A Policymaker's Guide to Broadband Competition

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Competition is a crucial component of broadband policy in that it pressures providers to be efficient and innovative. Whether any given market has adequate competition is a key underpinning question for the regulatory structure of broadband networks. However, broadband competition is not always analyzed directly. How much competition is enough, and is more always better? Many seem to believe the United States needs more broadband competition. Some even see competition as a universal elixir, fixing any and all broadband woes, real or imagined—simply add more competitors and broadband service will improve. For them, any additional—and even excess—costs are borne by providers (especially their shareholders), and all benefits are reaped by consumers.

In fact, the issue is not so simple. If you were to chart the number of competitors in the broadband industry against the outputs society cares about—fast speeds, efficient use of resources, and continuous innovation, for example—it would have the shape of an inverted "U." Too little competition drives up prices and restricts investment. Too much competition drives up cost and wastes resources. And these costs are borne by all parties, broadband providers and consumers alike.

The task for policymakers is not to be swayed by advocates who see more broadband competition as the key to all broadband challenges, whether they be prices, coverage, or net neutrality, and who look to government to spur more entrants, including government providers. Instead, policy should be pragmatic and recognize the unique economics of broadband: high fixed costs, spillover effects, and modularity, along with rapid technological change. The policy goal cannot be to simply maximize the number of

competitors in a market; rather, policymakers should recognize each specific geographic area's cost structure and existing infrastructure and work incrementally to produce superior outcomes for users. In addition, policymakers should not force square pegs into round holes by relentlessly pushing for ever-more wired broadband providers into particular places. They should, however, enable the emergence of new technology competitors, including both low-earth orbit (LEO) satellite and 5G broadband.

This report offers policymakers a framework for thinking about broadband competition. This framework recognizes the economic realities of different geographic markets with varying cost structures, while always seeking the competitive balance that maximizes output for society. The first section offers general guidance on how to think about competition in high fixed-cost industries that see innovative dynamism. The report then explores differences between facilities-based competition, such as that in the United States, and retail competition, which is more common in European countries. It explores the relative strengths and weaknesses of these two models, and what these lessons mean for contemporary broadband policy issues in the United States, such as the role of municipal broadband and policies designed to accelerate broadband and wireless deployment.

HOW TO THINK ABOUT COMPETITION

Thinking about broadband competition is influenced by thinking about competition generally. At the risk of oversimplification, many in the broadband competition debate hold to an "Econ 101" view of competition: Competition among numerous small firms in conditions of technological stasis drives down prices for consumers. In this view, more competition is better as consumer welfare and concentration are linearly and inversely related. More concentration, in contrast, reduces consumer welfare because consumers are deprived of the benefits robust, and even cutthroat, competition brings. Thus, the goal of policy is unambiguous: drive more competition. As former Obama FCC Chairman Tom Wheeler used to regularly state, his goal was "competition, competition, competition."[1] The great advantage of this view for policymakers and advocates is its wonderful simplicity. When in doubt, pull the competition policy lever. Facing a tough, complicated broadband policy question? No worries; just pick the answer that maximizes competition.

If only life were so simple. In fact, more sophisticated economic analysis recognizes that the optimal level of competition depends in large part on the characteristics of the industry under study. There are many industries wherein more concentration—rather than more competition—is welfare maximizing. For example, leading innovation economist William J. Baumol emphasized the extent to which competition among oligopolistic firms based on innovation, not prices, is the major driver of technological progress, comparing this oligopolistic competition to an arms race "that participants cannot easily quit."[2] Contrast the crude simplicities of Econ 101, in which competition among numerous small firms in conditions of technological stasis drives down prices for consumers with what might be called "Econ 201" or "modern industrial economics" whereby we understand that, at least in many industries, competition among a small number of large firms drives technological innovation and economic growth.

For more than a century, a rich body of academic economic and historical scholarship has treated oligopolistic competition among large firms in imperfectly competitive markets as the norm in modern industrial economies. And yet this scholarship is all but unknown to policymakers and the educated public. The fault lies largely with the mathematical turn taken by neoclassical economics departments in the second half of the twentieth century. In 1939, John Hicks, one of the founders of modern mathematical economics, observed that it was difficult, if not impossible, to produce elegant mathematical models of oligopolistic markets:

> If we assume that the typical firm (at least in industries where the economies of large scale are important) has some influence over the price at which it sells… [it] is therefore to some extent a monopolist…. Yet it has to be recognized that a general abandonment of the assumption of perfect competition, a universal adoption of the assumption of monopoly, must have very destructive consequences for economic theory.[3]

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Faced with a choice between complex reality and elegant equations that assumed competitive equilibrium, Hicks advised the academic economics profession to ignore reality in order to save the equations:

> It is, I believe, only possible to save anything from this wreck—and it must be remembered that the threatened wreckage is the greater part of general equilibrium theory—if we can assume that the markets confronting most of the firms with which we shall be dealing do not differ very greatly from perfectly competitive markets…. We must be aware, however, that we are taking a dangerous step, and probably limiting to a serious extent the problems with which our subsequent analysis will be fitted to deal.[4]

