

EMPIRICS OF BUSINESS DATA SERVICES

WHITE PAPER

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I. INTRODUCTION

This paper studies the market for business data services in the United States. Whereas businesses often have the option of using mass-market Internet service, such as offered by the local cable or telephone company, many business applications demand higher levels of quality, in terms of bandwidth, or service guarantees. For instance, a mobile phone company that requires backhaul from its cellular towers has large bandwidth requirements. A chain of retail outlets that relies on data services to process card payments cannot tolerate downtime in service. Financial institutions similarly require secure and reliable communication services.

Formally, business data service(s) (BDS) refers to electronic end-to-end communication services sold at symmetrical speeds with guaranteed service levels, such as high guaranteed uptime. Naturally, BDS are generally purchased for business purposes. BDS exclude complex services also sold to businesses, such as a managed voice, private network and Internet access solution, although BDS are an input into such services. BDS are integral to the functioning of the US economy, and approximately \$45 billion in BDS sales were made in 2013.¹ Providers of BDS primarily consist of legacy phone carriers from the period when local telephone service was monopolized (termed Incumbent Local Exchange Carriers – ILECs), and competitive local exchange carriers (CLECs), including many cable companies. We use the term competitive providers (CPs) to refer to CLECs inclusive of cable companies.

The Federal Communication Commission (FCC) has long been concerned that certain BDS providers may exercise market power due to a concentrated market structure and the difficulty of entry. As such, the FCC has developed a system of price caps and related regulation for these services, as well as a separate set of regulations under which CPs can sometimes purchase unbundled network elements (UNEs) from ILECs at prices set by state regulators.² The FCC relaxed price-cap regulations in metropolitan statistical areas (MSAs) that met certain triggers for competitive presence.³ However, indications that the triggers were not working as intended has led to a freeze on this process.⁴

¹ Revenue amount is based on total aggregate revenues reported by providers in response to questions II.A.15-16 and II.B.8-9 in the Collection.

² UNEs relevant to this proceeding come in three forms, DS1s, DS3s, and unbundled copper loops (to which the purchaser attaches its own equipment). UNEs are not uniformly available, for instance because availability declines as copper is retired and as certain competitive triggers relevant to DS1 and DS3 availability are met. *See Unbundled Access to Network Elements; Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers*, Order on Remand, 20 FCC Rcd 2533, 2614, para. 146 (2005) (Triennial Review Remand Order).

³ *See Access Charge Reform*, CC Docket No. 96-262; *Price Cap Performance for Local Exchange Carriers*, CC Docket No. 94-1; *Interexchange Carrier Purchases of Switched Access Services Offered by Competitive Local Exchange Carriers*, CCB/CPD File No. 98-63; *Petition of U.S. West Communications, Inc. for Forbearance from Regulation as a Dominant Carrier in the Phoenix, Arizona MSA*, CC Docket No. 98-157, Fifth Report and Order and Further Notice of Proposed Rulemaking, 14 FCC Rcd 14221 (1999), *aff'd WorldCom v. FCC*, 238 F.3d 449 (D.C. Cir. 2001). The FCC provided a fixed definition of MSAs based on 1980 Census delineations. 47 C.F.R. § 69.707; FCC Areas, Cellular Market Areas, <http://transition.fcc.gov/oet/info/maps/areas/>. In some cases, pricing flexibility was also granted to “non-MSAs”, regions within an ILEC’s study area within a state that fall outside of any MSA. *Id.*

⁴ *See Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services*, WC Docket No. 05-25, RM-10593, Report and Order, 27 FCC Rcd 10557 (2012).

This paper studies the supply of BDS, also called “special access.” An important goal of this project is to provide guidance to the FCC as it engages in a revamping of its regulatory approach to this industry. In particular, I have been instructed to examine whether, and if so where, there is market power in this industry. My analysis of market power is multipronged. I first consider revenue market shares. I then analyze the structure of supply in terms of the number and types of entrants, both nationally and locally at the level of the census block⁵ and even at the level of a unique location such as a single building or a cell tower (hereafter referred to by the shorthand “buildings”).⁶ Finally, I consider determinants of price, particularly in relation to the number of competitors for various geographic regions. The presumption is that if price is lower in the face of local competition, then the effect of competition is important. I also discuss factors that could lead to spurious findings, such as local cost heterogeneity. I control for a number of factors in a regression approach, and I consider prices for different classes of products and firms. The goal of these regressions is to test whether prices fall when there is local competition. If so, I take this as evidence of market power in the BDS industry, where there is not competition. That is, if market power did not exist, for instance because the threat of entry held down prices in all local markets, we would not necessarily see any further decrease in price when actual entry did occur. This approach is common in antitrust settings. For instance, the regression set up here is similar to the well-known use of regression in the merger case of Staples and Office Depot, successfully opposed by the Federal Trade Commission.⁷

This paper relies on a recent data collection, ordered by the FCC under its regulatory powers (the Collection). These data provide a new and deeper look at this industry, not available to previous researchers. The data provide locations served by each firm in the industry,⁸ down to the street address, as well as information on the characteristics of the connection medium (such as fiber optic cable). I use these data to study market structure at various geographies. Furthermore, the data contain billed service-by-service revenue as well as aggregate BDS revenues for ILECs and CPs. Interpreting billed service-by-service revenue as a price, and combining with the location data, allows me to study how price varies with competition.

⁵ Census Blocks are statistical subdivisions of Census Tracts, which are statistical subdivisions of a county or equivalent. See U.S. Census Bureau <http://blogs.census.gov/2011/07/20/what-are-census-blocks>

⁶ After this paper was finalized in April 2016, certain large cable companies corrected their filings to report additional locations, or in some cases census blocks with locations, connected to, or considered serviceable by hybrid fiber coaxial cable (HFC) network that is linked to, Metro Ethernet (MetroE) capable headends. Previously, these large cable companies had only reported locations they were directly making sales to, or to which they had a fiber connection. My analysis, which was primarily focused on facility-based fiber competition, including on IRUs, and as discussed more specifically below, is essentially unaffected by these updated submissions.

⁷ Serdar Dalkir and Frederick R. Warren-Boulton, (1997) “Prices, Market Definition, and the Effects of Merger: Staples-Office Depot” in *The Antitrust Revolution: Economics, Competition, and Policy*, edited by John E. Kwoka, Jr. and Lawrence J. White, Chapter 6, Oxford University Press; 6 ed. (July 23, 2013), <https://global.oup.com/academic/product/the-antitrust-revolution-9780199315499?cc=us&lang=en&>.

⁸ More strictly, ILECs reported locations where they currently sell BDS or more complex business services that require an underlying BDS to supply; cable companies were thought to have reported all locations they have connected to any headend that is capable of supplying Ethernet service, even if they do not sell service at that location, and otherwise any location where they currently sell BDS or more complex business services that require an underlying BDS to supply, but in fact recently acknowledged they reported only locations to which they actually supplied BDS; while all remaining CPs reported any location they are able to serve over the carrier’s own facilities. “Own facilities” for CPs includes not only facilities they own but also fiber under long-term leases from other carriers (known as indefeasible right of use – IRU). Non-cable CPs report locations even if they do not sell service at that location, and any location where they currently sell BDS or more complex business services that require an underlying BDS to supply over a UNE.

