5.49b) [$3.41b]	$16.83b ($16.22b) [$10.09b]

Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
150/25 Mbps	$13.31m ($12.73m)	$28.51m ($27.29m)	$84.18m ($80.57m)
300/100 Mbps	$14.74m ($14.17m)	$31.58m ($30.36m)	$93.25m ($89.68m)
1000/100 Mbps	$15.73m ($15.16m)	$33.70m ($32.48m)	$99.51m ($95.89m)

Notes: Economic gains equal aggregate WTP for improvement from a Mobile 5/1 Mbps connection to the listed fixed wireline speeds. Top line entries also include latency improvement from 60-100 Ms to <10 Ms. For comparison purposes, second line entries in (parentheses) exclude latency improvements. Finally, entries in [brackets] assume only 60% of the unserved population gets connected.

TABLE D6:
KENTUCKY ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
150/25 Mbps	$1.57b ($1.50b) [$0.94b]	$1.64b ($1.57b) [$0.98b]	$5.31b ($5.08b) [$3.19b]
300/100 Mbps	$1.74b ($1.67b) [$1.04b]	$1.82b ($1.74b) [$1.09b]	$5.89b ($5.66b) [$3.53b]
1000/100 Mbps	$1.85b ($1.79b) [$1.11b]	$1.94b ($1.86b) [$1.16b]	$6.28b ($6.06b) [$3.77b]

Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
150/25 Mbps	$9.29m ($8.89m)	$16.05m ($9.28m)	$31.43m ($30.08m)
300/100 Mbps	$10.29m ($9.89m)	$17.78m ($10.32m)	$34.81m ($33.46m)
1000/100 Mbps	$10.98m ($10.58m)	$18.98m ($11.05m)	$37.15m ($35.80m)

Notes: See Table D5 notes above.

TABLE D7:
MISSOURI ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
150/25 Mbps	$3.16b ($3.03b) [$1.89b]	$2.72b ($2.59b) [$1.63b]	$6.81b ($6.52b) [$4.09b]
300/100 Mbps	$3.51b ($3.37b) [$2.11b]	$3.01b ($2.89b) [$1.81b]	$7.54b ($7.25b) [$4.52b]
1000/100 Mbps	$3.74b ($3.61b) [$2.24b]	$3.21b ($3.09b) [$1.93b]	$8.05b ($7.76b) [$4.83b]

Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
150/25 Mbps	$18.72m ($17.92m)	$16.05m ($15.36m)	$40.26m ($38.56m)
300/100 Mbps	$20.73m ($19.93m)	$17.78m ($17.09m)	$44.59m ($42.87m)
1000/100 Mbps	$22.13m ($21.33m)	$18.98m ($18.29m)	$47.59m ($45.87m)

Notes: See Table D5 notes above.

TABLE D8:
TEXAS ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
150/25 Mbps	$4.94b ($4.73b) [$2.96b]	$6.84b ($6.54b) [$4.10b]	$24.43b ($23.38b) [$14.66b]
300/100 Mbps	$5.47b ($5.26b) [$3.28b]	$7.57b ($7.28b) [$4.52b]	$27.06b ($26.02b) [$16.27b]
1000/100 Mbps	$5.84b ($5.63b) [$3.50b]	$8.08b ($7.78b) [$4.85b]	$28.88b ($27.83b) [$17.33b]

Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
150/25 Mbps	$29.22m ($27.97m)	$40.41m ($38.68m)	$144.46m ($138.27m)
300/100 Mbps	$32.37m ($31.14m)	$44.76m ($43.02m)	$160.02m ($153.83m)
1000/100 Mbps	$34.54m ($32.28m)	$47.78m ($46.04m)	$170.77m ($164.57m)

Notes: See Table D5 notes above.

TABLE D9:
WISCONSIN ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
150/25 Mbps	$3.82b ($3.65b) [$2.29b]	$2.61b ($2.49b) [$1.57b]	$4.44b ($4.25b) [$2.66b]
300/100 Mbps	$4.23b ($4.07b) [$2.54b]	$2.89b ($2.78b) [$1.73b]	$4.92b ($4.73b) [$2.95b]
1000/100 Mbps	$4.52b ($4.35b) [$2.71b]	$3.08b ($2.92b) [$1.85b]	$5.25b ($5.06b) [$3.15b]
Foregone Gains	**RDOF Locations Delay Cost Per Month**	**FCC Unserved Population Delay Cost Per Month**	**BroadbandNow Unserved Population Delay Cost Per Month**
150/25 Mbps	$22.60m ($21.63m)	$15.43m ($14.76m)	$26.25m ($25.13m)
300/100 Mbps	$25.04m ($24.07m)	$17.08m ($16.43m)	$29.08m ($27.95m)
1000/100 Mbps	$26.72m ($25.75m)	$18.24m ($17.57m)	$31.04m ($29.91m)

Notes: See Table D5 notes above.

NATIONAL REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] In its annual Broadband Deployment Reports, the Federal Communications Commission cites the 1996 Telecommunications Act as charging the Commission with "'encourag[ing] the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans by removing barriers to infrastructure investment..." (FCC 2021, p.1).

[3] John Busby, Julian Tanberk, and Tyler Cooper, "BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans do not Have Access to Broadband," BroadbandNow Research, May 5, 2021, updated October 21, 2021 ("we manually checked availability of more than 11,000 addresses using Federal Communications Commission (FCC) Form 477 data as the 'source of truth.' Based on the results, we estimated that 42 million Americans do not have the ability to purchase broadband internet.") The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[4] Willingness to Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. See also Appendix B, Glossary of Technical Terms.

[5] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. See also Appendix B, Glossary of Technical Terms.

[6] See Lopez and Kravtin (2021) specifically Appendix C, Lists of Works Cited, "The Underlying Sources of Pole Owners' Market Power: A Combination of Hold Up Problems and Classic Barriers to Entry", and Appendix D, Empirical Methodology and Complete Results: Baseline / Alternative Assumptions.

[7] See FCC (2020) announcing launch of RDOF on February 7, 2020.

[8] See Lopez & Kravtin 2021, pp. 13-15, citing the Liu et al. study.

[9] Nationally, the average number of persons per household is 2.565 according to the U.S. Census Bureau. Therefore, 5.2 million locations would equate to approximately 2 million persons.

[10] Alaska is excluded from our RDOF calculations due to there being no reported RDOF results, dollars, or locations there. Therefore, our nationwide RDOF calculations include only 49 of the 50 states. Our other calculations that are based on FCC and BroadbandNow estimates of unserved populations are calculated for all 50 states.

[11] Appendix D below explains how this study relies on the underlying WTP estimates from the Liu et al. study.

[12] The appropriate discount rate and duration is debatable. We select the lower range of the average service lives of poles, generally identified at 25 to 50 years. A discount rate of 5% is reasonable, although it may be generously high for consumer and household applications, but it is less than the typical cost of capital

assumptions in the range of 6%.

[13] Poles officially identified as needing replacement by the utility as in situations where a pole has been found non-compliant with safety standards or fails to meet other utility or regulatory requirements such as pole resiliency criteria and placed on a replacement schedule is referred to as “red-tagged.” It is generally accepted that new attachers are not responsible for the cost of pole replacement for red-tagged poles.

[14] See Lopez & Kravtin 2021, Appendix C. and material as reiterated herein in Appendix B.

POLE ATTACHMENT POLICIES AND BROADBAND EXPANSION IN THE STATE OF FLORIDA

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CONNECT THE FUTURE

EXECUTIVE SUMMARY

Between 804,000 and 2.37 million Floridians currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $2.25 billion up to $16.83 billion of new economic gains to Florida's homes and small businesses (the amount varying based on the database of unserved locations used to quantify). This estimated economic gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in Florida.

Today broadband deployment is being inhibited due to utility pole infrastructure access issues and problematic behavior of certain utility pole owners. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In the study of economics, this is known as the *hold up problem*[1], an inefficient concentration of market power that harms the public interest.

When pole owners hold up the process, the result is foregone economic gains to Floridians. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Florida between $13.6 and $99.51 million.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate additional measures to recapture this economic value by revising and modifying pole policies and pole owner behavior to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Florida
> **$13.6M – $99.51M**
> *every month*
> it delays expansion.

CURRENT BROADBAND INITIATIVES IN FLORIDA

Depending on the basis of measurement, the total number of Floridians lacking access to high-speed broadband now ranges between 804,000 to 2,373,981.[2] We estimate that expanding broadband access to this unserved population would create new economic gains between $2.25 billion up to $16.83 billion (calculated as net present value over 25 years at 5% discount rate). As in many states nationwide, recent initiatives have been taken by lawmakers to respond to the problem. In May 2021, lawmakers passed the Broadband Deployment Act of 2021 (HB 1239), effective July 1, 2021. This comprehensive legislation created a new broadband grant program titled the Broadband Opportunity Program ("BOP") to provide "utility pole relief" for broadband providers attaching to poles owned by municipal utilities and funding for geographic information system ("GIS") mapping of broadband internet service availability throughout the state in a manner consistent with the FCC's new reporting standards. The legislation also directs the Florida Office of Broadband ("FOB") to create a strategic plan to increase the use of broadband internet services in the state by June 30, 2022.

The state's BOP, likely subject to initial funding in 2022, will award grants to applicants seeking to expand broadband service to unserved areas of the state. The BOP would augment an existing federal support grant program through the FCC's Rural Digital Opportunity Fund (RDOF) aimed at expanding broadband access to unserved locations throughout the country. Under the RDOF program, Florida was awarded $192 million in grant funding to enable providers to reach 141,625 unserved homes and small businesses in rural locations throughout the state. Other federal programs and funding available to the state include the recently announced U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) Program Broadband Infrastructure Program, as well as provisions within the American Rescue Plan Act (ARPA) and other federal stimulus programs whose overarching goal is to expand access to high speed fixed broadband connections to currently unconnected rural homes and small businesses. Under the ARPA Coronavirus Capital Projects Fund, Florida was allocated a substantial $366 million to fund broadband infrastructure projects. Although not specifically allocated to broadband, additional funding for broadband expansion in unserved areas of the state is available as part of the total $8.8 billion total state level fiscal funding awarded to Florida under ARPA.[3] The Infrastructure Investment and Jobs Act of 2021 ("IIJA"), recently enacted by Congress on a bipartisan basis, includes an additional $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to invest in the state's broadband infrastructure, as across the other 49 states, is unprecedented.

