Investment in Business Broadband in Rural Areas

The impacts of price regulation and the FCC's blind spot

James E. Prieger

Professor of Economics and Public Policy
Pepperdine University School of Public Policy
Malibu, California

August 9, 2016

About the author

JAMES E. PRIEGER is Professor of Economics and Public Policy at the Pepperdine University School of Public Policy, where he teaches classes in microeconomics, science and innovation policy, regulation and antitrust economics, and econometrics. Dr. Prieger spent a year as Senior Economist with the Federal Communications Commission during 2008-2009, advising on broadband and telecom merger policy. He has published many articles for scholarly journals and books concerning broadband Internet access and the digital divide, as well as on other topics in industrial organization, regulatory economics, and econometrics. He has consulted for major telecommunications and other companies on regulatory issues, and sits on the editorial boards of the academic journals *Applied Economics Quarterly* and the *International Journal of Business Environment*. He is a senior researcher at BOTEC Analysis Corporation (although BOTEC was not involved with this project). He received his BA (Magna Cum Laude) in Economics and Mathematics from Yale University and his PhD in Economics from the University of California, Berkeley. He was previously an Assistant Professor at the University of California, Davis and a Visiting Professor at the University of California, Berkeley. The complete C.V. of Dr. Prieger is available at https://sites.google.com/a/pepperdine.edu/jprieger/home/cv.

About the report

The research culminating in this report was sponsored by Invest in Broadband for America, and the author gratefully acknowledges their financial support. All analyses and conclusions are those of the author alone.

Investment in Business Broadband in Rural Areas

The impacts of price regulation and the FCC's blind spot

Executive Summary

Business data services—also known as *business broadband* or *special access*—provide businesses with high-quality, high bandwidth data transmission. Business data services are vitally important to the economic health of businesses and other users, rural regions, and the national economy. The Federal Communications Commission (FCC), accordingly, has stated that promoting investment in business data services is one of its core goals. Despite that claimed intention, the FCC has proposed potentially drastic rate cuts to be imposed on business data services provided by certain incumbent local exchange carriers (ILECs) in areas the Commission perceives to be "noncompetitive," which are largely rural areas. The regulations have the potential to destroy a huge amount of the ILECs' return on their investments in network infrastructure. There is voluminous evidence showing that overly restrictive regulation negatively affects investment in communications infrastructure. In particular, a preponderance of the evidence shows that investment declines when incumbents are forced to sell access lines at unreasonably low prices mandated by regulation.

The FCC's proposed new price regulation of business data services will affect both currently regulated areas as well as some areas where it granted regulatory relief in the past. The proposed regulation applies directly to business data services provisioned on older, circuit-based technology, but the

*The FCC's proposed price regulation for business broadband will have a major impact on available revenue in rural markets – as much as **$1.4B** or more. The lost opportunities for revenue will lead to less broadband investment for the communities that need it most – slowing deployment and hurting economies that need help competing.*

FCC also seeks to expand its authority in next-generation Ethernet markets. The FCC justifies its proposal by reference to ILECs' supposed cost advantages from economies of scale, even though the rural areas at issue are expensive to serve precisely because providers do not enjoy great economies of scale when demand is low and customer locations are sparse. The tighter price regulation the FCC proposes could lead to large, inappropriate reductions in revenue earned as returns to ILECs' investment in infrastructure in rural areas. Approximate yet reasonable calculations yield an estimated **$1.4B** of revenue destroyed by the new price regulation, with a range from **$0.8B** to **$2.2B** under alternative assumptions. Even half as much lost revenue would still be a huge amount with large consequences for investment. These figures do not include potential additional losses from packet-based markets such as for Ethernet.

The FCC betrays evidence in the proposed regulations of a significant blind spot regarding regulation, investment, and the proper role of price caps; apparently the FCC takes for granted that incumbents will continue to invest. The FCC adopts an inappropriate zero-sum mentality regarding business broadband providers and their consumers, despite the fact that unnecessary price regulation destroys economic welfare. The FCC also misconceives the economic rationale of price caps by focusing myopically on a textbook "competitive price" instead of recognizing that too-low prices trade limited short run gains for large long-run losses in investment and economic welfare.

As suggested by voluminous empirical evidence from closely related regulatory settings, substantially lowering the price caps will deter investment by ILECs and competitive providers. ILECs will have less incentive and capability to maintain existing levels of service and to expand the location and quality of business broadband. There are several channels through which the lower revenue will decrease investment, and the full magnitude of the impact cannot be estimated at present. However, just *one* of the channels—the cash flow effect—suggests that about **$0.5B** to **$0.75B** of ILEC investment would be lost in the first two years after the new regulation. Less obviously but no less important, lowering the price caps will also reduce the incentive for investment and entry by *competitive* providers offering packet-based business data services on next-generation networks. Lack of entry by other firms implies that the expected profits are too low to support multiple firms in the market, given the ILEC's current prices, and lowering the price caps will only exacerbate the problem. In sum, using regulation to

destroy the returns to an economic activity the FCC states it wants to encourage makes little sense. Do not tax what you want to encourage.

There will be several detrimental impacts from the forgone investment. Rural businesses will lose out on potential productivity enhancements. The forgone investment will also have direct repercussions in the regional and national economies, because every dollar not invested in communications infrastructure has a multiplied impact in the economy. Each dollar of investment discouraged by regulation costs the economy up to three dollars in lost output. Each job lost from the lack of investment costs the economy 1.4 to 3.6 jobs, half of which would have come from small business. While some proponents of regulation claim that imposing price regulation on business broadband would promote 5G wireless networks, price regulation is a step in exactly the wrong direction. Everything possible should be done to encourage investment in business broadband capacity to support the growth of next-generation mobile wireless networks.

The FCC is rushing to push through new regulation without giving adequate time to study the likely effects. The FCC should pause long enough to consider the consequences of the proposed regulation, allow industry and other interested parties sufficient time to investigate newly updated data and associated repercussions, and make a wise choice.

1. Introduction

Modern businesses are heavy users of broadband lines provided by traditional telecommunications companies, cable broadband providers, and other competitive providers. Firms use these *business data services*—also known as *business broadband* or *special access*—to meet their needs for high-quality, high bandwidth data transmission to enable applications such as voice communication, Internet, private network, cloud connection, and other services.[1] For example, banks use business data services to complete financial transactions quickly and securely, while retail establishments may use business broadband to expedite the processing of credit card transactions, whether in rural or urban areas.