The academic economics discipline has largely taken Hicks's advice. John Kenneth Galbraith compared the emphasis of academic neoclassical economics on small firms in competitive markets to a "description of the United States which, by assuming away New York, Chicago, Los Angeles and all other communities larger than Cedar Rapids, was then able to describe the country as essentially a small-town, front-porch community. Only an assumption very important to economics, as it is conventionally taught, would justify such a questionable defense."[5] Galbraith noted the mystical American belief in competitive markets: "For competition, with us, is more than a technical concept. It is also a symbol of all that is good. We wouldn't survive under a regime of competition of classical purity—with an economy rigorously so characterized we should have succumbed not to Hitler but to Wilhelm II—but we must still worship at its throne."[6]

But as "Econ 202" teaches, not all industries and markets are that simple. Indeed, as the Obama Council of Economic Advisors explained, "Allowing firms to exercise the market power they have acquired legitimately can maintain incentives for research and development, new product introduction, productivity gains, and entry into new markets, all of which promote long term economic growth."[7]

There are several factors that lead the optimal industry structure to diverge from the atomistic competition ideal epitomized by industries such as barbershops and dry cleaners. One important factor is scale economies. In some industries, firms are big because of economies of scale. The Obama Council of Economic Advisors' issue brief, "Benefits of

Competition and Indicators of Market Power," acknowledges scale efficiencies as one reason for a possible increase in concentration.[8] If marginal costs go down the larger a firm gets, it becomes efficient for the firm to grow in size—and that efficiency expands economic welfare. Imagine a world in which most automobile firms employed only 1,000 workers: Cars would cost considerably more and be considerably less technologically advanced, even though markets would be more competitive. Like the automotive industry, the broadband industry exhibits scale economies such that broadband providers that are too small are less cost efficient than larger providers (and often remain in business because of government subsidies).[9]

A second factor relates to the relationship between fixed costs and marginal costs. In many industries, much of the cost structures are related to marginal factors: costs that can be easily cut in order to cut production costs. For example, industries such as consulting have relatively high marginal costs. If a consulting firm faces a loss of sales, it can easily cut costs by laying off consultants. However, many other industries have relatively high fixed costs, such as research and development (R&D) invested to develop a new product (e.g., software, pharmaceuticals, aerospace), or fixed capital expenses, such as rail and aviation companies, utilities (e.g., electricity, gas, water), and broadband providers. The latter kinds of industries have already sunk significant amounts of capital into their production systems, from which they cannot easily cut costs when demand declines. As such, because the fixed cost to marginal cost ratio is high, competitive dynamics are often intense, even in industries with few competitors.

There is one final important characteristic of the broadband industry and infrastructure industries generally, and that relates to the high fixed costs of serving customers and the risk of infrastructure duplication. With infrastructure industries, multiple infrastructures serving the same customers can be duplicative and wasteful. This means additional competitors necessarily see redundant infrastructure that serves a smaller market share. This means fewer customers (and less revenues) to support both the already-high fixed costs and upgrades to network infrastructure. Market fragmentation is especially problematic when thinking about longer-term policy goals—not just the investment in infrastructure, but also R&D, introduction of new products and services, and offering such innovations at scale. In many cases, higher levels of concentration can better deliver long-term benefits that require large up-front expenditures, such as R&D or fixed capital investment.[10]

Some infrastructure industries such as water, electricity, gas (as well as last-mile mail delivery and garbage collection) are natural monopolies.[11] In other words, societal costs are minimized by having just one provider for each household. However, that natural monopoly comes with downsides. Because they are monopolies, there is generally a need for price regulation, which runs a high risk of limiting investment and innovation. Regulated monopolies are less problematic in industries that are characterized by technological stasis. For example, most houses in the United States have the same water and sewer pipes as when they were built. Even where innovation is possible, such as smart electricity meters or automated garbage pickup, adoption is often excruciating slow due to both industry reluctance to innovate (why invest in innovation when you have a monopoly?) and regulatory inertia (state public utility commissions are often loathe to allow rate increases to pay for innovation). In contrast, broadband networks are upgraded

regularly, with a typical 20-year-old home having gone through multiple iterations of upgrades—with no end in sight. This gets to the problem with regulated monopoly industries: Neither the industry structure nor the regulatory oversight system is conducive to innovation and modernization.

All this is to say that while clearly a market with only one provider is suboptimal, resulting in higher prices or reduced output, it does not follow that adding a competitor is always good. Nor, for that matter, is it always bad to eliminate a competitor.

For these reasons, a narrow focus on the number of competitors in a given broadband market is not particularly helpful. As the 2010 National Broadband Plan explained, quoting comments filed by the Department of Justice on the issue of competition, "[T]he critical question is not 'some abstract notion of whether or not broadband markets are "competitive"' but rather 'whether there are policy levers that can be used to produce superior outcomes.'"[12] Similarly, traditional measures of competition, such as the Herfindahl-Hirschman Index (HHI), are not particularly helpful in understanding the dynamics of broadband infrastructure competition. Markets with unusually high fixed costs can be quite competitive, even when they are concentrated by traditional measures. This is because firms that have already sunk significant amounts of capital into their networks cannot easily cut costs when demand declines—as, say, consulting firms can. Firms in high-fixed-cost industries such as broadband provision will fight vigorously for customers, even in markets with few competitors, because they cannot easily reduce costs when revenue is reduced.