In addition to the measures described above, the Broadband Deployment Act (HB 1239) also set forth a number of new rules for municipal utilities in new Fla. Stat. § 288.9963 aimed to advance broadband deployment in unserved areas of the state in municipal electric utility service territories. The new rules address both recurring and nonrecurring rates, terms, and conditions of access to municipal utility poles faced by broadband providers. The new rules provide for the establishment of a promotional recurring annual rate and related terms for wireline attachments of broadband facilities to municipal electric utility poles.[4] In addition, the new rules establish guidelines that limit the cost responsibility that municipal utilities can impose on broadband providers for replacement poles in certain circumstances at the upfront end of deployment.[5]

EXISTING HOLD UP POWER OF MUNICIPALITY & COOPERATIVELY OWNED ELECTRIC UTILITIES OVER FLORIDA BROADBAND EXPANSION

Despite existing regulations and substantial funding mechanisms from the state and federal governments, the public's return on current broadband investment in the state remains substantially vulnerable to the leverage and market power that pole owners enjoy over broadband service providers seeking to attach their broadband infrastructure to utility poles. This leverage has intensified in recent years due to a variety of factors: the increased urgency of policymakers to get broadband out to unserved areas of the state, the pole owner's information advantage as to where unserved customers – the target recipients of broadband grant awards and build out commitments – are located thereby raising the currency of the pole owners' gatekeeper status, the greater number of poles needed to reach those customers in outlying hard to reach rural areas of the state, and an increasing desire among pole owners to enter and compete in the broadband market against broadband attachers.[6]

The power to impede others' ongoing investment plans is classified in economics as a "*hold up problem*." A hold up problem is an example of the inefficient concentration of market power that harms the public interest and results in market failure absent adoption of public policies to prevent the exercise of the hold up power at its source.

In the case of pole attachments needed for broadband deployment, hold up power emanates from the charging of inefficiently high costs and imposing of delays on pole attachers at the upfront end of their planned broadband buildout as part of the "make-ready" process, although excessive recurring charges (rental rates for space on the pole) are not an insignificant factor. These high make-ready costs and delays are especially pronounced in connection with the change-out or replacement of existing poles. In the absence of effective pole policies, pole owners routinely seek to push the entire cost of pole replacement on to attaching entities, including broadband providers, thereby sharply, unpredictably, and inequitably increasing the cost of attachment.

In Florida, historically inefficient make-ready charges have been compounded by the high recurring annual rental rates charged by unregulated municipally and cooperatively owned utilities. Inefficiently high recurring charges also impede broadband expansion by raising the ongoing costs of attaching to a pole. A 2019 study examining pole rates nationwide found rates charged by unregulated municipally and cooperatively owned utilities in the state of Florida to exceed those charged by regulated investor-owned utilities ("IOUs") in the state by 2 to 2.5 times, respectively. Moreover, the study found the observed higher recurring pole rental rates charged by municipal and cooperatively owned poles and their peer IOUs in Florida were higher than the nationwide average, indeed representing some of the highest rates in the nation.[7]

The recent legislative reforms enacted in Florida address a number of inefficient make-ready practices of municipally owned utilities and represent a positive step forward in the state. Although helpful, the new make-ready rules still fall short in leveling the playing field entirely, given the extent of the hold up power that municipally and cooperatively owned utilities hold over broadband providers in unserved, rural areas of the state, and the degree to which these utilities can thwart the realization of the state's broadband expansion goals.

For example, while the recent legislative reforms applied to municipal utilities limits pole owner shifting of pole replacement costs onto broadband attachers in a number of situations e.g., when the pole is at the end of its useful life, or found currently out of compliance, the new reforms do not address the efficient sharing of cost responsibility for replacement poles required as a condition of broadband provider access more generally, and still affords the utility considerable discretion in terms of recurring and other non-recurring rates, terms, and conditions affecting access.

MEASURING THE ECONOMIC HARMS OF POLE OWNER HOLD UP POWER IN FLORIDA

Our analysis measures the economic harms to Florida residents and small businesses of the hold up power of pole owners. These harms are measured in the form of foregone consumer value, known in economics as *deadweight loss* (DWL).[8] The methodology employed applies well established metrics on consumer *willingness-to-pay* (WTP) from the economic literature (in lay terms, the highest price a household would pay for improved broadband).[9] We apply these WTP metrics to reported data on the number of unserved locations awarded grant funding in the state in the FCC's RDOF auction program. Under the RDOF program alone, third-party providers have committed to expand high-quality broadband access to as many as 141,625 currently unserved homes and small businesses across over 50 counties in the state of Florida, the majority in rural areas. We've expanded our prior analysis to include the total number of unserved locations in the state identified in the FCC's most recent Broadband Deployment Report, as well as information on total unserved locations from an independent data base of unserved Floridians compiled by a data aggregation company, BroadbandNow.[10] Given the substantial private investment and government funding mechanisms being deployed to serve all unserved locations in the state, including the IIJA's massive commitment to broadband infrastructure, this broader analysis is appropriate. The FCC Broadband Report database, which reports unserved population, indicates a total number of 303,396 unserved locations across the state based on the average 2.65 persons per household in Florida.[11] Similarly, according to the BroadbandNow data base, 2,373,981 Floridians have no broadband.[12]

In Tables 1 and 2 below, we present our main findings applied to the state of Florida. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $2.66 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $5.69 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $16.83 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

FL TABLE #1: ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION GAINS BROADBAND ACCESS

	All Assigned RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	$2.25B	$4.82B	$14.24B
300/100 Mbps at <10 Ms	$2.49B	$5.34B	$15.77B
1000/100 Mbps at <10 Ms	$2.66B	$5.69B	$16.83B

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate. See Appendix D of the companion Federal paper for explanation of methodology and modeling assumptions.

Moving to Table 2, this same computation methodology demonstrates the foregone economic gains, DWL, due to delayed or denied broadband expansion under the pole owner hold up problem. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, we compute the magnitude of DWL to be in the range of $15.73 million to $99.51 million per month, at speed thresholds of 1000/100 Mbps and <10 Ms latency.

We emphasize that these Florida estimates, as with our nationwide estimates, are conservative in magnitude given that the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the high speeds being deployed in current expansion plans. For these reasons, the true economic gain to Florida of full broadband expansion likely exceeds the estimates shown in Table 1.

FL TABLE #2:

ESTIMATES OF FOREGONE ECONOMIC GAINS DUE TO POLE ATTACHMENT HOLD UP

	Foregone Gains of Delayed Expansion to Currently Unserved RDOF Locations	Foregone Gains of Delayed Expansion to Currently Unserved FCC Estimated Population	Foregone Gains of Delayed Expansion to Currently Unserved BroadbandNow Estimated Population
150/25 Mbps at <10 Ms	$13.31M	$28.51M	$84.18M
300/100 Mbps at <10 Ms	$14.74M	$31.58M	$93.25M
1000/100 Mbps at <10 Ms	$15.73M	$33.70M	$99.51M

Note: Table entries are monthly aggregate foregone economic gains.

CONCLUSION: POLICY RECOMMENDATIONS TO PROMOTE FULL BROADBAND ACCESS IN FLORIDA

The Florida legislature's recent efforts on municipal utility reform including the creation of a utility pole relief program, that provides some small rate relief for the recurring annual rental rates municipal pole owners charge broadband attachers, and on the non-recurring make-ready front, sets a number of guidelines for the sharing of cost responsibility for pole replacements between Muni pole owners and attachers represents an important initial step towards addressing the hold up power that nonregulated pole owners have.

However, for the reasons described above, these measures do not go far enough in reducing the cost impediments facing broadband providers that have been imposed by pole owners.

Rapid broadband expansion in the state is particularly at risk given the current exemption of municipal and cooperative utilities from regulations governing both nonrecurring and recurring rates, terms, and conditions of third-party access to utility poles, with the exception of the pole replacement and rental rate guidelines included in the Muni reforms. The lack of an existing comprehensive regulatory framework enables these entities to potentially hold up broadband expansion that is in the public interest, and instead advance their narrow interests.

This study demonstrates that the economic stakes at risk are high. Necessary electric utility pole infrastructure investments and pole reforms that address nonregulated municipal utilities and cooperatively owned electric utilities to help speed broadband deployment should include: adoption of efficient pole replacement cost allocation standards based on the net book value of the poles to be replaced (taking into account the inevitable replacement of those poles and the betterment value to the pole owner from their earlier replacement), along with other economically fair, just and reasonable rates, terms, and conditions of access to utility poles for broadband providers, as delineated in Appendix A to the national study that accompanies this state study.

While a number of such legislative and regulatory initiatives are underway across the country, as in Florida, the ability of pole owning utilities to hold up broadband expansion still remains. In addition to the Muni reforms enacted in Florida, one of the first such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas legislature this past spring. The Texas law incorporates a number of the key elements of a model pole policy presented in the national study [and reproduced as Appendix A to this study] required to mitigate pole owner impediments to full broadband expansion. Given the substantial demonstrated consumer gains of full broadband expansion in Florida, there is a compelling public interest case for policymakers to act now to adopt more of these key reforms.

FLORIDA REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] See *FCC Fourteenth Broadband Deployment Report*, rel. January 19, 2021, FCC 21-18, Appendix A, https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[3] See Diane Goovaerts, "U.S. Broadband Funding State by State, September 15, 2021, https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[4] Under the state's utility pole relief program, effective July 1, 2021, a broadband provider can receive $1 per wireline attachment per pole per year for any new attachment necessary to make broadband service available to an unserved or underserved end user within a municipal electric utility service territory until July 1, 2024. Additionally, under the terms of the program, municipal pole owners may not increase the fees charged to broadband providers for pole attachments between July 1, 2021 and July 31, 2022.