The FCC is considering how to address current regulatory structures in a time frame that befits a rapidly evolving industry. The collected data are for 2013, and the market has evolved somewhat since then. Collecting and working with such an enormous data set is challenging. In vetting the collection, the FCC implemented many data error detection protocols, which led the FCC to revisit how firms constructed their contributions. These issues are typical for any empirical analysis, but in situations like this, there is always more work that could be done. My paper ends with a series of suggestions for future work to provide a deeper understanding of the industry.

The paper studies what are arguably three different data sets covering revenue, locations and prices. I find evidence of ILEC market power in each. The revenue data point to the importance of the ILECs in this industry, particularly if we are willing to include their revenue as CPs outside of their ILEC regions. The location data similarly show that the ILECs provide facilities-based service to many more locations than CPs. However, if we focus on buildings served by fiber, competitive providers are a robust presence, almost the size of ILECs in terms of number of buildings served.

The price data tell a similar story. Regressions of ILEC rates for DS1 and DS3 lines show that competition in the building, and the census block, consistently lowers prices in economically and statistically significant ways. Interestingly, we see some effects of competitive fiber in the census block, even if that fiber is not connected to any buildings in the block. In contrast, regressions for higher bandwidth lines show muddled and conflicting effects of competition, often at low levels of statistical significance. Thus, these results are in line with the analysis of the location data.

Looking beyond market power, it would be valuable to extend the analysis of the broad range of data available to the FCC to identify and develop triggers the FCC could use to choose when to apply, or refrain from applying, price cap and other regulation to this industry. Triggers could take into account the presence of local competition, the presence of high customer demand, or perhaps some demographic data such as the number of establishments. Predicting what triggers would work well is hazardous, but the results of this study would suggest that regulation of higher-end products is perhaps not necessary. For DS1 and DS3 lines, the presence of competition as I have measured it reduces prices. While that might suggest that just the presence of competition may be sufficient to forgo regulation, I find that more competition leads to lower prices, so I cannot say that just the presence of competition eliminates market power, only that the presence of competition reduces market power.

II. BACKGROUND

Understanding the data and my approach to the data require an understanding of the industry. The BDS market is populated by different types of providers making use of varying delivery technologies. An ILEC serves customers in its region using its own network facilities. CPs may also build facilities to customers, sometimes making use of ILEC facilities for some part of the service. In addition, CPs may lease lines from ILECs and sometimes other CPs in order to provide service entirely over leased facilities. In some circumstances, CPs may lease ILEC facilities at a regulated wholesale price, referred to as the UNE price. CPs also can purchase from ILECs or more commonly other CPs, for periods often exceeding ten years, the right to use dark fiber in many respects as if it were their own facility.⁹ Since multi-location customers often prefer to work with a single provider and since no provider has facilities in every location, providers often contract with each other to provide multi-location services, either via leased lines or UNEs (where they are available).

I divide competitive providers (CPs or CLECs) into three types: ILEC-affiliated CLECs, Cable

⁹ These arrangements are often called indefeasible rights of use (IRUs).

companies, and Other CLECs. Technically the cable companies are CLECs, but because of differences discussed below, I separate cable CLECs from non-cable, “traditional” CLECs. The largest traditional CLECs are affiliated with ILECs. For instance, Verizon operates both as an ILEC in its ILEC region and as a CLEC outside of its region. I call these companies ILEC-affiliated CLECs. As we will see, ILECs rarely build facilities outside of their region, and instead ILEC-affiliated CLECs make heavy use of leased lines. In addition, there are what I term Other CLECs, such as Level 3 and XO, which compete via owned facilities, leased lines and UNEs. Furthermore, Cable companies and Other CLECs can be grouped into the Independent CLEC category which consists of competitors that are not affiliated with an ILEC. All ILECs and CPs may provide further services, called managed services, over and above BDS, such as cloud-hosting services, running an internal phone system for a consumer, or managing their private networks.

Traditional CLECs provide BDS using a number of different technologies. Data services can be provided over traditional circuit-based technologies. Leading technologies of this type are DS1 lines and DS3 lines, typically carried over copper pairs (a relatively old form of wiring technology), which account for the majority of revenue in this industry, according to these data. A DS1 line transfers 1.5 megabits per second both in upload and download. A DS3 line carries about 30 times the bandwidth of a DS1 line. , which is a symmetric 1.5 Mbps service. It is also possible to achieve higher bandwidth levels over circuit-based technologies. An alternative to circuit-based technology is packet-based service, which includes Ethernet services. These are more commonly delivered over fiber optic cable but can be delivered over copper lines and hybrid fiber coaxial networks. Fiber optic cable can deliver higher bandwidth and service levels, and most new investment is in fiber. In several places in the paper, I distinguish between circuit-based and packet-based service, non-fiber and fiber service, or between DS1 lines, DS3 lines and higher bandwidth lines. In all three cases, the latter represents the higher-end technology. But keep in mind that low-bandwidth packet-based services also exist in the industry.

Cable operators hold an important place in this industry, offering two broad categories of service: “best-efforts” services supplied to mass-market (most commonly residential) customers that come with asymmetrical speeds and few if any service guarantees, and BDS, which comes with symmetrical speeds and significant service guarantees.¹⁰ While the symmetrical speeds and service guarantees provided for BDS over coaxial cable typically are not as robust as for fiber-based BDS, if cable services with such guarantees were sold in 2013, then they would appear as cable CP competition in the data on which my estimations were based.

In this paper, I do not study best-efforts services directly. That I have not directly modeled the impact of best-efforts competition is not to say that I have concluded best-efforts services are not a viable competition in this industry. The decision to focus on BDS stems from a belief (that receives support from my regressions) that BDS competition is likely to be different from best-efforts services competition, and the time limitations I faced. However, integrating best-efforts services is important for future research, and the FCC collected data on best-efforts service. That being said, the price regression section below discusses how the location fixed effects strategy addresses provision by cable CPs, including the issue that arises because of the failure of certain large cable companies to report all locations served by an HFC connection to a MetroE-capable headend in their original submissions, and how parameters can be interpreted in light of the issues alluded to here.

¹⁰ By installing a specialized modem for the customer and an equipment upgrade in its network, a cable company can deliver a relatively high quality data service over its HFC network that has some features of DS1, DS3 and Ethernet BDS. Cable HFC networks use a communication standard known as Data Over Cable Service Interface Specification (DOCSIS). The DOCSIS 3.0 standard allows for the provision of Ethernet over DOCSIS as a “best efforts” service or with service guarantees.