Business data services are provided by traditional phone companies, known in the industry as incumbent local exchange carriers (ILECs), competing local exchange carriers, cable system operators, other wireline and wireless service providers, and other companies who have deployed network infrastructure.[2] In 2013, business data service was a $45 billion market.[3] ILECs have nearly ubiquitous coverage of business locations in the nation[4] and cable operators also cover most business locations.[5] The networks of competing local exchange carriers also cover the majority of buildings demanding business broadband.[6] The two main forms of business data services are circuit-based and packet-based service. Circuit-based business data services generally are provisioned on traditional copper telephone lines, most often taking the form of DS1 and DS3 lines.[7] Packet-based business data services such as Ethernet do not rely on the traditional telephone network, typically being deployed on high-speed fiber lines.

Despite the importance of ILECs in the business broadband market, in urban markets they have faced significant competitive challenges in recent years from other providers of business data services. Packet-based business broadband, which makes up about two-fifths of the market for business data services,[8] is offered by many competitors. Growing competition to provide business data services has caused demand and revenue for at least some of the ILECs' business broadband segment to decline.[9]

Business broadband providers in rural areas—most often ILECs—face different challenges. Due to the economies of scale inherent in network infrastructure for broadband, areas with a less-dense customer base and lower overall demand are more expensive to serve on average.[10] Furthermore, network deployment and maintenance costs are generally higher in rural areas. Compared to urban areas, the possibilities for recouping investment in rural areas are relatively unattractive.

Broadband service and business data services are highly important for rural businesses and local economies, because broadband is a *general-purpose technology*.[11] A general-purpose technology is pervasive, has high potential for technical improvements, is greatly useful to businesses, and can be employed to increase productivity.[12] A general-purpose technology such as broadband spreads throughout all aspects of the economy and creates productivity gains in many industries. For example, broadband allows manufacturers to lower cost through better supply-chain management, rural businesses to expand markets through e-commerce, and the rural populace to enjoy access to higher quality healthcare and better health through telemedicine. Broadband in general and business data services in specific are thus im-

portant to the economic health of direct users, the whole region, and the national economy,[13] and have been shown to be particularly important for rural businesses and areas.[14]

Thus, it is highly important to have properly structured regulation, and only where needed, in order to stimulate the growth of infrastructure that enables business broadband. Investment depends crucially on its expected returns—even the Federal Communications Commission (FCC) recognizes this[15]—and regulators cannot take continued investment in telecommunications infrastructure for granted. When regulators fixate myopically on static efficiency, low prices that cover only short-run costs, or redistributing the gains from economic transactions among parties they can prevent the large improvements in dynamic efficiency that would arise from continuing investment. Regulatory policy that lowers revenue earned from infrastructure prevents some investment projects from ever attaining profitability, and firms will forgo such projects.

Yet, the ILECs that provide business data services now face a new challenge. The FCC has proposed potentially drastic rate cuts to be imposed on circuit-based business data services provided by price-cap ILECs in areas the Commission perceives to be "noncompetitive." The FCC also seems to contemplate substantial reductions in ILEC packet-based rates in these markets as well. Most of these markets will be outside urban areas. I thus refer to these as rural markets below, although many areas of suburbs and cities outside of the urban core business districts may also end up classified as noncompetitive. In some cases the strict price regulations will ratchet downward existing price caps, while in other areas market prices currently determined by free negotiation between customers and providers will come under new price ceilings. The regulations include not only an immediate mandated price cut but further yearly downward adjustments to the price caps.[16] While the details of the history of regulation in the industry, this particular market, and the proposed regulations are complex, the outcome is simple: the regulations have the potential to destroy a huge amount of the ILECs' return on their investments in network infrastructure. Given the FCC's rush to regulate and the limited public access to the necessary data, the scale of economic impacts can only be roughly estimated here. Nevertheless, the resulting economic costs of such heavy-handed regulation are real.

There is voluminous evidence showing that overly restrictive regulation negatively affects investment in communications infrastructure.[17] In particular, economic theory shows that when regulators attempt to push regulated price caps too low, firms are forced to reduce investment.[18] Empirical evidence also shows that telecommunications regulatory regimes in the United States that allowed providers more leeway in setting their prices induced investment that lowered operating costs.[19] Since other communications providers purchase most of the business broadband lines provided by ILECs,[20] evidence on artificially low prices on sales to competitors is also germane. The overwhelming preponderance of the evidence shows that investment declines when incumbents are forced to sell access lines to competitors at prices mandated by regulation, whether the investment of the incumbent,[21] the competitor,[22] both,[23] or the aggregate for the industry[24] is studied.

In the next section the scale of the implications of the proposed price regulation for ILECs' revenue is analyzed. Section 3 points out the FCC's apparent blind spot toward the adverse effects that

regulation can have on investment in the market for business data services. The particular negative consequences for the rural areas most affected by the proposed regulation—less investment by ILECs and their competitors—is discussed in section 4. The final section points out how lower investment has a multiplied negative impact on the economy.

2. New regulation could entail a large reduction in ILECs' return on investment in rural areas

The tighter price regulation the FCC proposes could lead to large, inappropriate reductions in revenue earned as returns to ILEC's investment in infrastructure in rural areas. In sections 4 and 5 I show that these impacts on ILECs will have severe negative consequences for rural markets; in this section the magnitude of the FCC's proposed regulatory takings from the ILECs is estimated. The FCC has not yet determined how much it will lower the existing price caps that ILECs face in certain areas. From the analysis and indications in the proposed regulations,[25] it appears that the caps may be lowered immediately by as much as one-fifth or more. The FCC presents a range of estimates for how much it believes the price caps should be tightened. Based on the data, method, and time period the FCC's staff analyzed in the main text of the proposed regulations, these one-time adjustments range from nil to a 21.9% decrease.[26] In an appendix to the proposed regulation, there is a broader set of estimates that ranges up to a 32.0% decrease in the price cap.[27] The FCC also proposes that this immediate reduction in the revenue stream of ILECs offering circuit-based business data services be followed by further annual ratcheting downward of the caps.[28]

The FCC's calculations underlying both the proposed immediate reductions and the ongoing annual reductions are complex, but the main idea driving both is that the telecommunications industry enjoys greater productivity gains than the economy in general. If so, then the costs to provide telecommunications services are falling in a manner not captured by the inflation rate used in the computation of the price caps; therefore, the reasoning goes that the caps should be adjusted downward to pass along some of the cost savings to buyers. As usual when regulation departs from the simplicity of prices determined by freely functioning markets, however, the devil is in the details—and there are a lot of details. In the FCC's calculations, the staff use data from the entire telecommunications industry to estimate declines in cost as if they were representative of the provision of circuit-based business data services in the rural regions in which most price capped areas lie. There are several problems with the calculations. The assumed productivity enhancements for the industry are computed from improperly broad data.[29] Furthermore, the FCC refers to economies of scale with respect to providing business data services to argue that "per unit costs likely have decreased significantly" since the caps were last adjusted for productivity.[30] However, even if the staff calculations for the cost reductions were correct for the industry as a whole, they overstate productivity enhancements in price cap areas, which are expensive to serve precisely because providers do *not* enjoy great economies of scale since demand is low and sparsely situated. It would be improper to assume that cost conditions, or how those conditions change, for provision of business broadband in rural areas are the same as in urban areas or as on average. Finally, the greatest productivity enhancements in the provision of business data services come from the ongoing transition to packet-

based service, and yet the price caps are for the legacy circuit-based service. By analogy, just because an Internet-based home alarm system is cheaper than a traditional system monitored over a telephone line, it is no cheaper to provide or maintain the older-style system.