When examining the broadband market, it is much better to focus on the actual performance outcomes rather than narrow measures such as HHI. An honest look at the data shows the U.S. broadband market is doing quite well.[13] Output continues to expand and prices continue to drop, especially in quality-adjusted terms. The performance of U.S. broadband networks is especially impressive considering the cost structure of serving America's detached single-family homes. Population density is often used as a rough measure of the cost of deploying broadband to a given area. But simple population density can be misleading because large unpopulated areas generally do not need to be connected. A better measure is so-called "urbanicity," which takes into account the density of populated areas. In this measure, the U.S. suburban sprawl is rivaled by only Canada and Australia.[14]

The ideal system for generating the best broadband benefits depends highly on the cost structure of a given area. A very dense area filled with high-rise apartment buildings can serve a large number of customers at relatively low costs compared with suburbs and exurbs filled with detached single-family homes. This is a significant reason South Korea consistently tops the charts for broadband speed: Roughly half of the country's population lives in the high-rise-dominated megacity of Seoul, allowing it to support the low cost of multiple providers offering the latest broadband technology.[15] Dense urban areas are more likely to see sufficient returns on investment to support multiple competing broadband providers. But many rural or otherwise high-cost areas justify a different policy that recognizes the economics will likely only ever justify a single terrestrial provider, with satellite- or 5G-based solutions the only alternative.

THE TWO MODELS FOR BROADBAND COMPETITION

Oversimplifying slightly, there are two high-level options for any nation's broadband competition policy: infrastructure competition or retail competition. Infrastructure competition, or facilities-based competition, sees operators that own their own infrastructure competing directly. The companies are responsible for working with local authorities to secure rights of way and access to public infrastructure, such as ducts, conduit, and utility poles, but otherwise they own and operate the facilities that run the network.

Retail competition, on the other hand, is where the entities separate from those running the broadband facilities can offer service to the end user. In this model, the infrastructure, such as the legacy copper telephone network or new fiber-optic networks, is deployed either by the government itself, or a heavily regulated monopoly. Separate firms are enabled to purchase wholesale capacity or other elements of the network from the infrastructure provider. Usually a few or several companies participate to provide competing retail services. This type of competition generally drives retail companies toward what economists call "static efficiencies," such as efficient operation, compelling advertising, effective price discrimination, and lower prices (limited by the regulated wholesale price of capacity), but comes with downsides, most notably diminished development or deployment of new technology or business models.[16]

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Breaking broadband competition into two models is painting with a broad brush, and there are of course gradations between the two. Under infrastructure competition, facilities are shared among broadband operators at some level. For example, wireless operators in the United States generally leave the construction and maintenance of cell towers to other companies, and simply rent the space for their equipment, allowing the tower infrastructure to be shared. Likewise, the conduit, ducts, and utility poles are functionally shared assets often owned by a local authority or electric utility. The decision to share the tubes laid under streets through which competing companies can pull fiber, for example, is an eminently practical one, as we wouldn't want every firm wanting to build a network to have to rip up the city streets. There is also relatively little opportunity for innovation in such infrastructure—it's a simple plastic tube.[17] Developments in 5G radio equipment necessitating a denser, more capital-intensive small-cell infrastructure deployment may see even greater voluntary infrastructure sharing. The relevant distinction is a policy one: Are providers forced to share infrastructure at any given level by mandate, or are market participants allowed to reach agreements of their own accord?

These two competition models generate very different outcomes long-term. When firms are responsible for the actual network, the competitive forces drive toward dynamism, whereby the companies compete to develop new and better products. Requiring firms to deploy their own infrastructure before offering retail sales (or at least refraining from imposing sharing) also obviously incents the actual deployment of new networks, or upgrades of existing networks. For this reason, infrastructure competition sees much higher levels of investment compared with service-based competition.[18] This is one reason the United States has seen more fiber deployment than Europe, where there is more retail competition.[19]

As a general matter, dynamic competition, espoused by economist Joseph Schumpeter, sees firms competing for a market itself. Driven by the opportunity to capture large portions of a market or effectively creating a wholly new market, firms are strongly incented to invest in developing new technologies that better serve consumers or can otherwise provide service at a lower cost. Scholars Thomas Hazlett and Dennis Weisman put it succinctly when comparing the two broadband competition models: "[N]etwork unbundling may reduce retail price-to-cost margins, thereby increasing static efficiency, while simultaneously discouraging efficient investment in the underlying telecommunications infrastructure, thereby decreasing dynamic innovation."[20] This is particularly important, as the authors explained, because "dynamic efficiencies [such as innovation] tend to dominate static efficiencies in generating consumer benefits."[21]

The U.S. Model: Infrastructure Competition

The reliance on intermodal, facilities-based competition (largely between cable and telephony broadband providers, but in the future likely to include LEO satellite and 5G providers) that characterizes the U.S. light-touch approach to broadband competition has seen expansion of networks, faster speeds, and considerably greater output at lower costs.[22] Speed isn't everything when it comes to broadband performance, but it is a decent benchmark for the relative performance of a nation's broadband sector.[23] By this measure, U.S. broadband offers the tenth-best download speeds in the world, with the United States lagging nations that have much higher urban densities, higher per capita gross domestic product (GDP), or strong intermodal competition, such as Japan, Korea, the Netherlands, and Luxembourg.[24]