III. DATA

The data can be usefully thought of in three parts: aggregate revenues, location and pricing. The first part collects aggregate BDS revenue data from each firm. We observe aggregate revenue by type of technology (packet-based or circuit-based) for each firm. While firms report all BDS revenue, a drawback of the revenue data is that firms do not report revenue from managed services. If BDS is sold to a customer as part of a larger managed service contract, and the BDS element is not priced separately, the data do not contain that revenue. Another drawback is that the data includes resale revenues, which exaggerate CPs' BDS revenue share.¹¹

The location data are meant to capture all locations at which a firm provides service. This exact data collection differs between ILECs and CPs. ILECs report all locations in their region at which they have a customer. The customers are serviced by ILEC facilities, because ILECs typically do not use CP facilities in the ILEC's own region. Whereas ILECs report every location they have a customer, non-cable CPs reported all locations at which the CP owns or leases per an IRU a connection to a location, including locations where it does not currently have a customer. Cable CPs were required to report all locations with connections owned or leased as an IRU that are connected to a MetroE-capable headend.¹² For connections not linked to a MetroE-capable headend, cable CPs reported in-service connections used to provide BDS or a managed service that includes BDS within the offering. The FCC did not collect locations at which ILECs have a connection but no customer, because ILEC facilities are practically ubiquitous in their region, so ILECs can be assumed to have facilities in every location.

In addition, CPs report any location at which they provide service not with their own facilities but over a leased line that is purchased at a regulated price, a so called UNE price. However, the data do not contain locations at which firms provide service over non-UNE leased lines. That said, the data would record the location served by the non-UNE leased line as a location of the provider that actually owns the connection. In this sense, the data are particularly strong for studying facilities-based competition. For this reason, I focus on facilities-based competition in much of the paper. An interesting question is whether UNE entry also provides some competitive pressure. I do address this indirectly, but recommend the FCC consider analysis of UNE competition.

For pricing data, providers report revenue in the form of monthly billing data for each BDS contract linked to locations reported elsewhere in the collection where applicable, and I interpret billings as a price. As with the revenue data, we do not observe billing data if the BDS service is part of a larger managed service contract. As above, the ILEC data includes substantial sales of DS1s and DS3s, because the ILECs must sell these services on a stand-alone basis due to the FCC's regulations. The data do not likely capture, however, all of the ILEC's packet-based sales, which the ILEC may have sold as a managed service. Likewise, the data contain CP billing data only for the subsample of CP customers that purchase BDS separate from or without any managed services. Of course, the data still contain unique CP location identifiers from the location data. For these reasons, I focus my analysis of prices on how ILEC prices respond to CP presence. I note that conventional wisdom is that ILECs hold any market

¹¹ CPs, including ILEC-affiliated CPs, often buy BDS from other providers, most commonly an ILEC, and in some cases, resell the service. In such instances, both the original sale, and the resale revenues, are reported when what we are interested in from the CP is the difference between the resale and wholesale prices. This issue does not arise for ILECs. An ILEC (operating as an ILEC, and not as a CP) would rarely purchase BDS from another carrier, and it would be even more unusual for the ILEC to then resell that service to another carrier.

¹² However, certain large cable companies failed to report all such locations in their original submission and subsequently updated their submissions to provide additional information on such locations or census blocks with locations after this paper was finalized in April 2016. *See supra* note 6.

power that exists rather than CPs, and that facilities-based entry is the most important source of competitive discipline, so my focus on facilities-based entry and ILEC prices is not particularly restrictive.

Attachment 4 further describes the background for the industry, and describes in detail the FCC's process for collecting these data. The data required significant processing in order to be usable for statistical analysis. Full descriptions of the FCC's approach appear in the appendices. I provide brief overviews here, particularly for the location and pricing data.

For the location data, a goal of the FCC was to assign locations to buildings, in part to determine competitive overlap within buildings. Identifying when two competitors are in the same building is a non-trivial problem with these data. Some data providers reported latitudes and longitudes, while others reported addresses, and even then, slightly different latitude and longitudes or slightly different addresses may actually be part of the same building for our purposes. In order to determine which customers were in the same building, the FCC assumed that locations less than 50 meters (approximately 164 feet) apart were the same building (unless the geocoded address reported that they were in distinct buildings). Naturally, this requires a procedure to address sequences of locations that are less than 50 meters apart each, but together are more than 50 meters apart. In practice, each customer in the data appears in only one building. We assign each building to a census block, which then implies its census tract¹³ and county.

For pricing data, providers report billing revenue, not prices. Even within a single buyer-seller relationship, we observe substantial variation in monthly revenue, even going to zero. From conversations with providers, this arises because of complex discounting and bonus terms in the contracts. I take the view that buyers focus on the average monthly price rather than any given one-month price, since customers tend to subscribe to a service for longer periods of time than a month. Indeed, many contracts commit the buyer to stay with the seller for extended periods. Thus, I take the average revenue across the months for any given contract as the "price." Even so, price varies substantially across the data, and so we must be on guard for spurious results, as the large number of observations means that most coefficients in a regression environment will be statistically significant at conventional levels of significance.

An additional challenge is how different providers price different elements of their service. Physically, a service is made up of several elements, such as the connection to the edge of the provider's network (sometimes referred to as the "last mile") and the transport from this edge to the Internet backbone or to another location owned by the customer. Altogether, these elements add up to a circuit. Some providers price the circuit, whereas some providers price different elements of a circuit. I add up revenue to a single circuit and use the total circuit revenue to construct price. Note that some authors (such as the National Regulatory Research Institute) have argued that the FCC should recognize separate markets for backhaul transport. My approach of aggregating to the level of the circuit rules out separate analysis of the transport market. In this paper, I focus only on the market for circuits provided to customers (sometimes called the channel termination market), although the transport market may also be interesting to study.

In addition, as described in Attachment 1, the FCC drops observations that fail some basic checks of quality. For instance, if a sequence of elements is reported to be part of the same circuit, but different bandwidths were reported for those elements, the FCC drops the observation. Even with these conditions, the data have more than 2 million observations, and that is after having summed over circuit elements and

¹³ Census Tracts are statistical subdivisions of a county or equivalent. See U.S. Census Bureau https://www.census.gov/geo/reference/gtc/gtc_ct.html.

after averaging over the time variation in the data.

IV. ANALYSIS

A. Revenues

In this section, I present tables that describe revenue in the industry, focusing on the distinctions between circuit-based and packet-based technology, as well distinctions between ILECs and competitive providers. These data came from revenue totals reported by providers in response to questions II.A.15-16 and II.B.8-9 in the Collection and not from the monthly billing data.

Table 1 presents total BDS revenues reported by the firms by provider type (ILECs or CP), and by technology (circuit-based or packet-based). Overall revenue to CPs is slightly greater than that of ILECs. In addition, we see that circuit-based services account for about 75% of ILEC BDS revenue. In contrast, CPs draw substantially more revenue than ILECs from packet-based services, almost 2.5 times more. Still, CPs make extensive use of circuit-based lines, which represent 42% of their BDS revenue.

As mentioned in the data section, an important caveat is that revenue from the resale of BDS that are leased from an ILEC, as well as revenues from the resale of UNE lines, count towards CP revenue reported. That is, these revenue data do not distinguish between facilities-based, leased-line, and UNE service provision. Conventional wisdom is that resale over ILEC BDS is likely to be a relatively weak form of competition for ILECs, and consequently these revenue shares overstate the competitive presence of CPs. In fact, it is probable that a substantial share of CP revenue over circuit-based lines actually represents lines leased from ILECs, since facilities-based entry from CPs tends to focus on packet-based technology.