[5] The new Muni law provides that "municipal utilities cannot charge broadband providers for pole attachments beyond the reasonable and nondiscriminatory costs, attributable solely to the new attachments minus the salvage value of the pole, if positive. More specifically, municipal utilities may not charge broadband providers for pole replacements necessitated (a) because a pole is out of compliance, (b) to bring a pole into compliance with changed standards, or (c) because a pole is at the end of its useful life (30 years for wood poles and 50 years for steel/iron/concrete etc).

[6] See, e.g. Sara-Meghan Walsh, "Lakeland, Fla., Approves High-Speed Internet Deal for City," The Ledger, July 7, 2021 at https://www.govtech.com/network/lakeland-fla-approves-high-speed-internet-deal-for-city and Lisa Maria Garza, "Winter Park to improve connectivity with fiber optic network for city buildings, 5G installation," Orlando Sentinel, February 24, 2021, at https://www.orlandosentinel.com/news/orange-county/os-ne-winter-park-connectivity-20210224-ptjas6bubjfhdpnvyorcubo7si-story.html.

[7] See Michelle Connelly, The Economic Impact of Section 224 Exemption of Municipal and Cooperative Poles, July 12, 2019, submitted before the FCC Broadband Deployment Advisory Committee, GN Docket No. 17-83, Wireline Infrastructure, WC Docket No. 17-84, Wireless Infrastructure, WT Docket No. 17-79, July 22, 2019, at 3,19, 22, Figure 1, Tables A4, A5.

[8] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. In Appendix D of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix B of the national study for a Glossary of Technical Terms used in this study.

[9] Willingness to Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. In Appendix A of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix C of the national study for a Glossary of Technical Terms used here.

[10] See http://BroadbandNow.com

[11] See *FCC Fourteenth Broadband Deployment Report*, rel. January 19, 2021, FCC 21-18, Appendix A.

[12] More precisely, the BroadbandNow estimates identify unserved population to which state-specific ratios of the average number of persons to households can be applied to derive a number of locations comparable to those identified in the RDOF data base, 2.65 in the case of Florida. The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

POLE ATTACHMENT POLICIES AND BROADBAND EXPANSION IN THE STATE OF KENTUCKY

Edward J. Lopez and
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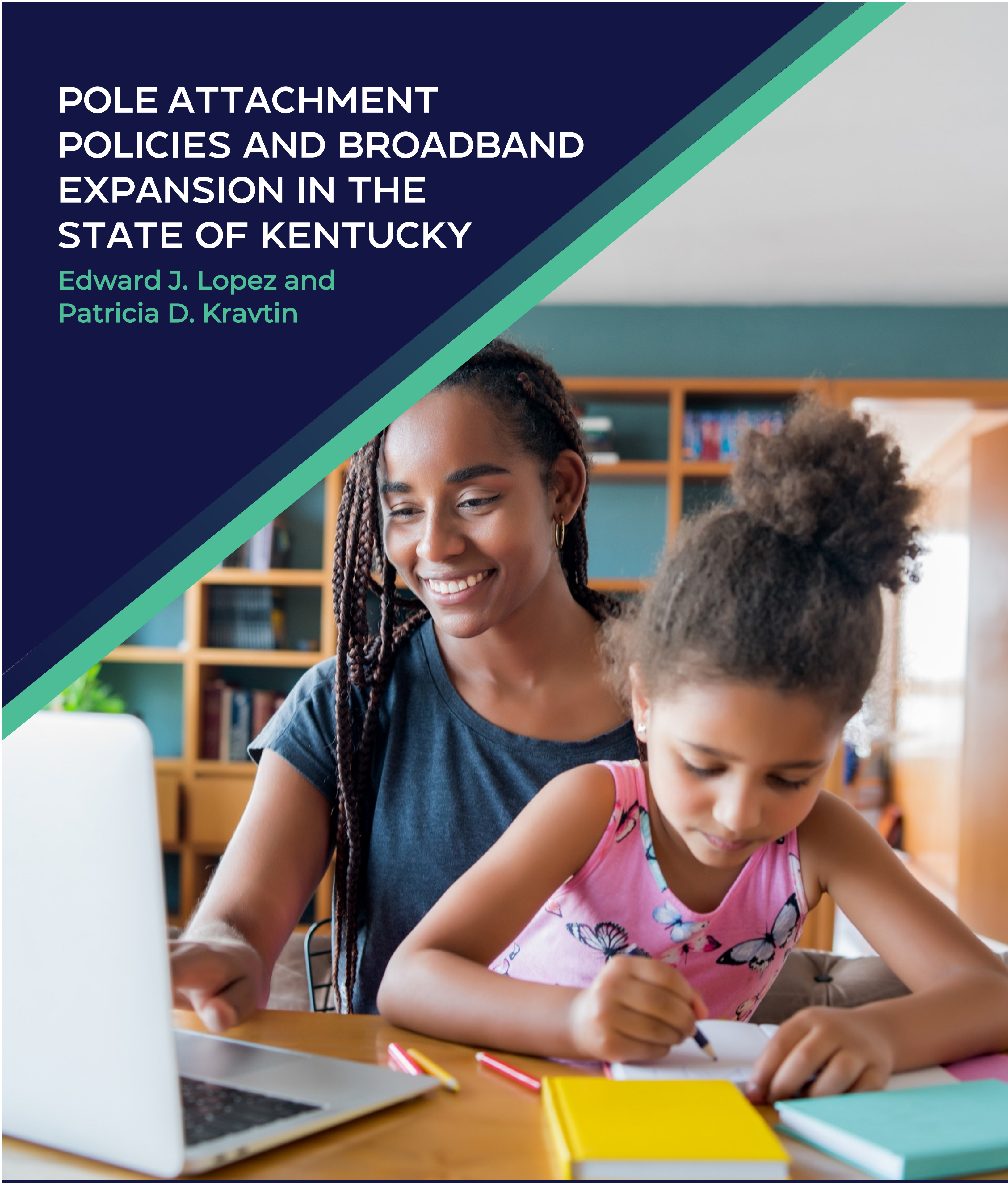

CONNECT THE FUTURE

EXECUTIVE SUMMARY

Between 257,000 and 832,791 Kentuckians currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $1.57 billion up to $6.28 billion of new economic gains to Kentucky's homes and small businesses (the amount varying based on the database of unserved locations used to quantify). This estimated economic gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in Kentucky.

Today, that broadband deployment is being inhibited due to utility pole infrastructure access issues and problematic behavior of certain utility pole owners. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In the study of economics, this is known as the ***hold up problem,***[1] an inefficient concentration of market power that harms the public interest.

When pole owners hold up the process, the result is foregone economic gains to Kentuckians. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Kentucky between $9.29 and $37.15 million.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures to recapture this economic value by revising and modifying pole policies and pole owner behavior to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Kentucky
> **$9.29M – $37.15M**
> ***every month***
> it delays expansion.

CURRENT BROADBAND INITIATIVES IN KENTUCKY

Depending on the basis of measurement, the total number of Kentuckians lacking access to high-speed broadband is reported in the range of 257,000 to 832,791.[2] We estimate that expanding broadband access to this unserved population would create new economic gains between $1.57 billion up to $6.28 billion (calculated as net present value over 25 years at 5% discount rate). The pandemic has vividly highlighted the problems associated with unequal broadband access and the heightened need for broadband services. To address the digital divide, policymakers in Kentucky have initiated action over the past year to pass legislation aimed "… to push Kentucky to the forefront of broadband expansion nationwide."[3]

In April 2021, the Kentucky House of Representatives passed two bills, House Bills 320 and 382, which allocated $300 million of federal American Rescue Plan Act ("ARPA") funding for building broadband internet in underserved communities of the Commonwealth. The $300 million in funding authorized in the 2021 legislation expanded upon 2020 legislation that enacted a state broadband deployment fund to provide grants to public and private entities to promote deployment into underserved and unserved communities throughout the state under the administration of the Kentucky Infrastructure Authority.

These state initiatives are in addition to the $149 Million in broadband grant funding awarded to providers in the state through the FCC Rural Digital Opportunity Fund ("RDOF") auction program – a program that will expand broadband access to 98,909 currently unserved homes and small businesses across the state.[4] Moreover, the state's broadband expansion funding effort also has access to $182.8 million from the ARPA Coronavirus Capital Projects Fund, and while not specifically allocated to broadband, some $2.2 billion in total ARPA state level fiscal funding was awarded to Kentucky.[5] The Infrastructure Investment and Jobs Act of 2021 ("IIJA"), recently enacted by Congress on a bipartisan basis, includes an additional $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to invest in the state's broadband infrastructure, as across the other 49 states, is unprecedented.

Supplementing these state and federal supporting grant infrastructure funding initiatives, are new regulatory initiatives governing make-ready processes applicable to poles owned by investor-owned utilities ("IOUs") and cooperatives in the state (excluding those under the jurisdiction of the Tennessee Valley Authority ("TVA"). Access and attachments to utility poles represent a vital part of any significant broadband deployment effort to serve unserved communities, especially in rural communities. Broadband providers need to attach broadband infrastructure to poles in order to efficiently and speedily get high speed broadband service deployed. Attaching to the existing utility pole network is the only practical, economically feasible, and socially desirable option.

In Kentucky, the state Public Service Commission ("PSC") has longstanding statutory authority to regulate the rates, terms, and conditions of third-party access to pole attachments of cooperatively owned utilities in the state (again, excluding those under TVA jurisdiction in addition to IOUs. While the number of state utility regulatory agencies joining ranks with Kentucky in regulating pole attachments of cooperatively and municipally owned utilities is growing, these types of utilities are historically unregulated, as remains the case with respect to TVA cooperatives and municipally owned utilities in Kentucky.

Following an extensive pole rulemaking proceeding, 807 KAR 5015, the PSC adopted new set of rules designed to better even the playing field between pole owning utilities and broadband providers during the make-ready process. These rules also address a comprehensive set of issues identified by broadband providers regarding impediments to deployment, especially in unserved rural areas, ranging from apportionment of the costs of replacement poles, to pre and post construction requirements, overlashing, timetables, invoicing, and other aspects of the make-ready process.