U.S. broadband networks have increased speeds considerably over the past decade. This is evident by the scaling up of the speed thresholds the Federal Communications Commission (FCC) has examined when considering the progress in broadband deployment.[25] It was 2008 when the FCC first started considering speeds higher than 200 kbps, noting that at that speed "consumers can enjoy the most popular applications, including web browsing and email."[26] Today, most users have near ubiquitous access to speeds more than two orders of magnitude faster. And that speed continues to grow. For example, consider that according to FCC estimates, "the number of Americans with access to at least 250 Mbps [down]/25 Mbps [up] broadband grew in 2017 by more than 36%."[27]

Networks continue to expand geographically as well, connecting those that previously did not have a robust broadband connection. This year's FCC Broadband Progress Report finds a number of Americans lacking access to terrestrial fixed broadband meeting the FCC's benchmark of at least 25 Mbps dropped from 26.1 million Americans at the end of 2016 to 21.3 million Americans at the end of 2017.[28] Most of these recently upgraded households were located in areas that are expensive to serve, usually because of low population density. It is important to note that satellite broadband—which is available to virtually every U.S. household—has improved dramatically in the last decade, with higher speeds (over 25 Mbps) enabling video streaming and even reasonable two-way video communications.[29]

This isn't to say a laissez faire approach will see all of the United States sufficiently connected. Many rural areas remain unserved by terrestrial broadband with existing fixed

broadband. High-speed broadband in rural or otherwise high-cost areas represents a classic market failure wherein high costs preclude coverage, absent subsidies or other policies to provide communities with adequate connectivity.[30] However, as a general matter, facilities-based competition is effective at incenting more investment and supporting a more dynamic and innovative ecosystem—a fact well supported by empirical evidence.[31] Moreover, alternative technologies may in fact solve much of this problem without subsidies. As a part of their merger-related settlement with the Department of Justice, T-Mobile committed to provide low-band 5G services to 97 percent of the U.S. population within 3 years, and 99 percent in 6 years.[32] Moreover, several companies, including SpaceX and OneWeb, have committed to a system of LEOs that is designed to provide virtually 100-percent broadband coverage at reasonable speeds, latency, and cost.[33]

The dynamic, innovative, and competitive nature of facilities-based broadband was recognized in the Federal Trade Commission's 2007 *Broadband Connectivity Competition Policy*.[34] While largely focused on the then-immediate question of network neutrality regulations, the report generally advised against extensive regulation of the sector because of its dynamic characteristics and increasing levels of competition. The report noted that "while there is disagreement over the competitiveness of the broadband Internet access industry, there is evidence that it is moving in the right direction."[35] The report also advised "proceeding with caution before enacting broad, ex ante restrictions in an unsettled, dynamic environment."[36] This is undoubtedly the right approach, especially in an environment of continued technological innovation and the emergence of new broadband technologies, and is the path the United States has, by and large, taken with respect to broadband—to great success.

European Model—Network Sharing

Some countries, particularly those that lack the existing infrastructure of competing telephony and cable systems, have tried to overcome this fundamental problem by having a regulated or government-owned monopoly infrastructure provider and structurally separate retail competitor. This approach comes with significant drawbacks, such as a diminished incentive to invest in infrastructure or develop new technologies.

European regulations have historically favored a separation of retail and infrastructure components, and require infrastructure providers to offer wholesale access at regulated rates or unbundle components of their network—although the European Commission has recently taken some modest steps to relax access regulations in an attempt to spur deployment of next-generation broadband.[37]

Many researchers have concluded that this policy has had a detrimental effect on the performance of EU broadband networks across a number of metrics.[38] In the United States, where policy allows operators to capture the value of their investments, the communications industry is a leading sector in terms of investment, and has seen capital expenditures over $1.7 trillion from 1996 through 2018.[39] However in the European Union, broadband infrastructure operators have invested less than half of those in the United States on a per-household basis.[40]

This investment gap is one reason average 2016 broadband speeds were 24.8 Mbps in Central and Eastern Europe, 30.2 Mbps in Western Europe, and 36.1 Mbps in the United

States.[41] Data from 2012 also showed 82 percent of the U.S. population had access to high-speed broadband (25 Mbps) compared with only 54 percent for Europeans.[42]

In 2010, the European Commission set forth a number of broadband related targets as a part of its "Europe 2020" long-term strategy. Despite nearly €15 billion in public subsidies and reduced-cost loans, most of the goals will not be met according to a report by the European Court of Auditors.[43] For example, only Malta has reached the target to offer coverage of 30 Mbps or more to its population.[44] Across the EU, 80 percent of households had access to 30 Mbps broadband by mid-2017.[45] By comparison, 88.5 percent of the U.S. population had access to networks of 100 Mbps in 2017, despite lower population densities.[46] European policymakers continues to undervalue the power of facilities-based competition to drive investment in high-speed networks, leading some scholars to ask whether "Europe has missed the endgame [of sustainable infrastructure-based competition] of telecommunications policy."[47]

The upside to massive amounts of bandwidth is consistently overstated, and the cost savings for consumers is marginal. But the societal expenditure of resources is anything but.