	ILECs	Competitive Providers
Circuit BDS	\$ 16.1	\$ 9.7
Packet BDS	\$ 5.6	\$ 13.3
Total	\$ 21.7	\$ 23.0

Table 1: BDS Revenue (billions \$) by Technology and Provider Type

In addition to the allocation of facilities-based revenue, it is important to recognize that much of the CP revenues in Table 1 can be ascribed to ILECs. We can see this in Table 2 which shows revenues by technology and firm for all firms with over \$400 million in BDS revenue. ILEC-affiliated-CLECs reported their revenue separately from their ILEC in the revenue data, and I report these separately in the table. We see that the largest CPs are arms of firms that also have ILEC operations. The four largest CPs are AT&T, Verizon, CenturyLink, and Windstream. The largest CPs without ILEC operations were Level 3 (plus tw telecom) and Zayo, the 7th and 10th largest firms on this list.¹⁴ These observations certainly affect our sense of how large CPs are that we might have drawn from Table 1. Table 1 shows that CP revenue is slightly more than ILEC revenue, but Table 2 shows that two-thirds of the CP revenue accrues to ILEC affiliates.¹⁵

¹⁴ Since the time of this data collection (in 2013), Level 3 merged with tw telecom,

¹⁵ As stated above, cable revenue is not counted if it comes from outside of BDS services, such as best-efforts DOCSIS 3.0 services.

telecommunications carriers. Shown in Table 3, these data indicate that while the combined Level 3 and tw telecom loom relatively larger, ILECs and ILEC-affiliates (not broken out) still dominate.¹⁸ As before, this table counts all earnings made over leased BDS and UNEs.

Company	2013	2014	2015
AT&T	\$30.11	\$29.52	\$28.93
Verizon	\$20.72	\$19.84	\$18.92
CenturyLink	\$11.04	\$11.00	\$10.56
Level3	\$3.01	\$4.19	\$4.99
Windstream	\$1.67	\$1.77	\$1.86
Comcast	\$3.24	\$3.95	\$4.74
Time Warner	\$1.90	\$2.31	\$3.28
Frontier	\$2.28	\$2.18	\$2.16
Charter	\$0.81	\$0.99	\$1.13
Earthlink	\$0.95	\$0.91	\$0.95
Cox*	\$1.80		
Total (excl. Cox)	\$75.72	\$76.67	\$77.52

Table 3: Revenues (billions \$) for Business Services 2013-2015

B. Locations

Using locations to measure market structure should be linked to our concept of a relevant market. In theory, the relevant market should be determined in both geographic and product space, both by customer willingness to switch away in both dimensions, and by the willingness of firms to switch towards a customer in both dimensions. In practice, I expect customers are unlikely to switch geographic locations based on the price of business data services. A provider that raises price is unlikely to drive a customer to a new address that is served by a rival provider. Similarly, it would be rare that the expected price of BDS or managed services would significantly influence a customer's location decisions because such costs are a relatively small part of the purchasing firm's overall costs, and because in many instances other factors will dominate, such as the need to meet the purchasing firm's own customers' desires.

Although customers would be unlikely to switch locations based on the BDS market, they may be willing to switch to products outside of the BDS market. For instance, some customers may view best-efforts broadband service as a viable alternative. Recall that the FCC's data collection defined the BDS market by the presence of service guarantees, and so customers willing to forgo service guarantees might purchase outside of the BDS market in response to a price increase of BDS. It is unclear how many customers fall into this category. Although I do not model best efforts service directly, my regression framework does address the presence of such service through location fixed effects.

I am primarily interested in suppliers switching towards customers. In terms of product space, I assume that a supplier providing any bandwidth could easily provide any other bandwidth at that location. An exception to this would be a copper connection that has no spare capacity and could not be readily replaced without de novo deployment. Consequently, while my assumption will generally be true for CP facilities, which are predominantly fiber, it may not be true for UNE competition, which is copper-based

¹⁸ Level 3 revenues include those from tw telecom, which Level 3 acquired in 2014. We were unable to obtain a revenue estimate for Cox in either 2014 or 2015. Data sources are discussed in Attachment 5.

and has regulatory capacity restrictions, and in some instances may not be true for ILEC deployments (where only copper facilities may be available).¹⁹ But in general, my approach should be reasonable.²⁰

Thus, the main focus of my paper is on the ability of suppliers to reach customers across geographical space. How close must customers be such that we should consider providers to those customers to be in the same geographic market? The answer to this question is crucial in designing regulation. For instance, previous regulation attempted to identify MSAs in which the FCC could significantly relax price regulation (so called Pricing Flexibility Phase I and II markets). Understanding the relevant market over which to identify competition is a critical step in determining whether to apply regulation at the level of the MSA, or some smaller or larger geographical region.

Building facilities from one location to another can be a costly endeavor, and can include not only the cost of stringing or burying lines, but also the cost of getting approval from the relevant government authorities and from building owners. Whereas some statements from industry sources suggest that a provider can easily reach any location in a census block, or beyond, in which it has presence, other statements suggest that in some cases, even building from one floor of a building to another can be prohibitively costly, especially if permission from the building owner is not forthcoming.²¹

Finally, while I examine competition at the level of different geographic regions, analysis of competition in a narrow geographic region may not properly measure competition. While some customers seek to connect a single building via BDS, most need to connect at least two and often many more locations together. Thus, a customer buying a bundle of connections to many locations may not be able to pick and choose providers at any given location, but may find their choices limited to carriers that can meet their bundled needs. For example, the record suggests there are economies in dealing with one provider, and that for some customers there are advantages in having all of one's services on facilities owned by the provider.²² In this light, a customer seeking a bundle of lines will generally have less competitive choice than any measure of competitiveness based on a specific geographic region might indicate. However, it is possible that these customers are particularly attractive and so competition for them is particularly fierce. Ultimately, this is an empirical question. Because it is difficult to track customers across providers, especially for customers that buy managed services from CP providers, I cannot address this issue, but I discuss data requirements for further study in this direction in the conclusion.

In this section, I describe market structure across different geographic regions, particularly focusing on the building and the census block as potential geographic relevant markets. Knowing the number of rivals for any given relevant market is important for determining the competitiveness of a market. In the next section, I relate prices to the amount of competition in different potential geographic markets to assess whether one geographic market definition makes more sense than another.

¹⁹ UNEs are available only to a limited extent for DS1s and DS3s. 47 C.F.R. §§ 51.319(a)(4)(i), 51.319(5)(ii).

²⁰ There is also the possibility of firms switching from outside of the BDS market into the market, particularly cable companies providing best-efforts services. Best efforts service is addressed in the price regression primarily with location fixed effects, which I further discuss below.

²¹ See, e.g., Mark Israel, Daniel Rubinfeld and Glenn Woroch, 11 "Competitive Analysis of the FCC's Special Access Data Collection" (Jan. 26, 2016) (IRW White Paper); and United States Government Accountability Office, FCC Needs to Improve Its Ability to Monitor and Determine the Extent of Competition in Dedicated Access Services, GAO 07-80, at 2, 19-20 (rel. Nov. 2006), <http://www.gao.gov/products/GAO-07-80>.