How much revenue would be potentially affected by stricter price regulation? Any claim to an accurate forecast is impossible at this point, given that much of the relevant data are confidential and the regulation has not been finalized. However, the rough calculations presented here illustrate the potential magnitude of the impacts.

Given the partial deregulation of the market for business data services, ILECs provide service in some areas under price caps only, in other areas under negotiated contracts while price capped tariffs remain available (Phase I areas), and in a third set of areas with no price caps at all (Phase II areas). Phase I and II areas are referred to as having "price flexibility." In 2015, revenue from circuit-based business data services[31] provided under price caps by ILECs totaled $4.2B.[32] However, for reasons discussed below a better base for the following calculations would include all circuit-based business data services revenue from price-cap ILECs, whether provided in price cap or price flexibility areas. Revenue specifically for circuit-based business data services is not publicly available from the companies, but the FCC reports that circuit-based business data services revenue from ILECs totaled $16.1B in 2013.[33]

How much that revenue would drop under a stricter price cap regime depends on three factors: which areas would be deemed "noncompetitive" under the yet-to-be-determined competitive market test, what the mandated reductions in the price caps would be, and how revenue responds to the price reductions. These factors are now discussed in turn. It is yet unknown which areas would fall under the stricter price caps. The FCC proposes to apply the new competitive market test to all markets served by price-cap ILECs.[34] It further suggests that the new, stricter price regulation will be imposed on ILECs in all areas failing the test, regardless of whether the area currently has price flexibility.[35] Since the triggers and the market geography chosen for the competitive market test have not yet been determined, it is impossible to know how many areas will fail the test. However, in public comments the FCC Chairman gave indication that he viewed 45% of the locations of customers using business broadband as noncompetitive.[36] For the sake of the present calculations I thus assume that 45% of price-cap ILEC's DS1 and DS3 revenue would be subject to the stricter price caps. Alternatives to this assumption are explored below.

The second factor, the amount of the mandated price decreases, will apparently range up to 32.0%, as discussed above. This is for areas currently under price caps. If areas not currently under price caps are reclassified as noncompetitive, then price decreases in some such areas could be even higher as caps are newly imposed.[37] For the main calculations I assume the price decrease will be 22%.[38]

The third factor is how the ILECs' revenue from business broadband will respond to the price decreases. If demand for business data services were completely insensitive to price, then current revenues in areas deemed noncompetitive could merely by multiplied by the discount. However, when demand is sensitive to price, the amount that revenue would fall is mitigated by the increased quantity of business broadband that customers would purchase at the lower prices. The key datum to ascertaining the change in revenue

is the percentage by which the quantity demanded changes due to a one percent change in price—i.e., the price elasticity of demand—for DS1 and DS3 special access provided in noncompetitive areas. This elasticity is unknown, but based on an older study for special access in noncompetitive areas I assume the relevant demand elasticity is -0.1.[39] With that elasticity, a one percent decrease in price lowers revenue by 0.9 percent.[40]

Putting all the pieces together yields an estimated **$1.4B** of ILEC revenue vanishing from the stricter price regulation.[41] As discussed below, it is inappropriate to view this amount as merely transferring wealth from ILECs to their customers—such an outcome would destroy real value. However, this figure is only an estimate, and alternative assumptions would lead to different figures. For example, if the mandated rate reduction is 13.5% (another of the focal figures in the proposed regulation)[42] instead of 22%, the reduction in revenue is still $**0.9B**. For another example, instead of assuming that $7.2B of revenue (that is, 45% of the $16.1B in ILEC circuit-based revenue) will be hit by the new price regulation, the $4.2B in revenue earned under price-capped rates can be taken as the revenue base. This base is overly conservative in that it ignores the FCC's stated willingness to expand price regulation beyond areas that currently have price caps. Regardless, with the alternative revenue base the final change is a decline of **$0.8B** in revenue.[43] On the other hand, under the original assumptions except that the demand elasticity is -0.04 and the rate cuts are 32%—the most extreme assumptions for each—then **$2.2B** would be destroyed by the price regulation.[44]

Despite the huge amounts of revenue destroyed by the FCC pushing prices down for ILECs' circuit-based business data services in these estimates, they are conservative because they do not include likely impacts in the packet-based segment of the market for business broadband. While the proposed regulation would not apply directly to ILECs' packet-based rates, the FCC proposes to "anchor" those prices to the circuit-based, price capped rates when determining whether packet-based rates are allowable as "just and reasonable".[45] This is one (but not the only)[46] way the FCC seeks to leverage its regulation of circuit-based rates to expand its authority in packet-based markets such as for Ethernet. Finally, note that even if the calculations were off by a factor of two, even half as much lost revenue would still be a huge amount, with large consequences for investment as we discuss in section 4.

3. Regulation, investment, and the FCC's blind spot

Before discussing the mechanisms by which the proposed tighter price regulation of business broadband will lead to less investment by industry, it is important to note that the FCC betrays evidence in the proposed regulations of a significant blind spot regarding regulation, investment, and the proper role of price caps. This is particularly ironic, given that promoting investment in the marketplace for business data services is one of the FCC's self-professed "core goals"[47] and that past and future investment has been and remains crucial to the market.[48] Discussion of the potential impacts on investment from the proposed price regulation is nearly absent in the document proposing the new regulations.[49] In the few places an explicit link between regulation and investment is noted, the context is how various actions by ILECs might hypothetically deter investment by competing providers;[50] apparently the FCC takes for granted that incumbents will continue

to invest. The FCC's presumption appears to be that the march toward competition and next-generation networks will continue regardless of the whether regulation destroys a great amount of potential return on investment (although it does invite comment on whether that will happen).[51]

Instead of focusing on how investment leads to outcomes that benefit both parties, the FCC adopts an inappropriate zero-sum mentality regarding business broadband providers and their consumers. For example, the FCC claims that "incorrect" adjustments to the price cap, by which it means those it deems not stringent enough, leads to "windfalls" for providers.[52] This is incorrect. A windfall is an unexpected profit gained through circumstances beyond the control of the firm, with the usual connotation that it is therefore undeserved. Normal usage of the term typically applies to examples such as a hurricane that temporarily drastically increases the demand for gasoline or food, providing windfalls to sellers of such goods. To allow a business broadband provider to earn a return on its investment in infrastructure—a return that is already artificially low due to price caps—in contrast to wringing out yet more profit from the provider by lowering the caps further is hardly a "windfall."