Many continue to falsely claim that Europe is a broadband nirvana compared with the United States.[48] Reports by advocacy organizations over the years have focused narrowly on advertised speeds (which often lag actual speeds in the European Union, unlike in the United States).[49] Many of these studies examine offerings that are only available in a very small geographic markets, for example touting high speeds of French fiber networks that at the time only reached 3 percent of the population in densely populated Paris, or in particular nations (such as Finland or Sweden).[50] Despite these and other methodological shortcomings, consistent media coverage of these flawed reports has developed a stubborn myth that European broadband is better than that in the United States.[51]

However, the relative success of U.S. policy isn't to say these European countries were inherently wrong in their approach. Broadband competition policies should be pragmatic and take into account existing infrastructure and industry structure. Many European countries have a strong broadcast television industry, and never saw robust cable television deployment; while others mistakenly allowed incumbent telephone companies to own cable TV franchises, which limited broadband deployment. When a country or area is faced with broadband infrastructure of only a single legacy copper incumbent and has a high cost-structure to deploy competing infrastructure, the trade-offs of an open-access model may be worth it.

MUNICIPAL BROADBAND

In the United States, this debate over the optimal level and type of competition often plays out around municipal broadband, whereby a local government, usually through a municipal bond, finances the deployment of a new fiber network. The city then either provides retail service itself or opens the infrastructure up for other firms to offer service to end users. Again, in limited circumstances, where an area is unserved and unlikely to be served anytime soon, the economic spillovers of providing an adequate connection can outweigh the long-run detrimental impacts to national investment and innovation.

Some advocacy organizations have favored a strong government role to encourage and incentivize many facilities-based broadband competitors in every market, even in those already served by a cable and telco broadband provider. For them, more competitors are an unalloyed good because, for them, more competition is an unalloyed good. But not only

does this represent a waste of societal resources by building redundant networks, it also reduces revenues and hence capital investment for network upgrades. In this sense, it is important to remember that competition is not a goal, but rather a means to the kinds of ends society wants—such as increased levels of consumer welfare, productivity, and innovation.

For these reasons, municipal broadband is not a good tool to improve the overall broadband system. Sacrificing dynamic efficiencies such as technological or business model innovation is simply not worth the switch to a model such as open-access dark fiber that focuses purely on such static efficiencies as price or customer service, even if it means municipalities can leapfrog to the latest access technology. The upside to massive amounts of bandwidth (either in the form of more or much faster "pipes") is consistently overstated, and the cost savings for consumers is marginal, while the societal expenditure of resources is anything but.[52]

It would be one thing if most municipal broadband were in unserved areas. But in fact, most municipal networks, such as in Bozeman, Montana; Chattanooga, Tennessee; and Burlington, Vermont for example, are in places where there are two wireline broadband providers: a telco and a cable offering.[53] And in virtually every case, these muni providers "cherry pick" the lowest-cost, highest-return areas of a region, leaving the less-dense suburban or rural areas with even worse economics to upgrade existing networks, potentially worsening the situation in surrounding regions from what prompted the municipality to enter the business in the first place.[54] In this sense, municipal broadband can be selfish in nature, siphoning off the lowest-cost, highest-return customers in a particular municipality, while leaving the rest of the surrounding area with a relatively higher cost structure to be served by private providers. Because virtually all multi-region broadband providers supply similar—if not the same—prices to all customers of a given speed, regardless of where they are located and what the underlying cost of service is, when muni broadband cherry picks the best customers (e.g., those with lower costs of serving and often higher rates of subscription), it makes it more challenging for competitive providers to serve the rest of the nation and continue to invest in innovation. A world with only muni broadband would be a world with very little broadband to people outside city jurisdictions.

Moreover, many municipal providers offer prices similar to those of private providers, which is somewhat surprising.[55] If there truly were a lack of competition, we would expect municipal providers to have dramatically lower prices. Beyond the lack of profit motive, public networks have a much longer time horizon to recoup capital investment, generally don't face the same fees to access the right of way, are not subject to the same local regulatory requirements as private companies, and are sometimes able to cross-subsidize off of electrical utility fees.[56] What is more, virtually every municipal provider focuses first on its "anchor institutions" and denser neighborhoods, and only incrementally expands into the next lowest-cost, highest-return areas. And of course, virtually all muni providers, by definition, are focused on providing broadband within the built-up city, not the higher-cost areas outside the city. This makes the economics even more difficult for private providers that are left with the higher-cost areas outside the more densely populated cities and towns.

Municipal broadband providers charging roughly the same as private providers could be due to several factors. In the United States, municipal broadband providers tend to be relatively small compared with the major broadband service providers. The largest municipal broadband provider, Electrical Power Board (EPB) of Chattanooga, TN, services slightly over 100,000 customers with fiber optic connections.[57] By comparison, the larger private wired broadband providers have over 25 million broadband subscriptions.[58] By some counts, there are over 800 community-led broadband networks of one form or another, the vast majority of which are far, far smaller than EPB's six-figure connections.[59] These small, fragmented networks cannot buy equipment in bulk, nor scale any innovation beyond their tiny footprints. This ultimately makes for a much higher cost structure for municipal builds, as they cannot participate in economies of scale. The fact that municipal broadband offers roughly the same prices as private providers indicates there is not a lack of competition in the market. This is consistent with economic analysis that shows intra-platform competition to be a more significant driver of prices charged to consumers than open-access models.[60]

Multiple competing providers may give consumers additional options, but come with significant trade-offs. If these options come from facilities-based providers, the high cost of redundant infrastructure drives up overall costs that ultimately must be borne by consumers. And in the case of municipal broadband overbuilds, most of the negatively affected consumers are outside the municipal jurisdiction. In other words, muni overbuilding imposes a negative externality on the overall U.S. broadband system.