²² Peter Bluhm with Bob Loube, Competitive Issues in Special Access Markets, 32 (Rev. Ed. 2009), (<http://nrri.org/download/2009-02-competitive-issues-in-special-access-markets/>).

Why focus on the building and the census block? Narrative evidence suggests that CPs generally build out no more than a quarter to a half-mile. Answers varied, but these sorts of distances appeared consistently in the narrative responses.²³ By way of comparison, we can consider the land area of census tracts that have at least one BDS-connected building in the location data. In this data set, the median census tract has a land area of 1.71 square miles. If the median census tract was a square, then its sides would each be 1.31 miles long, generally too long for a CP to build across according to the narrative responses. The median of 1.71 square miles masks substantial variation in the data. A square tract at the 25th percentile would be larger still, with sides of around 2.3 miles long. In contrast, the median census block is 0.026 square miles, so a square median-sized census block would have sides that were 0.16 miles long. The distribution around the median is also skewed. For instance, the 25th percentile is 0.1 square miles, so a square 25th-percentile census block would have sides that were 0.3 miles long. Based on the narrative evidence, census blocks appear to be better measures for competitive pressure than census tracts. I revisit this issue with price data, but it helps to inform my approach to the location analysis.²⁴

Table 4 shows the distribution of about 1.217 million buildings (unique locations) in the data by provider type and technology.²⁵ CPs report locations where they serve or at least have a connection to the location for approximately 522,000 buildings or 43% of buildings.²⁶ Of these, CPs report that they have connections to nearly 245,000 locations or 47% of CP locations (or 20% of all locations) through leased (UNE) lines.²⁷ Thus, CPs report that they can reach approximately 277,000 locations or less than a quarter of all buildings via their own facilities. About half of this facilities-based service is from cable companies, with most of the rest being CLECs with no ILEC operations.

A striking result is the low number of buildings connected by facilities-based service from ILEC-affiliated

²³ See Narrative Responses to Question II.A.8 in the Collection.

²⁴ There are several alternatives we might consider. One would be to define markets by a radius of distance or driving distance around a customer, so each customer has a unique market. Another would be to define markets by the census block group, or by the local exchange. I did not address these, largely due to time constraints, but I think they are worthwhile to explore.

²⁵ The FCC developed two estimates of building (strictly unique locations), and in both case found there to be approximately 1.2 million buildings. The one used here is referred to as Cluster Method 2, first treats any location with a unique geocoded street address as a separate location, and then considers any remaining locations within 50 meters of another (with a disambiguation process) to be unique. Cluster Method 1 uses the same process as Cluster Method 2, but does not treat unique geocoded street addresses as unique, but also amalgamates these if they are within 50 meters of each other. The FCC prefers Cluster Method 2 because the FCC believes geocoded street addresses generally represent unique buildings. For technical details on both methods. See Attachment 1. My location analysis presented here, consistent with my price analysis below, is of facility-based, largely fiber supply. It excludes competition over leased lines, over UNEs, and over an HFC network connection except where an active BDS or managed service sale was made. To see the effect of adding supply over UNEs and the entire HFC network coverage for cable CPs using DOCSIS 3.0 technology, see Tables 3 and 4 in the FCC's Further Notice of Proposed Rulemaking released on May 2, 2016 (FCC 16-54). However, using the entire DOCSIS 3.0 network coverage for cable CPs overcounts the competitive reach of the cable CPs' HFC network, especially in those instances where a cable CP has not upgraded all of its headends to MetroE-capable, which is a precondition for at least one major cable company to providing Ethernet services. See Comcast Letter to FCC at 1 (Mar. 25, 2016), WC Docket No. 05-25.

²⁶ Under Cluster Method 2, there were 521,594 unique locations with CP connections counting both locations that at least one CLEC could service over its own facilities, and connections that were only served over a UNE or UNEs (521,954/1,216,976 is approximately 43%). See *supra* note 8. Locations reported by CPs affiliated with ILECs within the affiliated ILEC's territory were treated as belonging to the ILEC.

²⁷ Under Cluster Method 2, there were 244,656 locations CLECs served over UNEs only (244,656/521,945 is approximately 47%; 244,656/1,216,976 is approximately 20%).

CLECs, 7%. This contrasts with the large share of CP revenue from ILEC-affiliated CLECs shown in Table 2. Recall that although competitive provider revenue is larger than ILEC revenue, two thirds of that revenue is to CLECs that are associated with ILECs. Thus, although Table 1 shows a substantial revenue share flows to CPs, Table 2 and Table 4 show a large portion of that revenue is going to ILEC-affiliated CLECs. This implies the top three ILEC-affiliated CLECs significantly rely on BDS leased from another LEC, typically the local ILEC.

In the location data, rather than report where they could supply service, ILECs report where they do provide service. ILECs provide service in 69% of buildings nationwide, with that number going up to 84% if I include ILEC UNE sales. In fact, at some points in the analysis, I assume that ILECs can provide service to any building. This is reasonable to the extent that ILECs have ubiquitous facilities. Most likely, there are some buildings where a competitive provider is delivering service and the local ILEC would find it very expensive to serve (for example, a newly built cell tower in a relative remote part of the ILEC's territory). However, I believe these situations are relatively rare.

	As Reported (Locations w/ Customers)	As Reported With CP UNEs Counted as ILEC	Locations if ILEC Assumed Everywhere
ILECs	69%	84%	100%
	As Reported (Locations with Connections)	UNEs	Facilities
All CPs	43%	20%	23%
Cable	14%	1%	13%
ILEC-affiliated CLEC	7%	6%	1%
Other CLECs	25%	15%	9%

Table 4: Locations

Table 5 reports several statistics describing firms in this market. There are 491 different providers in this data set, with the median firm serving only 35 buildings. Thus, there are many small players. Even the 90th percentile firm by size serves only 1,148 buildings.

Number of Providers	491
Median # of Buildings Served	35
90th Percentile of # of Buildings Served	1,148

Table 5: Summary of Providers²⁸

[BEGIN HIGHLY CONFIDENTIAL]

[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

²⁸ Some filers did not report any locations. In addition the FCC was unable to geocode a small percentage of the reported locations resulting in a fewer number of providers reflected in this data set.

Name	Total	ILEC	CP UNE	CP Fac.
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

[END HIGHLY CONFIDENTIAL]

Table 6, which lists the largest firms by number of buildings, paints a different picture. It shows that the largest providers are much, much larger than the median, or even the 90th percentile firm. The biggest four are ILECs, followed by a set of cable companies and CLECs. Windstream reports [BEGIN HIGHLY CONFIDENTIAL] [REDACTED] [END HIGHLY CONFIDENTIAL] buildings served via UNE, and we see the very low UNE use by the other ILECs. Sources beyond our data set tell us that cable companies are investing in BDS,²⁹ so we might be concerned that since these data are two years old, cable BDS are underrepresented. However, even if cable companies have been growing at 20% per year, or are 50% larger now than when the data were collected, they would still be much smaller than ILECs.³⁰

Table 7 shows the number of competitors per building. In the first column, I assume that ILECs can serve every building, and I assign UNE service from a competitive provider to the local ILEC. Thus, I do not count UNE service as competition. In the second column, I assume ILECs serve every building, and I assign UNE service to the associated CP. The assumptions incorporated into this column should lead to the most possible competitors per building.