EXISTING HOLD UP POWER OF MUNICIPALITY & COOPERATIVELY OWNED ELECTRIC UTILITIES OVER KENTUCKY BROADBAND EXPANSION

Despite existing regulations and substantial funding mechanisms from the state and federal government, the public's return on current broadband investment in the Commonwealth remains substantially vulnerable to the leverage and market power that pole owners enjoy over broadband service providers seeking to attach broadband infrastructure to poles. This leverage has intensified in recent years due to a variety of factors: the increased urgency of policymakers to get broadband out to unserved areas of the state, the pole owner's information advantage as to where unserved customers – the target recipients of broadband grant awards and build out commitments – are located thereby raising the currency of the pole owners' gatekeeper status, the greater number of poles needed to reach those customers in outlying hard to reach rural areas of the state, and the increasing desire among pole owners to enter and compete in the broadband market against broadband attachers.[6]

The power to impede others' ongoing investment plans is classified in economics as a ***"hold up problem."*** A hold up problem is an example of the inefficient concentration of market power that harms the public interest and results in market failure absent adoption of public policies to prevent the exercise of the hold up power at its source.

In the case of pole attachments needed for broadband deployment, hold up power emanates from the charging of inefficiently high costs and imposing of delays on pole attachers at the upfront end of their planned broadband buildout as part of the make-ready process, although excessive recurring charges (rental rates for space on the pole) are not an insignificant factor. These high make-ready costs and delays are especially pronounced in connection with the change-out or replacement of existing poles. Absent effective regulation, pole owners routinely seek to push the entire cost of pole replacement on to attaching entities, including broadband providers, thereby sharply, unpredictably, and inequitably increasing the cost of attachment.

In Kentucky, the PSC's recently adopted rules to address the inefficient make-ready practices of IOUs and cooperatively owned utilities represent a positive step forward that buttresses the PSC's longstanding effective regulation of recurring annual pole attachment rental rates that IOUs and cooperatives in the state may charge third party broadband providers.[7] Although helpful, the new make-ready rules still fall short in leveling the playing field entirely, given the extent of the hold up power that cooperatively and municipally owned utilities hold over broadband providers in unserved, rural areas of the state, and the degree to which these utilities can thwart the realization of the Commonwealth's broadband expansion goals.

For example, while the PSC's new rules defining "red-tagged" poles, i.e., poles that would have needed replacement at the time of the attachment request even if the new attachment was not made, more clearly defines the cost-apportionment standard from an economic perspective than existing FCC rules, the new PSC rules provide considerable discretion to pole owners in how red tagged poles are designated and how costs are to be shared. In particular, by not explicitly recognizing the betterment value of the new poles to the utility and/or limiting cost recovery to the economic efficient level, (the remaining net book value of the existing pole), the new rules still permit pole owners to shift a disproportionately high percentage of the true economic cost of pole replacement to the broadband provider.[8]

Moreover, as noted earlier, TVA cooperatives and municipally owned utilities in Kentucky are not subject to the PSC's new make-ready rules or to the regulated cost-based pole attachment rental rate formula methodology. The lack of effective pole regulation in restraining TVA cooperatives and municipal utility hold up power over attachers is borne out by the high pole rental rates they charge in comparison to similar rates charged by Kentucky's IOU and cooperatively owned pole owners that are currently subject to the PSC's rules. A 2019 study examining pole rates nationwide found rates charged by unregulated municipal utilities in Kentucky to exceed those charged by rate regulated IOUs and cooperatives in the Commonwealth by 2.5 to 2 times, respectively. Moreover, the study found the higher recurring pole rental rates charged by municipal pole owners in Kentucky exceeded the nationwide average by over 40%, indeed among the highest in the nation.[9] TVA rates trend even higher, with rates reported as averaging nearly 4 times the rates charged by PSC regulated utilities.[10]

MEASURING THE ECONOMIC HARMS OF POLE OWNER HOLD UP POWER IN THE STATE OF KENTUCKY

Our analysis measures the economic harms to Kentucky residents and small businesses of the hold up power of pole owners. These harms are measured in the form of foregone consumer value, known in economics as ***deadweight loss*** ("DWL").[11] The methodology employed applies well established metrics on consumer ***willingness-to-pay*** ("WTP") from the economic literature (in lay terms, the highest price a household would pay for improved broadband).[12] We apply these WTP metrics to reported data on the number of unserved locations awarded grant funding in the state in the FCC's RDOF auction program. Under the RDOF program alone, third-party providers have committed to expand high-quality broadband access to as many as 98,909 currently unserved homes and small businesses across over a hundred counties in the Commonwealth, the majority located in the Commonwealth's rural areas.

We've expanded our prior analysis to include the total number of unserved locations in the state identified in the FCC's most recent Broadband Deployment Report, as well as information on total unserved locations from an independent data base of unserved Kentuckians compiled by a data aggregation company, BroadbandNow.[13] Given the substantial private investment and government funding mechanisms being deployed to serve all unserved locations in the state, including the IIJA's massive commitment to broadband infrastructure, this broader analysis is appropriate. The FCC Broadband Report database of unserved population indicates a total number of 103,213 unserved locations across the state based on the average 2.49 persons per household in Kentucky.[14] Similarly, according to the BroadbandNow data base, 832,791 Kentuckians are currently without access to broadband, translating into a total of 334,454 unserved locations in the state – nearly three and a quarter times the identified number of unserved locations identified by the FCC of 103,213.[15]

In Tables 1 and 2 below, we present our main findings applied to the Commonwealth of Kentucky. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $1.85 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $1.94 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $6.28 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

KY TABLE #1:

ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION GAINS BROADBAND ACCESS

	All Assigned RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	**$ 1.57B**	**$1.64B**	**$5.31B**
300/100 Mbps at <10 Ms	**$1.74B**	**$1.81B**	**$5.89B**
1000/100 Mbps at <10 Ms	**$1.85B**	**$1.94B**	**$6.28B**

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate. See Appendix D of the companion Federal paper for explanation of methodology and modeling assumptions.

Moving to Table 2 below, this same computation methodology demonstrates the foregone economic gains, known in economics as ***deadweight loss*** (DWL), due to delayed or denied broadband expansion under the pole owner hold up problem. As our previous analysis demonstrated, the identified losses, in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, we compute the magnitude of DWL to be in the range of $10.98 million to $37.15 million per month, at speed thresholds of 1000/100 Mbps and <10Ms latency.

We emphasize that these Kentucky estimates, as with our nationwide estimates, are conservative in magnitude given that the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the high speeds being deployed in current expansion plans. For these reasons, the true economic gain to Kentucky of full broadband expansion likely exceeds the estimates shown in Table 1 above.

KY TABLE #2:

ESTIMATES OF FOREGONE ECONOMIC GAINS DUE TO POLE ATTACHMENT HOLD UP

	Foregone Gains of Delayed Expansion to Currently Unserved RDOF Locations	Foregone Gains of Delayed Expansion to Currently Unserved FCC Estimated Population	Foregone Gains of Delayed Expansion to Currently Unserved BroadbandNow Estimated Population
150/25 Mbps at <10 Ms	**$9.29M**	**$16.05M**	**$31.43M**
300/100 Mbps at <10 Ms	**$10.29M**	**$17.78M**	**$34.81M**
1000/100 Mbps at <10 Ms	**$10.98M**	**$18.98M**	**$37.15M**

Note: Table entries are monthly aggregate foregone economic gains.

CONCLUSION: POLICY RECOMMENDATIONS TO PROMOTE FULL BROADBAND ACCESS IN KENTUCKY

The efforts undertaken in the Commonwealth of Kentucky to date including the new make-ready rules applicable to cooperatively owned utilities (outside the TVA jurisdiction)[16] represent an initial step towards addressing the hold up power that cooperative pole owners have and their ability to deter rapid deployment of broadband infrastructure throughout Kentucky's unserved areas. However, for the reasons described above, these measures do not go far enough in reducing the cost impediments facing broadband providers that have been imposed by pole owners. Rapid broadband expansion in the Commonwealth is particularly at risk given how unregulated municipal utilities and cooperative utilities under TVA jurisdiction are currently exempted from existing PSC pole rules governing both nonrecurring and recurring rates, terms, and conditions of third-party access to utility poles. The lack of an existing comprehensive regulatory framework enables these municipal and cooperative pole owners to potentially hold up broadband expansion that is in the public interest and instead advance their narrow interests, especially under circumstances where they seek to enter into the broadband market in competition with the entities over which they enjoy the hold up power.

This study demonstrates that the economic stakes at risk are high. Necessary electric utility pole infrastructure investments and pole reforms that address nonregulated municipal utilities and cooperatively owned electric utilities to help speed broadband infrastructure deployment should include: adoption of efficient pole replacement cost allocation standards based on the net book value of the poles to be replaced (taking into account the inevitable replacement of those poles and the betterment value to the pole owner from their earlier replacement), along with other economically fair, just and reasonable rates, terms, and conditions of access to utility poles for broadband providers. While a number of such legislative and regulatory initiatives are underway across the country, as in Kentucky, the ability of pole owning utilities to hold up broadband expansion is going largely unchecked. One of the first such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas legislature this past spring. The Texas law incorporates a number of the key elements of a model pole policy (e.g., the creation of a utility pole replacement fund to facilitate the efficient use of available federal and state grant funding) presented in the national study (reproduced as Appendix A to this study).

Given the substantial demonstrated consumer gains of full broadband expansion in Kentucky, there is a compelling public interest case for policymakers to act now to adopt these key reforms.

KENTUCKY REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A, https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[3] See https://kentucky.gov/Pages/Activity-stream.aspx?n=GovernorBeshear&prId=702.

[4] See FCC (Federal Communications Commission) 2020. "FCC Launches $20 Billion Rural Digital Opportunity Fund to Expand Rural Broadband," Report and Order, FCC-20-5, February 7, 35 FCC Rcd 686 (1).

[5] https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[6] See, e.g., http://www2.murray-ky.net/, https://omu.org/internet/, https://www.precc.com/residential-0/broadband-internet-service/.

[7] The KPSC applies a cost-based formula methodology to IOUs and cooperatives that is closely aligned with the federal cable rate methodology, widely acknowledged as promoting broadband deployment.