If these multiple options come in the form of retail competition, it can be difficult to incent deployment of the next generation of technology—or for that matter, even develop it. Municipal networks generally see additional facilities that must be paid for but do not contribute to long-term R&D of new offerings. A compelling municipal offering might allow for a local authority to eventually pay down a bond to pay for a high-quality fiber technology, but such munis do not contribute to the development of the technology or business models of tomorrow. As the Congressional Research Service put it in enumerating the arguments against municipal broadband:

> The broadband market is subject to rapid technological change and intense competition. The bureaucracy of government is not well suited to making policy decisions in a dynamic and rapidly changing environment. This poses the risk of municipal broadband networks being reliant on soon-to-be obsolete technologies.[61]

Those who tout municipal broadband are not concerned with the long-term drag on development of new technology. They claim fiber optics— generally the technology of choice for new fixed terrestrial networks—is superior to all other forms of transmitting information and is "futureproof."[62] No doubt, fiber is a robust technology: It offers the fastest throughput, allowing for fast download and upload speeds, with relatively low operating and upgrade costs. But this fiber fanaticism is misplaced. Cable, DSL, and other recently developed access technologies have their own evolving upgrade paths, and offer robust performance for a lower total cost.

The private-sector broadband industry is more competitive than ever, and it is clear access networks are poised to change more in the next ten years than they did in the last ten. A

slew of new technologies are set to advance the capabilities of Internet Protocol networks generally. The dissemination of wide-area software-defined networking, which gives operators greater control over networks through software rather than purpose-built hardware, allows for lower-cost, more flexible, and programmable networking. These dynamics, combined with artificial intelligence and low-latency, high-throughput 5G access networks and LEO satellite broadband, will likely increase broadband competition even more.

Cable providers see the competitive threat from new broadband systems and are, in turn, continuously innovating. In addition to investing in order to push fiber deeper into the network and providing up to 10 Gbps symmetric capacity, the cable industry is examining leveraging its DOCSIS network for mobile backhaul, and developing low-latency and Internet of Things solutions.[63] Telco firms such as AT&T and Verizon, in addition to the advances in their wireless networks, continue to expand fiber and offer more robust wired connections.

Policymakers should work to enable robust competition but avoid actively promoting the addition of new competitors.

The architecture of access networks continues to evolve to better serve end users as well. In many ways the latest developments in broadband technology are aimed at reducing the latency or responsiveness of the network, rather than simply adding more download capacity. This requires intelligent caching throughout the network, and compute and storage resources at the edge of the network. These efforts are anticipated to enable next-generation, real-time applications that require very low delay in order to provide immediate haptic feedback to users. While fiber is certainly one important component of getting us to that future, a municipal fiber "dumb pipe" will not.

Enable, but Don't Promote

Considering the benefits that flow from the right amount of competition, public policy should generally work to clear barriers that could add undue cost to deploying facilities, thus improving the economic conditions for a potential new entrant. This general effort of eliminating undue limitations on communications infrastructure deployment has long been a hallmark of competition policy in the United States.[64] The work to lower unnecessarily or outmoded barriers to entry is especially important with the emergence of 5G (and LEOs) as a viable competition for wired broadband.

However, there are diminishing returns to more competitors, and, after a certain number for a given market, adding more competitors would do more harm than good. Each additional facilities-based provider adds significant sunk costs to the overall system that either mean higher prices or lower revenues, ultimately reducing the capacity to develop and deploy new technology.

Put simply, policymakers should work to enable robust competition, but avoid actively promoting the addition of new competitors. For rural and otherwise high-cost areas, the spillover benefits of having broadband can justify direct subsidies of a provider that is regulated to offer rates reasonably comparable to urban offerings. But, for places where there is already broadband, subsidizing a competitor (either private or municipally owned) to existing networks is not justifiable from a national interest perspective.

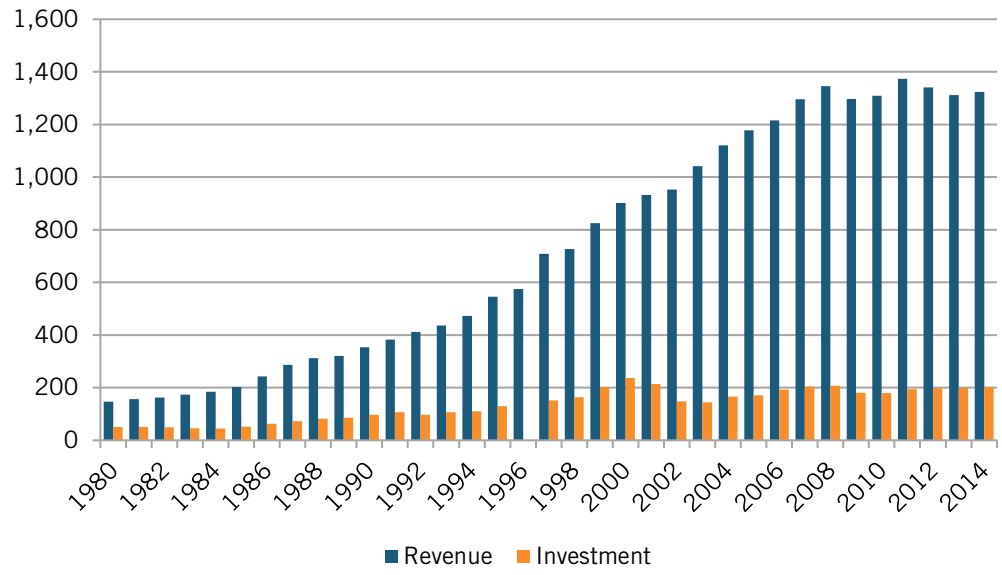
To improve the conditions for competition, policy can either work to lower the cost of deployment or improve the revenue opportunities. The first bucket of policy tools includes classic efforts to streamline the permitting process and ease access to rights of way, for example.