In any event, artificially lowering the price of business data services does not merely transfer money from one pocket (the ILECs) to another (the wholesale and retail buyers of business broadband). The FCC tacitly adopts this view when it refers to "balancing" the interests of ratepayers and ILECs.[53] By conjuring the image of a balance scale, the FCC reveals that it considers the weights (i.e., the economic benefits in the business broadband market) as something that can be shifted from one side of the balance to the other with no change in the total. But this image is false. As T. Randolph Beard, Dr. George Ford, and Lawrence Spiwak have shown in their analyses of the market for business data services, price regulation destroys economic welfare.[54] The price regulation prevents some sales that should occur, and forces others to happen even when they are uneconomic.[55]

Thus, the zero-sum mentality is incorrect even before considering that lower revenue will prevent some investment from occurring. Considering investment only strengthens the conclusion that price regulation destroys value. When discussing the zero-sum mentality, which he terms the "but the network is already there" fallacy, Professor Robert S. Pindyck remarks that consumers "are not well served by 'protections' that eliminate productive investments, and so limit service" and that regulator-mandated underpricing produces investment disincentives without offsetting benefits for other parties.[56] In other words, not only is the image of costlessly shifting weights from one side of a balance to the other incorrect, the correct image would be to take weights off one side and throw them away. As further evidence of the FCC's blind spot, it discusses its perceived consequence of setting price caps too high but gives short shrift to what might happen if the caps are set too low.

The FCC also misconceives the economic rationale of price caps. They are not, as claimed, intended to result in "rates and output levels roughly mirror[ing] rates and output levels in a competitive market".[57] Since price caps are intended for markets that are less than fully competitive due to high costs or low demand, there is no viable competitive price—forcing the price down to marginal cost (the textbook outcome in markets that *are* fully competitive) would lead to

no provision by any firm, since investment and fixed costs could not be recovered. There would be *no market at all*, which is conceptually equivalent to an infinitely high price. Furthermore, if regulators push regulated price caps too low, firms reduce investment,[58] harming the rural markets the regulation was intended to serve. The true purpose of price caps is to avoid production inefficiencies potentially caused by rate of return regulation while providing a certain level of consumer benefits.[59]

4. Negative consequences for rural business data services

Regulators must understand that incentives for investment are paramount to the continued health of existing and expanding networks. The revenue earned from investment that will be forgone due to ratcheting down the price caps will lead to several negative consequences for business data services in rural areas. Careful analysis of the specific regulatory issue at hand has shown that "price regulation of high capacity circuits would necessarily reduce economic welfare and likely reduce investment in new broadband facilities."[60] As suggested by the empirical evidence from other regulatory settings reviewed in the introductory section, substantially lowering the price caps will deter investment by ILECs and competitive providers.

Drastically lowering the price caps will inhibit investment by ILECs, for two reasons. First, with improperly low rates for business data services, many new investments by incumbents would be unprofitable. The argument rests on simple economic analysis. Existing facilities require constant investment in infrastructure to maintain given levels of service; up to 20% of ILEC revenue is plowed back into maintaining existing facilities and capabilities.[61] Some facilities used for business broadband that are only marginally profitable at the current price capped rate—for example, those in rural areas with high costs and few customers—will become uneconomic to maintain once the caps are lowered. For new projects, providers invest in opportunities that become profitable as market conditions improve; destroying a significant part of the potential return on investment will push many potential investment projects into the red and they will not be pursued.

Second, taking away so much revenue from ILECs may also slow their transition to packet-based business data services. With artificially low prices for circuit-based business data services, customers will be less inclined to demand packet-based service. Furthermore, large amounts of investment will be required to complete the transition.[62] With lower cash flow, ILECs will not be able to reinvest as much capital into business broadband. Evidence shows that investment in capital expenditure is sensitive to cash flow even for large firms, with a dollar taken out of current year cash flow reducing investment that year by $0.14 to $0.28.[63] The negative impacts of the lost revenue do not end there; in the next year the lost dollar of revenue reduces investment an additional $0.22 to $0.27.[64] These ranges are similar to the recent experience of the major ILECs.[65] Applying these figures to the main estimate of $1.4B revenue lost due to the price regulation, the new rules would destroy $196M to $392M in investment in the first year. An additional $308M to $378M would be discouraged in the second year, for totals in the range of one-half to three-quarters of a billion dollars in investment destroyed over the two years. It is important to recognize that these cash-flow impacts are mostly *in addition* to the direct but unquantifiable disin-

centives discussed in the preceding (and following) paragraphs.[66]

It is less obvious but no less important that lowering the price caps will also reduce the incentive for investment and entry by *competitive* providers offering packet-based business data services on next-generation networks. Consider an area with no actual competition in business broadband beyond the ILEC's service. Lack of entry by other firms implies that the expected profits are too low to support multiple firms in the market, given the ILEC's current capped price. If the price caps are lowered drastically, then the expected revenue a potential entrant could hope to realize can only go down, since the incumbent's price places a check on how much an entrant could charge.[67] Thus, even though lack of entry with the current price caps indicates that competition is already unprofitable, it will become even more so after the caps are lowered. Apart from the straightforward economic theory, this likely consequence is also suggested by data showing that provision of business data services from competitive providers is lower in areas where the ILECs have less pricing freedom.[68] This result is not because competitors are nowhere near; Nearly every building using business data services served by an ILEC alone—98.7% of them—has a potential competitor that has infrastructure close enough to serve the building if it so chose.[69]

The exact magnitudes of the total impacts on investment from lowering the price caps are unknown. While the cash-flow effect can be estimated, the direct disincentives the regulation would create for investment by ILECs and competitors cannot. There are not enough data in the public record to link definitively the decline in revenue to the amount of investment that would be forgone. However, related work by Dr. Hal Singer on exactly this topic suggests the impacts can be large.[70] Dr. Singer demonstrates that a 30% decline in revenue from extending special access regulations to ILECs' fiber networks would lead to an estimated 55% decline in investment in business broadband, compared to the baseline of pricing flexibility. While these calculations are not for further tightening of existing price caps on circuit-based business data services, they nevertheless illustrate that regulatory expropriations can have large, multiplied impacts on investment.

The arguments here can be summed up with this simple dictum: do not tax what you want to encourage. Lowering price caps places a regulatory tax on business data services, at least metaphorically. Using regulation in a fragile market to destroy the returns to an economic activity the FCC states it wants to encourage makes little sense.