[8] See "The Economic Case for a More Cost Causative Approach to Make-Ready Charges Associated with Pole Replacement in Unserved/Rural Areas: Long Overdue, But Particularly Critical in Light of the Pressing Need to Close the Digital Divide," September 2, FCC WC Docket No. 17-84, in the Matter of Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment., September 2021.

[9] See Michelle Connelly, *The Economic Impact of Section 224 Exemption of Municipal and Cooperative Poles,* July 12, 2019, submitted before the FCC Broadband Deployment Advisory Committee, GN Docket No. 17-83, Wireline Infrastructure, WC Docket No. 17-84, Wireless Infrastructure, WT Docket No. 17-79, July 22, 2019, Tables A4.

[10] See https://ustelecom.org/survey-shows-pole-attachment-improvements-remain-unrealized/.

[11] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. In Appendix D of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix B of the national study for a Glossary of Technical Terms used in this study.

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[13] See http://BroadbandNow.com.

[14] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A.

[15] More precisely, the BroadbandNow data base identifies unserved population to which state-specific ratios of the average number of persons to households can be applied to derive a number of locations comparable to those identified in the RDOF data base, 2.49 in the case of Kentucky. The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[16] See KAR 807 KAR 5:015. *Access and attachments to utility poles and facilities*, adopted October 6, 2021.

POLE ATTACHMENT POLICIES AND BROADBAND EXPANSION IN THE STATE OF MISSOURI

Edward J. Lopez and
Patricia D. Kravtin

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EXECUTIVE SUMMARY

Between 422,000 and 1.06 million Missourians currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $3.16 billion up to $8.05 billion of new economic gains to Missouri's homes and small businesses (the amount varying based on the database of unserved locations used to quantify). This estimated economic gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in Missouri.

Today, that broadband deployment is being inhibited due to utility pole infrastructure access issues and problematic behavior of certain utility pole owners. Specifically, pole owners can deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In the study of economics, this is known as the ***hold up problem***,[1] an inefficient concentration of market power that harms the public interest.

When pole owners hold up the process, the result is foregone economic gains to Missourians. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Missouri between $18.72 and $47.59 million.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures to recapture this economic value by revising and modifying pole policies and pole owner behavior to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Missouri
> **$18.72M – $47.59M**
> ***every month***
> it delays expansion.

CURRENT BROADBAND INITIATIVES IN MISSOURI

Depending on the basis of measurement, the total number of Missourians lacking access to high-speed broadband is reported in the range of 422,000 to 1,058,308.[2] We estimate that expanding broadband access to this unserved population would create new economic gains between $3.16 billion up to $8.05 billion (calculated as net present value over 25 years at 5% discount rate). With 21% of the state's rural population reported as lacking access to quality broadband internet service, the state ranked 35th in the nation for rural connectivity.[3] The pandemic has vividly highlighted the problems associated with unequal broadband access and the heightened need for broadband services. In a report issued in the spring of 2020, the Missouri Department of Higher Education & Workforce Development (DHEWD) identified the lack of access to reliable, quality broadband internet service as a "major inhibitor to online learning" in postsecondary education in Missouri, and a pressing statewide need to be addressed.[4] This finding was echoed in a 2020 survey by the Missouri Department of Elementary and Secondary Education, which found about 23% of Missouri school age students lacking sufficient internet access.

Policymakers in Missouri initiated action with the passage of HB 1872 in 2018, which created the Missouri Broadband Grant Program. In 2020, that program awarded $3 million in grant funding covering 35% of identified total project costs to serve an additional 4,400 new connections.[5] The DHEWD has sought an additional $56 million in broadband funding from the U.S. Department of Commerce's National Telecommunications and Information Administration ("NTIA") Broadband Infrastructure Program to connect more than 17,000 residential and business locations in the state. A Special Interim Committee on Broadband Development was created by lawmakers in May of this year, with a report expected to be issued by the end of the year.

These state initiatives are in addition to the $346 million in broadband grant funding awarded to providers in the state through the FCC Rural Digital Opportunity Fund ("RDOF") auction program – a program that will expand broadband access to 199,211 currently unserved homes and small businesses in the state.[6] Moreover, the state's broadband expansion funding effort also has access to $196.7 million from the ARPA Coronavirus Capital Projects Fund, and a reported $400 million of the total $2.7 billion in total ARPA state level fiscal funding was awarded to Missouri.[7] The Infrastructure Investment and Jobs Act of 2021 ("IIJA"), recently enacted by Congress on a bipartisan basis, includes an additional $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to invest in the state's broadband infrastructure, as across the other 49 states, is unprecedented.

EXISTING HOLD UP POWER OF MUNICIPALITY & COOPERATIVELY OWNED ELECTRIC UTILITIES OVER MISSOURI BROADBAND EXPANSION

Despite substantial funding mechanisms from the state and federal government, the public's return on current broadband investment in the state remains substantially vulnerable to the leverage and market power that pole owners enjoy over broadband service providers seeking to attach broadband infrastructure to poles. This leverage has intensified in recent years due to variety of factors: the increased urgency of policymakers to get broadband out to unserved areas of the state, the pole owner's information advantage as to where unserved customers – the target recipients of broadband grant awards and build out commitments – are located thereby raising the currency of the poles owners' gatekeeper status, the greater number of poles needed to reach those customers in outlying hard to reach rural areas of the state, and the increasing desire among pole owners to enter and compete in the broadband market against broadband attachers.[8]

The power to impede others' ongoing investment plans is classified in economics as a "hold up problem." A hold up problem is an example of the inefficient concentration of market power that harms the public interest and results in market failure absent adoption of public policies to prevent the exercise of the hold up power at its source.

In the case of pole attachments needed for broadband deployment, hold up power emanates from the charging of inefficiently high costs and imposing of delays on pole attachers at the upfront end of their planned broadband buildout as part of the "make-ready" process, although excessive recurring charges (rental rates for space on the pole) are not an insignificant factor. These high make-ready costs and delays are especially pronounced in connection with the change-out or replacement of existing poles. Absent effective regulation, pole owners can seek to push the entire cost of pole replacement on to attaching entities, including broadband providers, thereby sharply, unpredictably, and inequitably increasing the cost of attachment.

Inefficiencies in make-ready charges are in addition to high recurring annual rental rates, which also impede broadband expansion by raising the ongoing costs of attaching to a pole. A 2019 study examining pole rates nationwide found rates charged by cooperative utilities in Missouri to exceed those charged by rate regulated municipal and IOUs in the state by approximately 77% and 25%, respectively.[9]

MEASURING THE ECONOMIC HARMS OF POLE OWNER HOLD UP POWER IN THE STATE OF MISSOURI

Our analysis measures the economic harms to Missouri residents and small businesses of the hold up power of pole owners. These harms are measured in the form of foregone consumer value, known in economics as ***deadweight loss*** (DWL).[10] The methodology employed applies well established metrics on consumer ***willingness-to-pay*** (WTP) from the economic literature (in lay terms, the highest price a household would pay for improved broadband).[11] We apply these WTP metrics to reported data on the number of unserved locations awarded grant funding in the state in the FCC's RDOF auction program. Under the RDOF program alone, third-party providers have committed to expand high-quality broadband access to as many as 199,211 currently unserved homes and small businesses across the state of Missouri, the majority in rural areas.

We've expanded our prior analysis to include the total number of unserved locations in the state identified in the FCC's most recent Broadband Deployment Report as well as information on unserved locations from an independent data base of unserved Missourians compiled by a national data aggregation company, BroadbandNow.[12] Given the substantial private investment and government funding mechanisms being deployed to serve all unserved locations in the state including the IIJA's massive commitment to broadband infrastructure, this broader analysis is appropriate. The FCC Broadband Report database of unserved population indicates a total number of 428,465 unserved locations across the state based on the average 2.51 persons per household in Missouri.[13] Similarly, according to the BroadbandNow data base, 1,058,308 Missourians are currently without access to broadband, translating into a total of 428,465 unserved locations in the state – over 2.5 times the identified number of unserved locations identified by the FCC of 170,850.[14]

In Tables 1 and 2 below, we present our main findings applied to the state of Missouri. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $3.74 billion of new economic gains nationwide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $3 21 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $8.05 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

MO TABLE #1: ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION GAINS BROADBAND ACCESS

	All Assigned RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	**$3.16B**	**$2.72B**	**$6.81B**
300/100 Mbps at <10 Ms	**$3.51B**	**$3.01B**	**$7.54B**
1000/100 Mbps at <10 Ms	**$3.74B**	**$3.21B**	**$8.05B**

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate. See Appendix D of the companion Federal paper for explanation of methodology and modeling assumptions.

Moving to Table 2 below, this same computation methodology demonstrate the foregone economic gains, known in economics as ***deadweight loss*** (DWL), due to delayed or denied broadband expansion under the pole owner hold up problem. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, we compute the magnitude of DWL to be in the range of $18.72 million to $47.59 million per month, at speed thresholds of 1000/100 Mbps and <10 Ms latency.

We emphasize that these Missouri estimates, as with our nationwide estimates, are conservative in magnitude given that the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the high speeds being deployed in current expansion plans. For these reasons, the true economic gain to Missouri of full broadband expansion likely exceeds the estimates shown in Table 1 above.

MO TABLE #2: ESTIMATES OF FOREGONE ECONOMIC GAINS DUE TO POLE ATTACHMENT HOLD UP

	Foregone Gains of Delayed Expansion to Currently Unserved RDOF Locations	Foregone Gains of Delayed Expansion to Currently Unserved FCC Estimated Population	Foregone Gains of Delayed Expansion to Currently Unserved BroadbandNow Estimated Population
150/25 Mbps at <10 Ms	**$18.72M**	**$16.05M**	**$40.26M**
300/100 Mbps at <10 Ms	**$20.73M**	**$17.78M**	**$44.59M**
1000/100 Mbps at <10 Ms	**$22.13M**	**$18.98M**	**$47.59M**

Note: Table entries are monthly aggregate foregone economic gains.