²⁹ See generally Letter from Steven F. Morris, National Cable & Telecommunications Association (NCTA), to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25, 1 (Mar. 22, 2016) (“Over the past few years, cable operators have been expanding the number of commercial buildings they serve, the geographic footprint of their networks, and the types of services they offer to business customers (including increasing use of service level agreements.)”; see, e.g., Letter from Matthew Brill, Counsel to Comcast, to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25, 2 (Mar. 25, 2016) (“Like all cable providers, Comcast historically focused on residential areas, but in recent years the Company has expanded its cable/broadband plant to reach additional commercial customers.”); Sean Buckley, Time Warner Cable, Comcast threaten AT&T and Verizon Ethernet Market Status, FierceTelecom (Mar. 9, 2016) (“Time Warner Cable (NYSE: TWC), Comcast (NASDAQ: CMCSA) and other cable operators continue to make a dent in the Ethernet market, challenging incumbent telcos AT&T (NYSE: T) and Verizon (NYSE: VZ) as well as Level 3 Communications in the U.S. Ethernet market.”), <http://www.fiercetelecom.com/story/time-warner-cable-comcast-threaten-att-and-verizon-ethernet-market-status/2016-03-09>.

³⁰ As above, the cable locations are BDS locations, which I interpret to exclude residential broadband or connections to a non-MetroE cable headend that use DOCSIS to provide a best efforts service. See [Mari Silbey](#), Moffett: Business Services Critical to Cable Growth, Light Reading (Dec. 1, 2015) (noting that cable “[c]ommercial services only make up roughly 10% of revenue contribution today, but they’re growing at a 20% rate,” which is approximately 44% estimated growth since 2013), <http://www.lightreading.com/cable/cable-business-services/moffett-business-services-critical-to-cable-growth/d/d-id/719612>. Also, it is possible that although the physical growth rate of cable networks was about 50%, the act of adding service guarantees to existing DOCSIS service could lead to much higher growth rates within the BDS market.

Number of providers	ILECs assumed everywhere UNE locations assumed ILEC		ILECs assumed everywhere UNE locations assumed CLEC	
	Number of buildings	Percentage of buildings	Number of buildings	Percentage of buildings
1	939,638	77.2	694,982	57.1
2	265,708	21.8	479,615	39.4
3	9,482	0.8	33,693	2.8
4	1,335	0.1	5,564	0.5
5	495	0	1,709	0.1
6	318	0	1,413	0.1

Table 7: Number of competitors per building

In either case, the number of competitors per building seems small with the median building being served by a single provider. In the first case, 21.8% of buildings are served by two providers, and in the second, 39.4%. Almost no buildings are served by 3 or more providers. Thus, by this measure, there is relatively little competition present.

We also observe very few buildings with facilities-based competition. The level of competition observed in Table 7 is in part due to the assumption that ILECs are everywhere. If we consider only the set of buildings where ILECs list an active customer or CPs list being able to serve a customer with facilities (so UNE buildings are dropped), we have a set of 1,055,517 buildings, of which 778,179 (74%) are served only by ILECs, 214,502 (20%) are served only by CPs (include ILEC-affiliated CLECs), and only 62,836 (less than 6%) are served by both.

Although it appears in Table 7 that relatively few buildings are served by competitive providers, that result may be masking important heterogeneity in buildings. In their narrative responses, CPs reported that they target high bandwidth and fiber customers. It is possible that Table 7 understates important competition at higher bandwidths. In order to pursue this issue, I examined the set of buildings in which an ILEC or CP reported fiber connections. There were nearly 490,000 of these, or about 40 percent of the unique 1.2 million locations reported. Table 8 provides the breakdown by carrier type. We see that 6% of buildings with fiber are served by both an ILEC and a CP, somewhat higher than buildings overall. More strikingly, the number of buildings served by CPs is almost equal that of ILECs. Thus, when looking at fiber-connected buildings, which are presumably buildings with greater demand, whether due to at least one high-bandwidth customer or many small customers, CPs are a much more robust presence.³¹

³¹ As stated above, it would be interesting to study the market for customers that require bundles of locations to be served, to see whether CP services are viable. I discuss the data requirements in the conclusion section.

	ILEC only	CP only	ILEC and CP	Total
Number of buildings with fiber	237,730	221,469	27,866	487,085
Percent of total buildings with fiber	49%	45%	6%	100%
Percentage of total 1.2 M buildings	20%	18%	2%	41%

Table 8: Buildings served by fiber

There are some problems inherent in analyzing the data at the building level. It is possible that providers in nearby buildings exert competitive pressure even if they cannot immediately serve the building in question. A further problem is that many buildings may contain only one customer, and thus we will observe only one provider regardless of how competitive the market to serve that customer is. For these reasons, we also consider the census block. A census block can be thought of as a city block, and in many cases, there are multiple potential customers in a block. As discussed earlier, based on narrative evidence about CP buildout strategies, building across a census block is often feasible.³²

I look only at the approximately 650,000 census blocks in the data with reported locations, rather than all census blocks in the United States.³³

Table 9 reports the percentage of census blocks with a given number of competitors, as well as the mean number of competitors, by provider type. Strikingly, the vast majority of census blocks have 0 or 1 of each of the 5 competitor types. Although the average census block has 0.36 competitive providers, we see that 69.05% have no competitive provision at all. Even counting ILECs, less than 5% of census blocks have 3 competing firms in them. Some reports suggest cable providers have grown by 50% since the collection of these data, but even if we optimistically assume that cable is now in 50% more census blocks, the qualitative results do not change. However, we should keep in mind that based on the results in Table 8, selecting on census blocks served by fiber presumably would show a much stronger CP presence.

Number of Providers	1. ILEC in Region	2. Cable	3. ILEC Affiliated CP	4. Other CLEC	5. Competitive Providers (2+3+4)	6. Total (1+5)
0	0	80.33	98.46	87.15	69.05	0
1	98.95	19.26	1.39	11.49	27.15	68.38
2	1.04	0.39	0.14	1.03	2.83	27.57
3	0.01	0.01	0.01	0.23	0.58	3.00
4	0.00	0.00	0	0.08	0.20	0.63

³² However, blocks may be large in some cases so building across a block may be expensive, and when census blocks are small, they are often in dense locations where obtaining permissions to build and deployment is more problematic. Nonetheless, census blocks are another useful cut of the data to evaluate competition.

³³ The 2010 Census defined 11,166,336 Census blocks. From 2010 Census Tallies of Census Tracts, Block Groups & Blocks for United States, Puerto Rico, and the Island Areas. See U.S. Census Bureau, <https://www.census.gov/geo/maps-data/data/tallies/tractblock.html>.