5. The impact of forgone investment

There will be several detrimental impacts from the forgone investment. To the extent that local businesses will not be able to maintain or expand their usage of high quality, reliable broadband, or to switch to services enabled by next-generation networks provided by competitive providers, they will miss out on the productivity enhancements that the technology would provide. When businesses are able to invest an additional 10% in information and communications technology (ICT), their labor productivity growth rises by 0.6% on average.[71] These benefits would be forgone. Broadband adoption in particular has been shown to increase firms' productivity by 7–10%.[72] Advanced broadband applications of the kind that benefit highly from business data services, such as video communication, virtual pri-

vate networks, and supply chain management, have been shown to increase productivity the most.[73] These forgone productivity enhancements for firms can aggregate to significant negative economic impacts, since the positive links between investment in ICT and broadband and economic growth are well attested.[74]

Apart from the beneficial impacts of broadband usage that firms and on which the economy will miss out, the forgone investment itself will have direct repercussions in the regional and national economies. Every dollar not invested in communications infrastructure has a multiplied impact in the economy. Investment in broadband infrastructure contributes to economic performance through direct and indirect channels. The investment boosts growth directly through the obvious impacts of the money spent on the infrastructure and the employment required to deploy and maintain it. There are also several indirect effects, because the spending on infrastructure and employment creates ripple effects in the economy. When providers of business broadband purchase additional equipment, the suppliers of the inputs increase their own demand for the inputs needed to produce their goods. However, those inputs themselves came from supporting upstream industries, and creating the inputs required additional purchases by those industries. Thus the investment expenditure by ILECs results in further rounds of new spending as the inputs used by the industries are linked to the outputs of the supplying industries. Similarly, the extra earnings in the pockets of workers involved with deploying or maintaining infrastructure stimulate consumption in the economy at large. Thus, each dollar invested in infrastructure can create about three dollars' worth of economic activity.[75] While the total impact of investment in infrastructure supporting business broadband depends on the area and the nature of the local network investment, it is clear that each dollar spent has a final impact of much more than a dollar in the economy. Similarly, each direct job created for broadband network construction or maintenance leads to total job creation of between 1.4 and 3.6 jobs.[76] Roughly half of these jobs come from small businesses.[77]

What benefits are purported to offset the clear and significant harms from the proposed price regulation? The FCC chairman recently claimed a link between imposing regulation in the business broadband market and promoting 5G wireless networks.[78] However, if business data services are such an important part of next-generation wireless networks—which they will be—then everything possible should be done to promote investment in business broadband capacity.[79] Price regulation is a step in exactly the wrong direction.

6. Conclusions

Given the huge potential impacts of the proposed price regulation of business data services—billions in lost revenue for providers, curtailed investment by incumbents and competitors, forgone economic benefits for business, workers, and rural economies—it is important to craft regulation carefully in a fully informed manner. The FCC seems bent on pursuing the opposite course. After a regulatory proceeding dragging on for years, now all of a sudden the FCC is rushing to push through new regulation without giving adequate time to study the likely effects.[80] The FCC should pause long enough to consider the consequences of the proposed regulation, allow industry and other interested parties sufficient time to investigate the repercussions, and make a wise choice.

Notes

[1] Despite the general nature of the terms *business data services* and *business broadband*, the regulation under discussion pertains to a specific type of service: dedicated point-to-point transmission of data at guaranteed speeds and service levels using high-capacity connections. The guaranteed speeds distinguish business data services from the mass market, "best-effort" broadband most familiar to consumers and small businesses.

[2] Federal Communications Commission, *Tariff Investigation Order and Further Notice of Proposed Rulemaking*, FCC 16–54, (FCC *O&FNPRM*) adopted April 28, 2016, at 42. All references herein are to the version of the *O&FNPRM* that is redacted for public viewing.

[3] FCC *O&FNPRM* at 44. This figure includes business data services provided to end users as well as wholesale provision to other communications providers.

[4] FCC *O&FNPRM* at 2.

[5] FCC *O&FNPRM* at 221.

[6] Economists Dr. Mark Israel, Prof. Daniel Rubinfeld, and Prof. Glenn Woroch (*Second supplemental declaration of Mark Israel, Daniel Rubinfeld and Glenn Woroch*, comments filed with the FCC in the matter of Special Access for Price Cap Local Exchange Carriers (WC Docket No. 05-25), April 20, 2016) show that in 2013 already, the networks of competitive local exchange carriers covered 78% of buildings with a special access connection to within 500 feet. The same networks covered 86% of such buildings to within 1000 feet and 98.7% to within a half mile. The authors chose these distances as being the range within which providers compete for customers.

[7] DS1 and DS3 lines have symmetrical transmission capacities of 1.5 Mbps and 45 Mbps, respectively.

[8] FCC *O&FNPRM* at 81.

[9] See, for example, the most recent annual filing with the SEC of the second largest ILEC provider of business data services: "Demand for our private line services (including special access) continues to decline…." (*2015 Summary Annual Report and 2016 Annual Meeting Documents*, CenturyLink, Inc., p. B-15). The filing also notes that decline in special access revenue contributed to overall declines in business segment and strategic services revenues.

[10] FCC *O&FNPRM* at 227.

[11] See J.E. Prieger, "The broadband Digital Divide and the economic benefits of mobile broadband for rural areas," *Telecommunications Policy*, vol. 37 (2013), pp. 483–502.

[12] See T.F. Bresnahan and M. Trajtenberg, "General purpose technologies: 'Engines of growth'?" *Journal of Econometrics*, vol. 65 (1995), pp. 83–108.

[13] See L. Holt and M. Jamison ("Broadband and contributions to economic growth: Lessons from the U.S. experience," *Telecommunications Policy*, vol. 33 (2009), pp. 575–581) for a review of the voluminous empirical evidence linking broadband availability and usage to economic growth.

[14] High broadband speed, of the sort provided by business data services, has been found to be "particularly important for firms in rural locations" since it substitutes for the physical proximity to other firms and customers that businesses in urban areas enjoy (E.A. Mack, "Businesses and the Need for Speed: The Impact of Broadband Speed on Business Presence," *Telematics and Informatics*, Vol. 31 (2014), p. 617).

[15] The FCC quotes a commenter, apparently in agreement, when stating that "competitive carriers can connect their networks to 'customer locations … where the revenues associated with the location are sufficient to make loop deployment profitable'" (FCC *O&FNPRM* at 227). Despite this recognition that investments require sufficient returns, the FCC does not draw the obvious conclusion that regulation threatening returns to investment threatens the investment itself, as discussed below.

[16] The formula for the annual changes in the price caps may, theoretically, result in higher nominal prices (for example in inflation was high the past year). Here I am referring to the so-called "X-factor", intended to lower prices in line with perceived productivity improvements leading to lower costs of providing business data services. The FCC proposes to use the X-factor to ratchet prices downward from what the price cap formula would otherwise dictate them to be.