The second category of policy tools—increasing revenue opportunities for providers—also improves the conditions for investment. Broadband providers offer service where the return on investment justifies the capital expense and ongoing operating expenses. And they make investments when existing and projected revenues support them. Any improvements to the average revenue per user will likely see additional investment. We see this quite clearly in the correlation between telecommunications investment and revenue. Organization for Economic Cooperation and Development (OECD) data shows a strong positive correlation (r=0.92) in the relationship between revenue and investment.[65] When looking at revenue and investment one and two years later, the correlation is also strong (0.89 and 0.87 respectively). The data indicates that as telecommunications revenues go up, so does investment. While this often comes in the form of investment from existing providers, after a certain point, the incentives are strong enough to see entry by new competitors, as long as there are no other overwhelming barriers to entry. Therefore, policies to limit broadband taxes and avoid government-funded overbuilding will lead to more investment.

Table 1: Investment and revenue correlation[66]

Correlation Without Lag	Investment Lags Revenue	Investment Lags Revenue
	1 year	2 years
0.92	0.89	0.87

Figure 1: OECD trends in telecom revenue and investment in billion USD[67]



One of the most salient touchpoints around policies designed to enable more robust broadband competition in recent years has centered on streamlining the permitting processes and lowering the fees for deploying wireless infrastructure on a local level. The wireless industry is in the process of shifting to an architecture that sees many more, smaller, lower-power radios distributed throughout their service footprint. These so-called "small cells" allow for much greater spectrum reuse and can dramatically increase the overall available capacity for a system, whether used by 5G or 4G technology.

These small cells are being deployed in a regulatory environment that was designed for 100-plus-foot-tall cell towers that cover up to a one-mile radius with cell coverage. Numerous regulatory processes that were workable or made sense when cell towers were large and relatively few become unworkable when the number of "towers" to be deployed goes up by one or two orders of magnitude. There is evidence that some cities took advantage of the opportunity to take advantage of the fees they could charge for access to poles and rights of way.[68]

To help ameliorate this challenge, the FCC tightened the shot clocks—the time by which localities must respond to permitting requests—and set a cap on what they considered reasonable fees.[69] This is generally good policy to enable deployment of 5G infrastructure that may well compete directly with home broadband offerings, in addition to providing robust mobile wireless. Some in the debate have claimed that the FCC functionally lowering the costs of deploying broadband without actually requiring any additional investment. But again, these investment decisions are made on the margin, and lowering the costs of deployment will likely expand the area of deployment or the capital intensity of a given area's build. Even if you think of these cost reductions as functionally providing revenue to operators, again, we see in the data that increases in revenue generally lead to increases in investment.

INTERMODAL AND CROSS-PLATFORM COMPETITION

An initial question of any competition analysis is that of market definition. Some commentators analyze broadband markets narrowly, looking only at the choices available to consumers for fixed, terrestrial (non-satellite) broadband to the home. Others take a broader view, examining how broadband Internet access firms compete with other players in the market. So far, this paper has largely focused on the narrower market for fixed, terrestrial services, or wired broadband to the home. However, this is not a full picture of the market.

Perhaps the most important dynamic is the increasing convergence of fixed and mobile networks. Wireless is increasingly directly competing with wired connections for home broadband. The Pew Research Center has for years tracked smartphone dependency, noting "a growing share of Americans now use smartphones as their primary means of online access at home."[70] As of early 2018, about 20 percent of American adults rely on mobile broadband and do not have a traditional wired broadband service at home.[71]

This convergence of fixed and wireless is poised to accelerate with one of the initial 5G applications being fixed wireless to the home. Some new companies, such as Starry, are

focused on this technology. And some incumbent broadband providers, such as Verizon, are deploying fixed 5G networks outside their wired broadband footprint, adding another competitor in these new locations. Both T-Mobile and Dish have committed to impressive build-outs of 5G as a part of merger commitments.[72]

In addition, some new broadband providers are hoping LEO satellites may be the answer to low-latency, high-performance connectivity with a lower cost structure. Numerous large companies, such as Facebook, Amazon, SpaceX, and OneWeb, are investing heavily in space-based broadband.[73] These services promise to provide high speeds and low latency compared to prior satellite-based offerings. For example, OneWeb predicts it will offer service with 500 Mbps and 30 milliseconds of latency by 2021.[74]