Number of Providers	1. ILEC in Region	2. Cable	3. ILEC Affiliated CP	4. Other CLEC	5. Competitive Providers (2+3+4)	6. Total (1+5)
5 or more	0	0.00	0	0.03	0.19	0.42
Mean	1.01	0.20	0.02	0.15	0.36	1.38

Table 9: Number of Facilities-Based Providers per Census Block

In some of the price regressions that follow, I distinguish between census blocks subject to different regulatory status. These regressions might be difficult to interpret if the level of competition under different regulatory regimes were very different. However, that is not the case. In Table 10, I present just column 5 of Table 9, broken up by whether census block is under a price cap, or subject to Phase 1 or Phase 2 pricing flexibility regulation. We see more providers in Phase 1 markets, and more still in Phase 2 markets, but the difference is not enormous. There are an average of 0.33 CPs in price cap regions, and 0.41 in Phase 2 areas.

Number of Providers	Phase 1	Phase 2	Price Cap	All Areas
0	70.24%	66.69%	69.49%	69.05%
1	25.21	28.12	28.27	27.15
2	3.07	3.90	1.95	2.83
3	0.80	0.81	0.23	0.58
4	0.32	0.28	0.04	0.20
5 or more	0.36	0.20	0.02	0.19
Mean	0.37	0.41	0.33	0.36

Table 10: Number of competitive providers per census block by Regulatory Regime

C. Prices

I now turn to the price data. For each price, I observe the name of the customer, an indicator about the type of customer (provider, mobile provider, end user), the provider, the type of provider (ILEC, CLEC, Cable), the bandwidth, and whether the service is circuit-based or packet-based. Based on the location data analyzed above, the FCC has added several variables, such as the number of facilities-based competitors in the building, and the number in the census block. Given the results in Table 7 and Table 9, I focus on indicators for whether there is competition in the building or census block, since that captures most of the variation in the data. I also have census data at the zip code level, such as the number of establishments, the total payroll and total employment. A detailed description of the variables and their construction appears in Attachments 1-2.

Table 11 presents the number of observations by product.³⁴ The data provide extensive information about DS1 lines, more than 2 million observations. Even for higher-end products, the data have more than 30,000 observations. This is important because a priori, it is not clear which products should exhibit competitive effects. In addition, Table 12 provides the number of observations by provider. We have a large number of observations of ILECs, and we have more than 180,000 observations each of both ILEC-affiliated CLECs and Other CLECs. Even for cable companies, we observe more than 90,000 prices. The data set is truly vast, since these numbers of observations are computed after having summed up over circuit elements and averaging over month-to-month variation.

DS1	DS3	45 - 1024 Mbps	> 1024 Mbps
2,132,847	206,945	259,054	37,481

Table 11: Number of Observations by Product

ILEC in-region	ILEC-affiliated CLEC	Cable	Other CLEC
2,076,427	189,106	95,044	275,750

Table 12: Number of Observations by Provider

Before turning to price regressions, I present some important summary tables from the regression data set. In the regressions, I use only observations from ILECs in their region. In particular, my dependent variable is ILEC in-region prices. Summary statistics appear in Table 13.

	DS1	DS3	High Bandwidth
Price (\$)	218.96	1,314.03	3,002.09
Std Deviation of Price	252.36	4,400.74	9,138.56
Facilities-Based Comp. Provider in Bldg	0.24	0.44	0.45
An Indep. CLEC has Fiber in the CB	0.87	0.93	0.93
Customer is a Telecom Provider	0.90	0.90	0.81
Customer is a Mobile Telecom Provider	0.24	0.23	0.35
Customer is a Cable Operator	0.03	0.02	0.00
Packet-Based Connection	0	0	0.86
Observations	1,399,440	120,129	80,326

Table 13: Summary Statistics for Price Data for ILEC (in region) prices

The table reports three columns, for DS1 lines, DS3 lines, and all others, which the table refers to as “High Bandwidth,” referring to all services, circuit- or packet-based with throughput in excess of a DS3 (45 Mbps).³⁵ The average price differs significantly, with the price of DS1 lines at \$218.96 per month, DS3 lines at \$1,314.03 per month, and the rest substantially more.

The vast majority of sales are to other telecom providers, about 90%. About a quarter of that is for mobile providers, even for DS1 lines, suggesting that in 2013 many mobile towers still utilized DS1 lines for backhaul. About 86% of the higher bandwidth circuits are packet-based. The regressions contain

³⁴ A discussion of the methodology used for constructing the monthly billing observations into a data set for analysis, including the aggregation of monthly elements into monthly circuits and monthly circuits into an average, is provided in Attachment 1.

³⁵ Due to timing constraints, the data set analyzed did not include packet-based services with bandwidths of 45 Mbps and less.

several more variables, such as some census data. Attachment 2 provides tables with descriptions of all variables used and more descriptive measures of each variable, such as the median, minimum, and maximum.

Now we turn to price regressions. An observation is a price paid by a customer, and the dependent variable in all of the regressions is the log of price. By using the log, I can interpret coefficients as the percent change in price. I use only ILEC prices. I present separate regression for DS1 lines, DS3 lines, and all lines with greater than DS3 bandwidth (greater than 45 mbps), which I term “High Bandwidth” observations.

To measure competition, I focus on an indicator for when a facilities-based competitor can serve a customer in the census block. This indicator is drawn from the location data used to construct the building-level analysis described above. Thus, the indicator is on if a CLEC has a connection to a building in the census block, whether or not the CLEC has an active customer.

To further explore the effect of local competition, I also break out this indicator into whether the competitor has a customer in the same building as the ILEC customer in question, or just in the same census block. In order to check whether more competitive provision leads to further lower prices, I also present a regression where, rather than an indicator for facing a competitor in the census block, I include indicators for different numbers of competitors. In addition, I present a regression with an indicator for competitive provision at the census tract, to check for an effect of more distant competition.

In addition, in some cases I use an indicator for whether an Independent CLEC has a fiber optic cable in the census block. This indicator is drawn from network maps provided to the FCC by CPs, and thus is drawn from a separate data set than the one used to construct the indicators for a CP in the building, census block or tract. The theory behind using this variable is that it might be relatively easy to build out from the network throughout the census block, even if the CP is not currently connected to any buildings. It is possible for this indicator to be off even when there is a CP customer in the census block. This can arise because the CP serves the customer without fiber, or because the network just skirts a census block border. It can also happen because of data error, which can happen any time that a researcher combines information from two separate data sets.³⁶ The rest of the results change very little when dropping this variable.

The basic idea that motivates my regressions is that if more competition reduces prices, it tells us that markets without competition exhibit market power. If the threat of entry, or alternatively highly elastic demand, eliminated the ability to raise price over competitive levels, we would not see prices decline when actual entry occurred.³⁷ I do not test whether entry eliminates market power, or how much entry would be necessary to do so. The goal of this paper is to detect market power.

In this statistical analysis, it is important that the presence of competition determines the price, rather than that the price determines the presence of competition, or that some omitted variable determines both price

³⁶ It is possible that some ILECs with ILEC-affiliated CLECs reported their network in both their CLEC and ILEC areas, which is contrary to the goals of the data collection. Therefore I used an indicator for the presence of an Independent CLEC fiber network in the census block, which would exclude ILEC-affiliated CLECs but include both Cable and Other CLEC’s facilities.