[17] For reviews of the sizeable literature documenting how communications investment and innovation can be choked off by poor regulatory policy, see J.E. Prieger and D. Heil ("Is regulation a roadblock on the information highway?" in I. Lee (ed), *Handbook of Research on Telecommunications Planning and Management for Business*, IGI Global, 2008) and C. Cambini and Y. Jiang ("Broadband investment and regulation: A literature review," *Telecommunications Policy,* vol. 33 (2009), pp. 559–574).

[18] See F. Roques and N. Savva ("Investment under uncertainty with price ceilings in oligopolies," *Journal of Economic Dynamics & Control*, vol. 33 (2009), pp. 507–524,) and T. Nagel and M. Rammerstorfer ("Modeling

investment behavior under price cap regulation," *Central European Journal of Operations Research*, vol. 17 (2009), pp. 111–129), who show that a stringent price cap disincentivizes investment. The latter authors show that "a price cap set below this level [i.e., the price that triggers the optimal amount of investment] delays the investment considerably because possible higher firm values are truncated" (p. 127).

[19] C. Ai and D.E.M. Sappington ("The impact of state incentive regulation on the U.S. telecommunications industry" *Journal of Regulatory Economics*, vol. 22 (2002), pp. 133–159) compare rate-of-return regulation with (at the time) less restrictive price-cap regulation.

[20] The data in Appendix B to FCC *O&FNPRM* (see Table 13) show that in the DS1 and DS3 markets, ILECs sell 90% of lines to other telecommunications providers (of which about a quarter are mobile telecommunications providers) and an additional 3% of lines to cable operators.

[21] See, for example, R.W. Crandall and H.J. Singer ("An accurate scorecard of the Telecommunications Act of 1996: rejoinder to the Phoenix Center Study No. 7," (2003) Criterion Economics, LLC.); Ingraham and Sidak ("Mandatory unbundling, UNE-P, and the cost of equity: Does TELRIC pricing increase risk for incumbent local exchange carriers?" *Yale Journal on Regulation*, vol. 20 (2003), article 6); and L. Waverman, M. Meschi, B. Reillier, and K. Dasgupta ("Access regulation and infrastructure investment in the telecommunications sector: An empirical investigation," LECG Ltd., London, September 2007). The empirical studies cited here and elsewhere in this section consider the impact of either lower prices for mandatory inputs sold to other telecommunications firms or the impact of the mandate itself (which is another form of a price decrease, since without mandated access the effective price of the input is infinite if it is not supplied).

[22] See, for example, R.W. Crandall, A.T. Ingraham, and H.J. Singer ("Do unbundling policies discourage CLEC facilities-based investment," *Topics in Economic Analysis & Policy*, vol. 4, no. 1 (2004)); T. Hazlett and C. Bazelon ("Regulated unbundling of telecommunications networks: A stepping stone to facilities-based competition," *Proceedings of the 33rd Telecommunications Policy Research Conference*); and H. Friederiszick, M. Grajek, and L.-H. Röller ("Analyzing the relationship between regulation and investment in the telecom sector," ESMT White Paper WP-108-01, March 2008).

[23] See, for example, J. Hausman ("The effect of sunk costs in telecommunications regulation," pp. 191–204 in *The New Investment Theory of Real Options and its Implication for Telecommunications Economics,* Springer US, 1999); K. Christodoulou and K. Vlahos ("Implications of regulation for entry and investment in the local loop," *Telecommunications Policy*, vol. 25 (2001), pp. 743–757); J. Hausman and G. Sidak ("Did mandatory unbundling achieve its purpose? Empirical evidence from five countries," *Journal of Competition Law and Economics*, vol. 1 (2005), pp. 173–245); M. Grajek and L.-H. Röller ("Regulation and investment in network industries: Evidence from European telecoms," *The Journal of Law & Economics*, vol. 55 (2012), pp. 189–216); W. Zarakas, G. Woroch, L. Wood, et al. ("Structural simulation of facility sharing: unbundling policies and investment strategy in local exchange markets," The Brattle Group, Cambridge, MA, May 2005); R. Pindyck ("Mandatory unbundling and irreversible investment in telecom networks," *Review of Network Economics*, vol. 6, no. 3 (Sept. 2007), pp. 274–298).

[24] See, for example S. Wallsten ("Broadband and unbundling regulations in OECD countries," Working Paper 06-16 (2006), AEI-Brookings Joint Center for Regulatory Studies.); W. Briglauer, G. Ecker, and K. Gugler ("The impact of infrastructure and service-based competition on the deployment of next generation access networks: Recent evidence from the European member states," *Information Economics and Policy*, vol. 25 (2013), pp. 142–153).

[25] See FCC *O&FNPRM*.

[26] See FCC *O&FNPRM*, Tables 7–9 in the main text.

[27] See Table 6 in Appendix C of FCC *O&FNPRM*.

[28] FCC *O&FNPRM* at 364–368.

[29] It would, in fact, be the merest happenstance that the estimated productivity increases calculated by FCC staff in in Appendix C of FCC *O&FNPRM* were accurate for the telecommunications industry. The staff used two sources for total factor productivity, which is the key datum regarding productivity increases used in calculations of the price cap adjustments. The first, from the Bureau of Labor Statistics, is for the Broadcasting and Telecommunications sector, which is overly broad. Broadcasting technology is quite different than that for wired broadband. The second, from the Federal Reserve Bank of San Francisco, is even broader: it is apparently for the whole economy.

[30] FCC *O&FNPRM* at 365.

[31] In particular, revenue from DS1 and DS3 lines, which make up the majority of circuit-based access lines for business data services. Based on data from Table 13 in Appendix B of FCC *O&FNPRM*, it can be calculated that about 96% of special access lines provided by ILECs to customers in their regions are circuit based and that over 99% of such circuit-based lines are DS1 and DS3. These fractions would be lower if weighted by bandwidth,

since other circuit-based lines enable higher transmission speeds than DS1 and DS3.

[32] The price cap ILECs included in this figure are ACS, AT&T, CenturyLink, Cincinnati Bell, Consolidated Communications, FairPoint, Frontier, Hawaiian Telecom, Puerto Rico Telephone Company, Verizon, Virgin Islands Telephone Company, and Windstream. Revenue data are for 2015, DS1 and DS3 special access lines, from the companies' Tariff Review Plans filed with the FCC.

[33] Table 1 of Appendix B to FCC *O&FNPRM*.

[34] FCC *O&FNPRM* at 272.

[35] FCC *O&FNPRM* at 351 and 355.

[36] FCC Chairman Tom Wheeler stated in a blog post on April 8, 2016 that, "… competition remains uneven, with competitive carriers reaching less than 45 percent of locations where there is demand." See http://tinyurl.com/gs59c94.