CONCLUSION: POLICY RECOMMENDATIONS TO PROMOTE FULL BROADBAND ACCESS IN MISSOURI

Rapid broadband expansion in the state is particularly at risk given the lack of effective make-ready rules governing the nonrecurring rates, terms, and conditions of third-party access to utility poles. The lack of an effective regulatory framework applicable to utility make-ready practices in Missouri enables these entities to potentially hold up broadband expansion that are in the public interest, and instead advance their narrow interests, especially under circumstances where they seek to enter into the broadband market in competition with the entities over which they enjoy the hold up power. The hold up power that unregulated cooperative and municipal pole owners can impose on broadband attachers at the front end of deployment is further compounded in the case of cooperative utilities – currently exempted from both federal and state recurring pole rate rules and regulation – by cost impediments associated with high annual pole rental rates they can impose on broadband providers in addition to the high upfront attachment costs.

This study demonstrates that the economic stakes at risk are high. Necessary electric utility pole infrastructure investments and pole reforms that address municipal utilities and cooperatively owned electric utilities to help speed broadband infrastructure deployment should include: adoption of efficient pole replacement cost allocation standards based on the net book value of the poles to be replaced (taking into account the inevitable replacement of those poles and the betterment value to the pole owner from their earlier replacement), along with other economically fair, just and reasonable rates, terms, and conditions of access to utility poles for broadband providers as delineated in Appendix A to the national study that accompanies this state study.

While a number of such legislative and regulatory initiatives are underway across the country, the ability of pole owning utilities to hold up broadband expansion is going largely unchecked. One of the first such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas legislature this past spring. The Texas law incorporates a number of the key elements of a model pole policy presented in the national study (and reproduced as Appendix A to this study.)

Given the substantial demonstrated consumer gains of full broadband expansion in Missouri, there is a compelling public interest case for policymakers to act now to adopt these key reforms.

MISSOURI REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A, https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[3] See FCC 21-18, Appendix A.

[4] https://dhewd.mo.gov/documents/AAR.pdf.

[5] http://ded.mo.gov/sites/files/Broadband%20Documents.pdf.

[6] See FCC (Federal Communications Commission) 2020. "FCC Launches $20 Billion Rural Digital Opportunity Fund to Expand Rural Broadband," Report and Order, FCC-20-5, February 7, 35 FCC Rcd 686 (1).

[7] https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[8] See, e.g., https://www.pemdunk.com/, https://osagevalley.com/broadband-update/, https://westplains.gov/fiber-broadband-high-speed-internet/, https://muninetworks.org/content/houston-missouri-forging-ahead-fiber.

[9] See Michelle Connelly, *The Economic Impact of Section 224 Exemption of Municipal and Cooperative Poles,* July 12, 2019, submitted before the FCC Broadband Deployment Advisory Committee, GN Docket No. 17-83, Wireline Infrastructure, WC Docket No. 17-84, Wireless Infrastructure, WT Docket No. 17-79, July 22, 2019, Tables A4.

[10] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. In Appendix D of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix B of the national study for a Glossary of Technical Terms used in this study.

[11] Willingness-to-Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. In Appendix A of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix C of the national study for a Glossary of Technical Terms used here.

[12] See http://BroadbandNow.com.

[13] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A.

[14] More precisely, the BroadbandNow data base identifies unserved population to which state-specific ratios of the average number of persons to households can be applied to derive a number of locations comparable to those identified in the RDOF data base, 2.47 in the case of Missouri. The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

POLE ATTACHMENT POLICIES AND BROADBAND EXPANSION IN THE STATE OF TEXAS

Edward J. Lopez and
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CONNECT THE FUTURE

EXECUTIVE SUMMARY

Between 1.23 million and 4.37 million Texans currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $4.94 billion up to $28.88 billion of new economic gains to Texas's homes and small businesses (the amount varying based on the database of unserved locations used to quantify). This estimated economic gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in Texas.

Today, that broadband deployment is being inhibited due to utility pole infrastructure access issues and problematic behavior of certain utility pole owners. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In the study of economics, this is known as the ***hold up problem***,[1] an inefficient concentration of market power that harms the public interest.

When pole owners hold up the process, the result is foregone economic gains to Texans. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Texas between $29.2 and $170.7 million.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures to recapture this economic value by revising and modifying pole policies and pole owner behavior to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Texas
> **$29.2M – $170.7M**
> ***every month***
> it delays expansion.

CURRENT BROADBAND INITIATIVES IN TEXAS

Depending on the basis of measurement, the total number of Texans lacking access to high-speed broadband is reported in the range of 1.23 million to 4.37 million, representing approximately one in ten of the total estimated unserved population in the United States.[2] The pandemic has vividly highlighted the problems associated with unequal broadband access and the heightened need for broadband services. The problem has been recognized as particularly acute given its impact on the school age population in Texas. According to a 2020 article, an estimated 30% of the state's 5.5 million public school students don't have the right technology for online learning.[3] Based on a survey of state educators, a reported one of every six public school students in Texas does not have access to high-speed internet.

Legislators in the state have taken steps to study and address the problem, with the establishment in 2019 of a Governor's Broadband Development Council ("GBDC"),[4] followed by the establishment in 2021 of a Broadband Development Office ("BDO") in HB 5 (87R). Per its charter, the GBDC is required to monitor the progress of broadband development in unserved areas; identify barriers to residential and commercial broadband deployment in unserved areas; and to study and analyze how statewide access to broadband would benefit economic development, the delivery of educational opportunities in higher education and public education; state and local law enforcement; state emergency preparedness; and the delivery of health care services.

The BDO is tasked with creating a broadband map indicating areas of financial assistance, setting thresholds for broadband speed in unserved areas at 25/3 Mbps, creating and updating a state broadband plan, doing outreach to communities regarding the expansion and adoption of broadband service and the programs administered by the BDO, and serving as the state's subject matter expert for federal funding to help local governments.

Lawmakers in the state further stepped up in the spring of this year with the enactment of HB 1505, which established a Broadband Pole Replacement Fund ("BPF") with an initial appropriation of $75 million to help underwrite the cost of pole replacements required as part of the deployment of broadband facilities in areas served by cooperatively owned utilities. As noted in Lopez & Kravtin 2021, pole replacement costs can serve as a major cost impediment to broadband expansion into unserved rural areas of the state. Under the BPF, the state comptroller is authorized to reimburse the lesser of $5,000 or 50 percent of the total amount paid by a broadband provider or cooperative pole owner for an eligible pole replacement, plus administrative costs associated with the grant application process up to 5% of the replacement cost, to accommodate broadband facilities used to deploy retail broadband service at speeds of 25/3 Mbps or faster to areas that currently lack such service or are subject to another state or federal grant program.

These state initiatives are in addition to the $363 million in broadband grant funding awarded to providers in the state through the FCC Rural Digital Opportunity Fund ("RDOF") auction program – a program that will expand broadband access to currently 310,962 unserved homes and small businesses across Texas. Moreover, the state's broadband expansion funding effort also has access to $500.4 million from the ARPA Coronavirus Capital Projects Fund, and while not specifically allocated to broadband, some $15.8 billion in total ARPA state level fiscal funding awarded to Texas.[5] The Infrastructure Investment and Jobs Act of 2021 ("IIJA"), recently enacted by Congress on a bipartisan basis, includes an additional $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to invest in the state's broadband infrastructure, as across the other 49 states, is unprecedented.

Texas policymakers recently extended its regulation of recurring pole rental rates to apply to cooperatively owned utilities in the state. Previously, pole rate regulation in Texas was limited to municipally owned utilities only, leaving investor-owned utility ("IOU") rate regulation to the FCC pursuant to federal Section 224 regulation and pole rates charged by cooperative utilities unregulated. However, unlike the pole rate regulations applied to municipal utilities, the new regulations governing pole rates charged broadband providers by cooperatives do not establish a specific cost-based formula, only a general standard of just, reasonable, and nondiscriminatory rates.[6]

EXISTING HOLD UP POWER OF MUNICIPALITY & COOPERATIVELY OWNED ELECTRIC UTILITIES OVER TEXAS BROADBAND EXPANSION

Despite existing regulations and substantial funding mechanisms from the state and federal government, the public's return on current broadband investment in the state remains substantially vulnerable to the leverage and market power that pole owners enjoy over broadband service providers seeking to attach broadband infrastructure to poles. This leverage has intensified in recent years due to a variety of factors including: the increased urgency of policymakers to get broadband out to unserved areas of the state, the pole owner's information advantage as to where unserved customers – the target recipients of broadband grant awards and build out commitments - are located thereby raising the currency of the pole owners' gatekeeper status, the greater number of poles needed to reach those customers in outlying hard to reach rural areas of the state, and the increasing desire among pole owners to enter and compete in the broadband marketplace against broadband attachers.[7]

The power to impede others' ongoing investment plans is classified in economics as a "***hold up problem***." A hold up problem is an example of the inefficient concentration of market power that harms the public interest and results in market failure absent adoption of public policies to prevent the exercise of the hold up power at its source.

In the case of pole attachments needed for broadband deployment, hold up power emanates from the charging of inefficiently high costs and imposing of delays on pole attachers at the upfront end of their planned broadband buildout as part of the "make-ready" process, although excessive recurring charges (rental rates for space on the pole) are not an insignificant factor. These high make-ready costs and delays are especially pronounced in connection with the change-out or replacement of existing poles. Absent effective regulation, pole owners routinely seek to push the entire cost of pole replacement on to attaching entities, including broadband providers, thereby sharply, unpredictably, and inequitably increasing the cost of attachment.