There are important competitive dynamics not just between different infrastructure operators, but between operators and other parts of the overall information technology system. Some economists argue that broadband shares many characteristics with other high-tech markets in that it is difficult to justify any difference in policy treatment. AEI scholar and ITIF board member Jeffrey A. Eisenach, for example, has argued that broadband, like other information technology markets, "is characterized by rapid innovation, high sunk costs, and declining average costs" and "functions as a complementary component in modular platforms" while being subject to network effects.[75]

There is no doubt the dynamism, modularity, and network effects of broadband networks are driving increasing convergence between different layers of the Internet, producing new fronts of competition and more vertical relationships. Likely the most discussed dynamic in cross-platform competition is between new over-the-top services that compete with incumbent systems that traditionally required dedicated facilities. Over-the-top Internet-based communications services and video streaming have eaten into the traditional services of incumbent providers. This is healthy competition, and leads incumbents to either differentiate their video product offerings to better serve consumers or shift business focus to enhancing general-purpose broadband offerings. This competition ultimately makes the new entrants, incumbent networks, and end users better off through value creation. Broadband providers likely have sufficient incentives to maintain open opportunities for over-the-top providers to distribute their content, as it makes their broadband product more valuable.[76]

There are more interesting and obscure ways in which dynamic competition sees complex interactions between networks and other Internet players. One good example is the advances around mobile edge or multi-access edge computing. 5G networks are designed to leverage breakthroughs in software-defined networking and network functions virtualization to, among other things, provide compute and storage functionalities much closer to the end user. This allows for radically reduced latency, and could potentially see some of the functionalities of the cloud in one direction, or the end-user device in the other, migrate into the "edge" of the 5G network. Some see mobile edge computing as a potentially high-value distributed cloud or as functionally replacing a local operating system for some devices. Others are more skeptical.[77] This is one example of dynamic competition across traditional platforms that makes broadband ill-suited to proscriptive regulation, and better overseen by a flexible ex post enforcement.

NET NEUTRALITY AND COMPETITION

Many of the fiercest broadband policy debates revolve around competition. Net neutrality regulations are often invoked as a cure for the ails of insufficient competition. Advocates for net neutrality regulations complain that consumers lack options for particularly high-speed broadband. They are correct in that the economics of infrastructure-based competition are unlikely to see a plethora of options for high-speed broadband, which indeed challenges the ability of market forces to determine the ideal level of active network management. But where they go wrong is in pushing for maximalist net neutrality rules that rely on expansive common-carrier regulatory power under Title II of the Communications Act.[78]

Those on the other side of the net neutrality debate put competition as the fulcrum around which broadband regulation turns as well. But unlike Title II advocates, they either see existing competition as adequate to obviate the need for neutrality regulations, or look to induce additional competition in lieu of open Internet rules. Either way, this camp sees no need for net neutrality regulations.

For example, consider the FCC's decision to completely remove both the Obama-era net neutrality rules grounded in Title II, as well as ceding other potential grounds for authority over broadband. Ajit Pai, in discussing the decision to leave broadband oversight to the generalist FTC, explained his thinking, "In those marketplaces where there's not as much competition as we'd like to see, the solution isn't to preemptively regulate as if it were a monopoly [using Title II], … but to promote more competition."[79] Again, competition is held up as the elixir to fix whatever problems there might be in the market.

The answer is in getting right-sized net neutrality regulations that recognize the contemporary dynamics of broadband—that neither go overboard with restrictive regulations nor abdicate oversight with the hope that competition will guide a market that for good economic reason will remain relatively concentrated, at least in the short to medium term. Light-touch net neutrality regulation can provide protections to ensure a flourishing, open Internet without imposing the costs of either utility regulation or forcing additional competitors into markets.

Ben Thompson, a strategic advisor to technology companies, wrote a controversial 2017 blog post describing the interaction of broadband competition and network neutrality. He explained that "these trade-offs are brutally difficult… what is not at all helpful, though, is framing these trade-offs as moral choices."[80] Different policy choices inherently have trade-offs, but many seem to think adding more and more competitors to a broadband market is an unmitigated good, or that a broadband can be regulated as a utility without any downside. These trade-offs are not always easy choices in every market, but the evidence is quite clear that the infrastructure-based competition enjoyed by nations such as the United States, Japan, the Netherlands, and South Korea, for example, works quite well at driving consumer benefit and long-term innovation.

Empowering an expert agency such as the FCC with the ability to step in whenever anticompetitive behavior develops avoids the drag on investment and innovation that

comes with common carrier-based regulation and gets us the best of both worlds: Efficient provision of broadband that continues to evolve and support new services, with strong incentives to invest and innovate, as well as protections in place that ensure consumers the ability to explore the Internet, and small web companies the confidence to scale new offerings.[81]

CONCLUSION

As Congress, the FCC, and states consider broadband policies over the next few years, the issue of competition is sure to play a central role in their deliberations. This paper has argued: 1) competition is not an end in itself but rather a means by which the economic system produces the benefits citizens desire; 2) increased broadband competition is by no means a panacea for solving perceived or real limitations in a nation's broadband infrastructure, and in many cases government mandated competition does more harm than good; and 3) the emerging broadband innovation wave, especially 5G and LEOs, will in a market-based way bring more competition. As a result, policymakers should balance the desire for more competition to enhance consumer welfare in the broadband access with the need for the most efficient broadband industry structure. That means enabling, not promoting, more broadband competition, and allowing technological innovation to continue to bring ever-more benefits.

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