[37] This is because in at least some areas without price caps, special access prices appear to be higher. The Government Accountability Office found that special access prices from price cap ILECs rose in the small subset of MSAs it examined where the Commission had granted Phase II pricing flexibility. However, the report examined only 16 of the currently more than 200 MSAs in which an ILEC has been granted pricing flexibility. See GAO, *Telecommunications: FCC needs to improve its ability to monitor and determine the extent of competition in dedicated access services*, report GAO-07-80 (Nov. 2006), available at http://tiny.cc/6xqddy.

[38] This figure is the high end of the range discussed in the main text of the *FNPRM*, as mentioned above. Even if a lower figure is eventually chosen, the possibility that prices would decrease by more than that amount in some areas with current pricing flexibility argues against adopting too low a number.

[39] There are very few econometric demand studies of special access markets, and none of which I am aware that have passed peer review. The elasticity estimates used here come from a discussion in L. Taylor (*Telecommunications demand in theory and practice*, Kluwer Academic Publishers, 1994; see pp. 145–148) of an unpublished (and difficult to find) study by J. Watters and P. Grandstaff (cited in the book as: "An econometric model of interstate access," presented at BELLCORE/Bell Canada Telecommunications Demand Analysis Industry Forum, Key Biscayne, FL, Jan. 25–27, 1988, Southwestern Bell Telephone Co., St. Louis, MO). Those authors calculate the price elasticity of special access demand to be in the range of –0.04 to –0.146, depending on whether partial or full elasticities are computed. I choose the figure of –0.1 as the rounded midpoint of the range. Since their study's data come from an ILEC at a time when competition in special access was virtually nonexistent, the competitive conditions well approximate the noncompetitive markets at issue here. The only other elasticity estimates for special access of which I am aware are those from an unpublished study by P. Rappoport *et al.* ("Macroeconomic Benefits from a Reduction in Special Access Prices," white paper dated June 12, 2003 filed on behalf of the Special Access Reform Coalition in FCC proceeding with RM Docket No. 10593), who find elasticity for DS1 to be –1.3 and DS3 to be –1.9. These estimates are not appropriate for the current analysis; even setting aside econometric criticisms which could be made of the simple estimations, the estimates are so high precisely because in areas *with competition* customers have the luxury of being highly price sensitive to the ILECs tariffed offerings.

[40] The revenue elasticity with respect to price is found from the formula $1 + \varepsilon$, where ε is the price elasticity of demand (calculated as $(dQ/dP) \times P/Q$). The derivation follows from the definition of revenue elasticity: $(dR/dP) \times (P/R)$, where R is revenue and P is price. Since $R = P \times Q$, revenue elasticity is $[Q + P \times (dQ/dP)] \times P/R$, which simplifies to $1 + \varepsilon$. Strictly speaking, the formula holds only approximately, with the accuracy of the approximation declining with the size of the price change. The tendency of the formula to overstate revenue changes given a price elasticity, however, is offset in the present case by the fact that as prices decline and demand increases, the price elasticity of demand itself typically moves toward zero.

[41] This figure is found as follows: (revenue of price cap ILECs from circuit-based business broadband of $16.1B) × (45% of revenue from areas deemed to be noncompetitive) × (–22% price change due to stricter regulation) × (0.9% revenue impact per 1% price change) = $1.4B.

[42] See FCC O&FNPRM at 407 and Dissenting Statement of Commissioner Ajit Pai to the FCC O&FNPRM, footnote 9.

[43] This figure is found as follows: (revenue of price cap ILECs from price-capped circuit-based business broadband of $4.2B) × (–22% price change due to stricter regulation) × (0.9% revenue impact per 1% price change) = $0.8B.

[44] This figure is found as follows: (revenue of price cap ILECs from circuit-based business broadband of $16.1B) × (45% of revenue from areas deemed to be noncompetitive) × (–32% price change due to stricter regulation) × (0.96% revenue impact per 1% price change) = $2.2B.

[45] FCC *O&FNPRM* at 420ff.

[46] Again, the details are complex to understand for those not steeped in the regulatory history of the business data services market, and a full discussion is beyond the scope of this note. Section IV.B of G.R. Faulhaber and H.J. Singer ("The curious absence of economic analysis at the Federal Communications Commission: An agency in search of a mission," white paper posted July 10, 2016 at http://tinyurl.com/hhh86oq) describes how the FCC has or is seeking to extend regulation to the packet-based business data services market through direct price regulation, rules for mandatory wholesale access, and removal of freedom to set freely terms of contract.

[47] FCC *O&FNPRM* at 492.

[48] E.g., "[m]odernizing this legacy infrastructure requires significant investment by the incumbent LECs," FCC *O&FNPRM* at 52. See also paragraphs 55, 189, and 227.

[49] The word "investment" appears nearly 50 times in the main text of the FCC *O&FNPRM*, but many of those instances are in footnotes or quotations and paraphrases of comments made by other parties. At 245, the FCC notes with promise that until the recent data collection that it was "simply impossible to … consider the impacts of our regulatory regime on prices and investments" but in the rest of the *O&FNPRM* fails to investigate the potential impact of stricter price caps on investment.

[50] FCC *O&FNPRM* at 198, 332.

[51] *Ibid*. at 271, 286, 291, 311, 464, 469, and 494. In each instance the FCC invites comment on whether the proposed regulation at issue in that part of the text will impede investment, but often the concern appears to be about competitive providers rather than ILECs.

[52] FCC *O&FNPRM* at 358 and 362.

[53] FCC *O&FNPRM* at 364 and 367.

[54] T. Randolph Beard, George S. Ford, and Lawrence J. Spiwak, "Market definition and the economic effects of special access price regulation," *Commlaw Conspectus*, vol. 22 (2014), pp. 237–266. See p. 252.

[55] This analysis assumes that the ILEC must sell to all at the regulated price, which is the case under price capped, tariffed services. The argument rests on the obvious notion that a uniform price that must be offered to all customers will fail to cover opportunity costs for some trades and will be too high compared to the buyer's reservation price (even though a suitable price for both parties could be found absent regulation) for some other trades.

[56] Pindyck (2007), *op. cit.*, p. 296. The immediate context of his analysis is mandatory unbundling of network elements, but his analysis also applies to other artificial price reductions such as overly stringent price caps (as discussed above in the review of the academic literature). Lack of offsetting benefits to competitors in the long run in his analysis follows from excess profits being competed away by entry in the long run.

[57] FCC *O&FNPRM* at 365.

[58] See F. Roques and N. Savva, *op. cit*. See also note 18.

[59] As the seminal article on price caps states, "permitting prices to be flexible… can approximate the behavior of a firm maximizing profit subject to an aggregate consumer surplus constraint" (T. Brennan, "Regulating by capping prices," *Journal of Regulatory Economics*, vol. 1 (1989), pp. 133–147).

[60] T.R. Beard, G.S. Ford, and L.J. Spiwak, *op. cit.*, p. 243.