In Texas, recently adopted HB 1505 represents a positive step forward that buttresses the state's application of recurring pole attachment rental rate regulation to extend to cooperatives, which previously the state had only applied to municipally owned utilities. Although helpful, as noted above, the new pole rate regulation as applied to cooperatives provides more discretion in setting rates to the pole owner than the regulations applied by the state to municipal utilities. Similarly, under the new make-ready process, including the apportionment of costs between the pole owner and the broadband provider, pole owners retain substantial discretion in determining the costs to be borne by the provider. This provides an opportunity (and incentive) for the cooperatives to continue to exercise hold up power over broadband providers in unserved, rural areas of the state, and thwart the public interest objectives of Texas' broadband expansion goals. For example, by not specifying a cost allocation methodology, the opportunity remains for the pole owner to seek to shift a disproportionately high percentage of the true economic cost of pole replacement to the broadband provider, regardless of the betterment value of the new poles to the utility and/or the remaining net book value of the existing pole.[8]

Remaining inefficiencies in make-ready charges are compounded by the high recurring annual rental rates charged by the more lightly regulated cooperatively owned utilities. Inefficiently high recurring charges also impede broadband expansion by raising the ongoing costs of attaching to a pole. A 2019 study examining pole rates nationwide found rates charged by cooperative utilities in the state of Texas (pre regulation) to exceed those charged by municipal utilities in the state by over 20% and to exceed those charged by IOUs by over 80%.[9]

MEASURING THE ECONOMIC HARMS OF POLE OWNER HOLD UP POWER IN THE STATE OF TEXAS

Our analysis measures the economic harms to Texas residents and small businesses of the hold up power of pole owners. These harms are measured in the form of foregone consumer value, known in economics as ***deadweight loss*** (DWL).[10] The methodology employed applies well established metrics on consumer ***willingness to pay*** (WTP) from the economic literature (in lay terms, the highest price a household would pay for improved broadband).[11] We apply these WTP metrics to reported data on the number of unserved locations awarded grant funding in the state in the FCC's RDOF auction program. Under the RDOF program alone, third-party providers have committed to expand high-quality broadband access to as many as 310,962 currently unserved homes and small businesses across the state of Texas, the majority in rural areas.

We have expanded our prior analysis to include the total number of unserved locations in the state identified in the FCC's most recent Broadband Deployment Report, as well as information on unserved locations from an independent data base of unserved Texans compiled by a national data aggregation company, BroadbandNow.[12] Given the substantial private investment and government funding mechanisms being deployed to reach all unserved locations in the state, including the IIJA's massive commitment to broadband infrastructure, this broader analysis is appropriate. The FCC Broadband Report database of unserved population indicates a total number of 1.53 million unserved locations across the state based on the average 2.86 persons per household in Texas.[13] Similarly, the BroadbandNow data base, the number of Texans without broadband access is 4,396,820, translating into 1.53 million unserved locations in the state – over 3.5 times the identified number of unserved locations identified by the FCC of 430,070.[14]

In Tables 1 and 2 below, we present our main findings applied to the state of Texas. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $5.84 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $8.08 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $28.88 billion.

Moving to Table 2 below, this same computation methodology demonstrate the foregone economic gains, known in economics as deadweight loss (DWL), due to delayed or denied broadband expansion under the pole

TX TABLE #1:
ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION GAINS BROADBAND ACCESS

	All Assigned RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	**$ 4.94B**	**$6.84B**	**$24.43B**
300/100 Mbps at <10 Ms	**$5.47B**	**$7.57B**	**$27.06B**
1000/100 Mbps at <10 Ms	**$5.84B**	**$8.08B**	**$28.88B**

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate. See Appendix D of the companion Federal paper for explanation of methodology and modeling assumptions.

owner hold up problem. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, we compute the magnitude of DWL to be in the range of $29.22 million to $170.77 million per month, at speed thresholds of 1000/100 Mbps and <10Ms latency.

We emphasize that these Texas estimates, as with our nationwide estimates, are conservative in magnitude because the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the high speeds being deployed in current expansion plans. For these reasons, the true economic gain to Texas of full broadband expansion may likely exceeds the estimates shown in Table 1 above.

TX TABLE #2:
ESTIMATES OF FOREGONE ECONOMIC GAINS DUE TO POLE ATTACHMENT HOLD UP

	All RDOF Locations Gain Access	All FCC Estimated Population Gains Access	All BroadbandNow Estimated Population Gains Access
150/25 Mbps at <10 Ms	**$29.22M**	**$40.41M**	**$144.46M**
300/100 Mbps at <10 Ms	**$32.37M**	**$44.76M**	**$160.02M**
1000/100 Mbps at <10 Ms	**$34.54M**	**$47.78M**	**$170.77M**

Note: Table entries are monthly aggregate foregone economic gains.

CONCLUSION: POLICY RECOMMENDATIONS TO PROMOTE FULL BROADBAND ACCESS IN TEXAS

The efforts undertaken in the state of Texas to date including the new make-ready rules and recurring rate regulations applicable to cooperatively owned utilities represent an initial step toward addressing the hold up power of municipal and cooperative pole owners and their ability to deter rapid deployment of broadband infrastructure throughout Texas' unserved areas. However, for the reasons described above, and especially as it applies to the charges for pole replacement imposed by pole owners on third party broadband providers, they do not go far enough in reducing the cost impediments facing broadband providers due to the behavior of pole owners.

This study demonstrates that the economic stakes at risk are high. Necessary electric utility pole infrastructure investments and pole reforms that address nonregulated cooperatively owned utilities to help speed broadband infrastructure deployment should include: adoption of efficient pole replacement cost allocation standards based on the net book value of the poles to be replaced (taking into account the inevitable replacement of those poles and the betterment value to the pole owner from their earlier replacement), along with other economically fair, just and reasonable rates, terms, and conditions of access to utility poles for broadband providers as delineated in Appendix A to the national study that accompanies this state study.

Given the substantial demonstrated consumers gains of full broadband expansion in Texas, a compelling public interest exists for policymakers to act now to adopt more of these key reforms.

TEXAS REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[3] See https://www.texastribune.org/2020/08/14/texas-schools-remote-internet-access/.

[4] See https://gov.texas.gov/business/page/governors-broadband-development-council.

[5] https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[6] See Tex. Util. Code 252 (cooperatives)., Tex. Util. Code Ann. Section 54.204 (municipal).

[7] See e.g., https://taylorelectric.com/residential-fiber-2/, https://www.greenbeltelectric.coop/content/twn-high-speed-internet, https://victoriaelectric.coop/content/internet, https://www.geus.org/35/Internet-Cable-TV.

[8] See "The Economic Case for a More Cost Causative Approach to Make ready Charges Associated with Pole Replacement in Unserved/Rural Areas: Long Overdue, But Particularly Critical in Light of the Pressing Need to Close the Digital Divide," September 2, FCC WC Docket No. 17-84, in the Matter of Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment., September 2021.

[9] See Michelle Connelly, *The Economic Impact of Section 224 Exemption of Municipal and Cooperative Poles,* July 12, 2019, submitted before the FCC Broadband Deployment Advisory Committee, GN Docket No. 17-83, Wireline Infrastructure, WC Docket No. 17-84, Wireless Infrastructure, WT Docket No. 17-79, July 22, 2019, Tables A4.

[10] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. In Appendix D of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix B of the national study for a Glossary of Technical Terms used in this study.

[11] Willingness-to-Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. In Appendix A of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix C of the national study for a Glossary of Technical Terms used here.

[12] See http://BroadbandNow.com.

[13] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A.

[14] More precisely, the BroadbandNow data base identifies unserved population to which state-specific ratios of the average number of persons to households can be applied to derive a number of locations comparable to those identified in the RDOF data base, 2.86 in the case of Texas. The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

POLE ATTACHMENT POLICIES AND BROADBAND EXPANSION IN THE STATE OF WISCONSIN

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CONNECT THE FUTURE

EXECUTIVE SUMMARY

Between 394,000 and 670,592 Wisconsinites currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from $3.82 billion up to $5.25 billion of new economic gains to Wisconsin's homes and small businesses (the amount varying based on the database of unserved locations used to quantify). This estimated economic gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in Wisconsin.

Today, broadband deployment is being inhibited due to utility pole infrastructure access issues and problematic behavior of certain utility pole owners. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In the study of economics, this is known as the ***hold up problem***,[1] an inefficient concentration of market power that harms the public interest.

When pole owners hold up the process, the result is foregone economic gains to Wisconsinites. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Wisconsin between $22.60 and $31.04 million.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures to recapture this economic value by revising and modifying state pole policies and pole owner behavior to facilitate broadband deployment.

> Pole Owner
> Hold Up
> Costs Wisconsin
> **$22.60M – $31.04M**
> ***every month***
> it delays expansion.

CURRENT BROADBAND INITIATIVES IN WISCONSIN

Depending on the basis of measurement, the total number of Wisconsinites lacking access to high-speed broadband is reported in the range of 394,000 to 670,592.[2] We estimate that expanding broadband access to this unserved population would create new economic gains between $3.82 billion and up to $5.25 billion (calculated as net present value over 25 years at 5% discount rate). With about 22% of the state's rural population reported as lacking access to quality broadband internet service, the state ranked 38 in the nation for rural connectivity.[3] The pandemic has vividly highlighted the problems associated with unequal broadband access and the heightened need for broadband services.[4] State broadband expansion grants have been in place in Wisconsin since 2013. Administered by the state Public Service Commission ("PSC"), these grants have totaled over $78 million and have funded 279 projects since the program's inception.[5] The existing PSC program received a substantial infusion from a recent $129 million appropriation by the Wisconsin legislature, including $100 million of the state's total $2.5 billion allocation of federal ARPA funding dollars.[6] PSC awards of the ARPA monies in October 2021 will fund the expansion of high-speed broadband to close to 30,000 unserved locations in the state.[7]

These state and federally funded PSC grant awards are in addition to the $374 million in broadband grant funding awarded to providers in the state through the FCC Rural Digital Opportunity Fund ("RDOF") auction program – a program that will expand broadband access to an additional 240,546 unserved homes and small businesses in the state.[8] Moreover, the state's broadband expansion funding effort also has access to $189.3 million from the ARPA Coronavirus Capital Projects Fund over and above the $100 million appropriated by the legislature from the direct payments received by the state under the ARPA program.[9] The Infrastructure Investment and Jobs Act of 2021 ("IIJA"), recently enacted by Congress on a bipartisan basis, includes an additional $42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to invest in the state's broadband infrastructure, as across the other 49 states, is unprecedented.