[61] See Pindyck (2007), *op. cit.*, footnote 21 and associated text. Professor Pindyck notes that "[c]learly, substantial
expenditures are needed simply to maintain the existing infrastructure…" (p. 291).

[62] Readers with an MBA may be puzzled by this fact, recalling the famous Modigliani-Miller Theorem from the field of theoretical corporate finance which states that if capital markets were perfect, the choice between internal and external financing of investment is unimportant for a firm. Empirically, however, investment has been shown to be sensitive to cash flow even for firms that should be unconstrained. See J. Lewellen and K. Lewellen ("Investment and cashflow: New evidence," *Journal of Financial and Quantitative Analysis*, forthcoming, available at http://tinyurl.com/j6sdfmc), who study the top decile of nonfinancial firms listed on the NYSE, and Ş. Ağca and A. Mozumdar ("The impact of capital market imperfections on investment–cash flow sensitivity," *Journal of Banking & Finance*, vol. 32, Issue 2 (Feb. 2008), pp. 207–216), who study U.S. manufacturing firms. To my knowledge no similar studies have been performed specifically for the telecommunications industry, apart from my regressions reported in note 65 below.

[63] The figures are from Lewellen and Lewellen, *op. cit.*, and are the coefficients from regressions of capital expenditure on cash flow and various other controls (either Table 7 Model 1 or 2 for the low estimate; Table 4 Model 1 for the high estimate).

[64] The figures are from Lewellen and Lewellen, *op. cit.* (Table 7 Model 2 for the low estimate; Table 4 Model 1 for the high estimate).

[65] When capital expenditure is regressed on current cash flow and the same controls as in Model 1 of Lewellen and Lewellen, *op. cit.* using a sample consisting of the major price-cap ILECs (AT&T, CenturyLink, Cincinnati Bell, Consolidated Communications, FairPoint, Frontier, Verizon, and Windstream), 2012 to 2015, the coefficient on cash flow is 0.254, indicating that a dollar of extra cash flow is associated with additional capex of

$0.25. When the regression includes both current and last year's cash flow, the coefficient on lagged cash flow is 0.178, indicating that a dollar of extra cash flow last year is associated with additional capex of $0.18. Both coefficients are statistically significant at the 1% level.

[66] The cash flow effects stem from three reasons: external funding being more expensive than internal funding, the nature of internal constraints on managers' spending of internal vs. external funds, and cash flow being directly related to investment opportunities (Lewellen and Lewellen, *op. cit.*). Only the latter even partially overlaps with the direct disincentives created by the price regulation.

[67] One might argue that the caps do not deter entry, since the ILEC will respond to entry by lowering prices below the caps anyway. This appears to be incorrect given the evidence filed in the proceeding. Appendix B to FCC *O&FNPRM* shows that ILEC prices for DS1 and DS3 lines remain essentially unchanged after competitive entry in price cap areas ("I take the main results to be that the census tracts fixed effects columns show little or no competitive effect in price cap markets…." p. 221). If ILECs do not lower prices upon entry with the current price caps, then (*a fortiori*) there is little chance they would be to with even lower caps in place.

[68] See Appendix B to FCC *O&FNPRM*, Table 10. Compared to price cap areas, there are 12.1% more competitors on average in areas with Phase I pricing flexibility and 24.2% more competitors in Phase II areas.

[69] Second supplemental declaration of Israel, Rubinfeld and Woroch, *op. cit*. See note 6 above.

[70] See H. Singer, "Assessing the consequences of additional FCC regulation of business broadband: An empirical analysis," Economists Incorporated (undated document with PDF creation date of April 6, 2016, available at http://tiny.cc/edrddy). Dr. Singer is a principal at Economists Incorporated, an Adjunct Professor at Georgetown University's McDonough School of Business, and a Senior Fellow at George Washington University's Institute for Public Policy.

[71] This result comes from M. Cardona, T. Kretschmer, and T. Strobel's ("ICT and productivity: conclusions from the empirical literature," *Information Economics and Policy*, vol. 25 (2013), pp. 109–125) careful review of the voluminous literature in firm- and industry-level investment in ICT and labor productivity growth. The authors also find that the impact of ICT investment on productivity has been increasing over time.

[72] See A. Grimes, C. Ren, and P. Stevens, "The need for speed: impacts of internet connectivity on firm productivity," *Journal of Productivity Analysis*, vol. 37 (2012), pp. 187–201.

[73] See generally M.G. Colombo, A. Croce, and L. Grilli ("ICT services and small businesses' productivity gains: An analysis of the adoption of broadband Internet technology," *Information Economics and Policy*, vol. 25 (2013), pp. 171–189), and in particular their footnote 23. The advanced uses of broadband are distinguished from basic uses such as web browsing and email.

[74] See Holt and Jamison, *op. cit.*, M. Draca, R. Sadun, B. Faber, et al. ("The economic impact of ICT: First interim report," Centre for Economic Performance, London School of Economics, 2008), and M. Cardona, T. Kretschmer, and T. Strobel, *op. cit.*, for reviews of the large literature on how ICT and broadband investment and usage positively affect economic growth.

[75] J.A. Eisenach, H. Singer, and J.D. West ("Economic effects of tax incentives for broadband infrastructure deployment," Fiber-To-The-Home Council, 2009) calculate output multipliers of 2.8–3.1 for fixed broadband investment.

[76] See R. Katz and S. Suter, "Estimating the economic impact of the broadband stimulus plan," Columbia Institute for Tele-Information Working Paper 7.

[77] See R.D. Atkinson, D. Castro, and S.J. Ezell, "The digital road to recovery: a stimulus plan to create jobs, boost productivity and revitalize America," The Information Technology and Innovation Foundation, Washington, DC, 2009.

[78] See FCC Chairman Wheeler's blog post of April 8, 2016, *op. cit.*

[79] Some mobile wireless providers use business broadband to "backhaul" voice and data traffic from cell sites to their switching offices. However, as an industry association for cable system operators put it: "If 5G services will need denser and more robust backhaul starting a few years from now, the Commission should be taking steps now to encourage the construction of those facilities. But what provider is going to pursue this market opportunity if the 'reward' for taking the risk of building new fiber facilities is an obligation to provide access to wireless carriers at rates established by the Commission?" (National Cable & Telecommunications Association, quoted in J. Eggerton, "NCTA has major problems with special access," *Broadcasting & Cable*, April 13, 2016, available at http://tiny.cc/56fbdy).

[80] As some commentators stated, "by virtue of a last minute data dump, the Commission, in effect, curtailed the opportunity to prevent useful public comment on critical peer reviews that supposedly support its preferred analysis" (R. May and S. Cooper, "The FCC's special access proposal is infected with special pleading," *Perspectives from FSF Scholars*, vol. 11, no. 26 (July 15, 2016), Free State Foundation).