In addition to the PSC-administered broadband expansion grant program, under the current governor, a Taskforce on Broadband Access was created "to ensure base level broadband service to all Wisconsinites with measurable goals" [target dates to achieve broadband access based on current speed thresholds of 25/3 Mbps, 50/10Mbps, 100/50Mbps] but also "point toward the future use of broadband infrastructure by measuring access to 1 Gbps download speed."[10] In addition to increasing broadband expansion grant funding, the Task Force identified a number of tactical recommendations, including "increasing construction and permitting coordination" and "aligning, coordinating, and maximizing present and future federal funding."[11] A Blue Ribbon Commission on Rural Prosperity, was also created to address affordable, high-quality broadband given connectivity's importance as one of the "essential components of an economic development strategy."[12]

EXISTING HOLD UP POWER OF MUNICIPALITY & COOPERATIVELY OWNED ELECTRIC UTILITIES OVER WISCONSIN BROADBAND EXPANSION

Despite substantial funding mechanisms from the state and federal governments, the public's return on current broadband investment in the state remains substantially vulnerable to the leverage and market power that pole owners enjoy over broadband service providers seeking to attach broadband infrastructure to poles. This leverage has intensified in recent years due to a variety of factors: the increased urgency of policymakers to get broadband out to unserved areas of the state, the pole owners' information advantage as to where unserved customers – the target recipients of broadband grant awards and build out commitments – are located thereby raising the currency of the pole's owners' gatekeeper status, the greater number of poles needed to reach those customers in outlying, hard-to-reach rural areas of the state, and the increasing desire among pole owners to enter and compete in the broadband market against broadband attachers.[13]

The power to impede others' ongoing investment plans is classified in economics as a "***hold up problem***." A hold up problem is an example of the inefficient concentration of market power that harms the public interest and results in market failure absent adoption of public policies to prevent the exercise of the hold up power at its source.

In the case of pole attachments needed for broadband deployment, hold up power emanates from the charging of inefficiently high costs and imposing of delays on pole attachers at the upfront end of their planned broadband buildout as part of the "make-ready" process, although excessive recurring charges (rental rates for space on the pole) are not an insignificant factor. These high make-ready costs and delays are especially pronounced in connection with the change-out or replacement of existing poles. Absent effective regulation, pole owners routinely seek to push the entire cost of pole replacement onto attaching entities, including broadband providers, thereby sharply, unpredictably, and inequitably increasing the cost of attachment.

In Wisconsin, inefficient make-ready charges are compounded by the high recurring annual rental rates charged by unregulated municipality and cooperatively owned utilities. Inefficiently high recurring charges also impede broadband expansion by raising the ongoing costs of attaching to a pole. A 2019 study examining pole rates nationwide found rates charged by unregulated cooperative and municipal utilities in Wisconsin to exceed those charged by federal rate regulated IOUs in the state by approximately three times.[14] While pole rental rates charged by both cooperative and municipal utilities in

Wisconsin exceed the national average, the degree to which those rates do so is more pronounced for cooperative utilities in the state. As compared to municipal utilities, cooperative utilities in Wisconsin are totally exempted from any form of pole rate regulation.[15] Significantly, the national study found average poles rates charged by cooperative utilities in Wisconsin to be among the highest in the nation.

MEASURING THE ECONOMIC HARMS OF POLE OWNER HOLD UP POWER IN THE STATE OF WISCONSIN

Our analysis measures the economic harms to Wisconsin residents and small businesses of the hold up power of pole owners. These harms are measured in the form of foregone consumer value, known in economics as ***deadweight loss*** (DWL).[16] The methodology employed applies well established metrics on consumer ***willingness-to-pay*** (WTP) from the economic literature (in lay terms, the highest price a household would pay for improved broadband).[17] We apply these WTP metrics to reported data on the number of unserved locations awarded grant funding in the state in the FCC's RDOF auction program. Under the RDOF program alone, third-party providers have committed to expand high-quality broadband access to as many as 240,546 currently unserved homes and small businesses across the state of Wisconsin, the majority in rural areas. We've expanded our prior analysis to include the total number of unserved locations in the state identified in the FCC's most recent Broadband Deployment Report, as well as information on unserved locations from an independent data base of unserved Wisconsinites compiled by a data aggregation company, BroadbandNow.[18] Given the substantial private investment and government funding mechanisms being deployed to serve all unserved locations in the state, including the IIJA's massive commitment to broadband infrastructure, this broader analysis is appropriate. The FCC Broadband Report database of unserved population indicates a total number of 279,413 unserved locations across the state based on the average 2.41 persons per household in Wisconsin.[19]

In Tables 1 and 2 below, we present our main findings applied to the state of Wisconsin. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create $4.52 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be $3.08 billion. And connecting all unserved persons as estimated by BroadbandNow would yield $5.25 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

WI TABLE #1: ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION GAINS BROADBAND ACCESS

	All Assigned RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	$ 3.82B	$2.61B	$4.44B
300/100 Mbps at <10 Ms	$4.23B	$2.89B	$4.92B
1000/100 Mbps at <10 Ms	$4.52B	$3.08B	$5.25B

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate. See Appendix D of the companion Federal paper for explanation of methodology and modeling assumptions.

Moving to Table 2 below, this same computation methodology demonstrates the foregone economic gains, known in economics as ***deadweight loss*** (DWL), due to delayed or denied broadband expansion under the pole owner hold up problem. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, we compute the magnitude of DWL to be in the range of $22.60 million to $31.04 million per month, at speed thresholds of 1000/100 Mbps and <10 Ms latency.

We emphasize that these Wisconsin estimates, as with our nationwide estimates, are conservative in magnitude given that the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the high speeds being deployed in current expansion plans. For these reasons, the true economic gain to Wisconsin of full broadband expansion likely exceeds the estimates shown in Table 1 above.

WI TABLE #2: ESTIMATES OF FOREGONE ECONOMIC GAINS DUE TO POLE ATTACHMENT HOLD UP

	Foregone Gains of Delayed Expansion to Currently Unserved RDOF Locations	Foregone Gains of Delayed Expansion to Currently Unserved FCC Estimated Population	Foregone Gains of Delayed Expansion to Currently Unserved BroadbandNow Estimated Population
150/25 Mbps at <10 Ms	$22.60M	$15.43M	$26.25M
300/100 Mbps at <10 Ms	$25.04M	$17.08M	$29.08M
1000/100 Mbps at <10 Ms	$26.72M	$18.24M	$31.04M

Note: Table entries are monthly aggregate foregone economic gains.

CONCLUSION: POLICY RECOMMENDATIONS TO PROMOTE FULL BROADBAND ACCESS IN WISCONSIN

Rapid broadband expansion in the state is particularly at risk given the lack of effective make-ready rules governing the nonrecurring rates, terms, and conditions of third-party access to utility poles. The lack of an effective regulatory framework applicable to utility make-ready practices in Wisconsin enables pole owners to potentially hold up broadband expansion that is in the public interest, and instead advance their narrow interests, especially under circumstances where they seek to enter into the broadband market in competition with the entities over which they enjoy the hold up power. The hold up power that unregulated cooperative and municipal pole owners can impose on broadband attachers at the front end of deployment is further compounded in the case of cooperative utilities – currently exempted from both federal and state recurring pole rate rules and regulations – which impose high annual pole rental rates on broadband providers in addition to the high up front attachment costs.

This study demonstrates that the economic stakes at risk are high. Necessary pole reforms that address municipal utilities and non-regulated cooperatively owned electric utilities to help speed broadband infrastructure deployment should include: adoption of efficient pole replacement cost allocation standards based on the net book value of the poles to be replaced (taking into account the inevitable replacement of those poles and the betterment value to the pole owner from their earlier replacement), along with other economically fair, just, and reasonable rates, terms, and conditions of access to utility poles for broadband providers, as delineated in Appendix A to the national study that accompanies this state study. While a number of such legislative and regulatory initiatives are underway across the country, the ability of pole-owning utilities to hold up broadband expansion is going largely unchecked. One of the first such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas legislature this past spring. The Texas law incorporates a number of the key elements of a model pole policy presented in the national study [and reproduced as Appendix A to this study] required to mitigate pole owner impediments to full broadband expansion.

Given the substantial demonstrated consumer gains of full broadband expansion in Wisconsin, there is a compelling public interest case for policymakers to act now to adopt these key reforms.

WISCONSIN REPORT END NOTES

[1] The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

[2] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A, https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

[3] See FCC 21-18, Appendix A.

[4] See 2021 Governor's Task Force on Broadband Access pdf.

[5] See http://jsonline.com/story/money/business/2021/05/18/Wisconsin-rural-broadband-gets-100-million-american-rescue-plan/514077001/.

[6] https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[7] See Id.

[8] See FCC (Federal Communications Commission) 2020. "FCC Launches $20 Billion Rural Digital Opportunity Fund to Expand Rural Broadband," Report and Order, FCC-20-5, February 7, 35 FCC Rcd 686 (1).

[9] https://www.fiercetelecom.com/special-report/u-s-broadband-funding-state-by-state.

[10] See 2021 Governor's Task Force on Broadband Access pdf.

[11] See Id.

[12] See "Rural Voices for Prosperity: A Report of the Blue Ribbon Commission on Rural Prosperity," provided by the Wisconsin Economic Development Corporation and the Community Strategies Group, The Aspen Institute.

[13] See, e.g., https://ruclightspeed.com/, https://www.piercepepin.coop/ppcs-receives-672-million-broadband-grant, https://ntera.net/ntera/.

[14] See Michelle Connelly, *The Economic Impact of Section 224 Exemption of Municipal and Cooperative Poles,* July 12, 2019, submitted before the FCC Broadband Deployment Advisory Committee, GN Docket No. 17-83, Wireline Infrastructure, WC Docket No. 17-84, Wireless Infrastructure, WT Docket No. 17-79, July 22, 2019, Tables A4.

[15] The statutory framework requires "reasonable" compensation, with disputes resolved by PSC where parties cannot agree. See Wis. Stat. § 196.04(1)(b)(1) & 196.04(2).

[16] Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. In Appendix D of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix B of the national study for a Glossary of Technical Terms used in this study.

[17] Willingness-to-Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. In Appendix A of the national study that accompanies this state study, we explain the economic methodology used to generate these estimates. See also Appendix C of the national study for a Glossary of Technical Terms used here.

[18] See http://BroadbandNow.com.

[19] See FCC Fourteenth Broadband Deployment Report, rel. January 19, 2021, FCC 21-18, Appendix A.