³⁷ The idea of using the relationship between prices and entry to detect entry is well-known in the field of antitrust. A well-known example is the FTC vs. Office Depot and Staples. See FTC, <https://www.ftc.gov/enforcement/cases-proceedings/1510065/ftc-v-staplesoffice-depot>.

and entry. My approach relies on some randomness (at least, relative to the other variables I study) in how CPs choose where to enter, driven perhaps by strategic decisions or internal cost concerns.

A major concern is that locations differ in important and unobservable ways. For instance, locations may differ in how costly they are to serve with BDS. Thus, low cost areas might see low prices and high competition independent of any causal effect of competition on price. Locations also differ in their regulatory status, such as whether they are subject to price flex regulation, and locations differ to the extent they face competition from outside the BDS market, such as from best efforts cable, or from locations without an active BDS, but with HFC connections to a MetroE capable headend. To address these issues, I use location fixed effects in my regressions. In particular, I try both census tract fixed effects and county fixed effects.

With census tract fixed effects, I cannot measure the effects of variables that vary across census tracts, but not within them. For those not familiar with fixed effects in a regression framework, I provide some intuition. Using census tract fixed effects is intuitively akin to the following: At each census tract, I take the average ILEC price at census blocks with a CP, and the average ILEC price in census blocks without a CP. I then compute the difference in these average prices. Thus, it is like having a data set where the observation is a census tract and the data are the price difference observed in the tract. The coefficient in the regression is essentially the average difference over the census tracts.

Importantly, if some factor affects one census tract but not another, but affects the ILEC prices in both the competitive census blocks and the non-competitive ones in the same way, it will not affect the coefficient that I measure. For instance, suppose that in census tracts with Phase II pricing flexibility, the ILEC raises all of its prices by \$10, and in census tracts with strong cable presence, the ILEC lowers all prices by \$10. Although prices in both competitive and non-competitive census blocks in these tracts have changed by \$10, I use only the difference in those prices, which has not changed. Thus, to the extent that my setup is appropriate, it does not matter whether some markets differ in ways that are constant across the census tract, since the fixed effects allow me to isolate the effect of the competitive variables by comparing only within census tracts. In this way, I measure the effect of the competitive variables I focus on, without including explicit measures of every variable that affects the BDS market, many of which are unobserved.

Thus, I control for the effects of unobserved cost, price flex regulation and cable penetration, among other issues, with location fixed effects. I am not claiming that those unobserved variables are not important. Indeed, it is entirely possible that these variables have important effects on prices. My only claim is that my regressions measure the effect of competition in the BDS market, over and above any of those effects that might also be present. Regardless of how big or small unobserved effects might be, I show the effect of the CPs serving customers in a census block. To the extent that local BDS competition is important, it shows that those other effects at the very least cannot be eliminating all market power in all the BDS markets.

I do not include provider fixed effects. That is because the ILECs rarely vary within census tracts or counties, so provider fixed effects would be identified from only unusual circumstances. Thus, another attractive feature of using census tract fixed effects or county fixed effects is that it addresses provider heterogeneity. Indeed, location fixed effects can be interpreted as addressing provider-location heterogeneity.

My approach is problematic to the extent that unobserved effects differ across census blocks within the same census tract. For instance, it might be the unobserved costs of providing service varies substantially even within census tracts. Also, it is possible that the ability of cable operators to provide alternatives to

BDS (such as service over via best effort cable) varies across census blocks within the same census tract. These issues are difficult to address directly, but I discuss them in turn after presenting the results.

My results rely on how ILECs respond to local competitive conditions. A concern is that under price-cap regulation, ILECs must set a single price for a particular service with the same term and volume commitments, and other characteristics in any given density zone. Thus, prices are unlikely to vary within census tracts or sometimes even counties. In that case, how can I find or interpret any results? I provide two possible answers. First, as discussed above, some locales are under more liberal regulation and are subject to pricing flexibility. Thus, my results could be an average of effects in price-capped and price flexibility areas. In this case, breaking out results by these areas should find much larger effects in price flexibility areas, and essentially no effect in areas with price caps. Indeed, I perform such an exercise and find results along these lines.³⁸

Second, keep in mind that I do not observe prices, but rather average revenue. In practice, ILECs can offer discounts for various factors, such as term commitments or volume commitments. While these must be constant across study areas, the provider has an expectation over which customers will be interested in these discounts, and thus the provider can structure discounts in a way that they will particularly appeal to customers that face competition. Thus, although the ILECs do not discount prices to firms that face competition directly, ILECs can *de facto* achieve the same goal through thoughtful discount plans that are consistent with tariffing regulation.

In addition to the indicators for competition and the location fixed effects, I use several other control variables. I use indicators for whether the customer is a telecommunications firm and whether the firm is a mobile telecommunications firm. I also include an indicator for whether the customer is a cable operator. For the regressions with high-bandwidth prices, I include controls for the log of bandwidth and whether the connection is packet- or circuit-based. I also include several control variables from the census that are measured at the level of the 5 digit zip code: the log of employment, the log of payroll and the log of the number of establishments.³⁹ In addition, I use two measures of the number of establishments in a census block from Dun & Bradstreet, the number of establishments in the block and the number of establishments per square mile in the census block.⁴⁰ These are meant to control for demand. I use robust standard errors in all regressions.

The first set of results appears in Table 14. In this regression, I use a single variable to measure competition, an indicator variable for whether a CP can serve a customer in the same census block. Recall that a CP can serve a customer if it has a physical connection to the customer's building, even if it does not have an actual sale at the time of the survey. With census-tract fixed effects, we see negative and statistically significant effect for DS1 and DS3 lines. The presence of competition for DS1 lines is associated with a 3.2% decline in prices, which is economically significant, although not especially large

³⁸ See Table 20.

³⁹ When using zip code measures with census tract fixed effects, it is important to remember that census tracts are a finer geographic measure than zip codes. That is, there are substantially more census tracts than zip codes in the US. Many census tracts do not perfectly fit in a zip code, so the effect of zip code demographics are identified but the interpretation of census variables when they are identified by these overlap areas is confusing. Thus, I do not emphasize the interpretation of the coefficients on the census variables in my discussion.

⁴⁰ I have Dun & Bradstreet data only for census blocks located in MSAs.

by the standards of competition analysis.⁴¹ However, for DS3 lines, the effect is a 10.9% decrease in price. When we turn to county fixed effects, we find large effects for competition for DS1 and DS3 lines. Competition is associated with a 5.6% decline in prices for DS1 lines and an 11.4% decline for DS3 lines. The effect for high-bandwidth lines is statistically insignificantly different from zero for census tract fixed effects and is positive for county fixed effects.⁴²

Whether census-tract fixed effects or county fixed effects are more appropriate is difficult to say. Naturally, census-tract fixed effects better insulate regression results against unobserved heterogeneity. However, highly granular fixed effects can capture too much variation in the sense that they prevent us from making use of any regional variation in market structure, even if that variation is large or useful for identification purposes. Ideally, we look for results that are robust across specifications, and those become more apparent as we dig deep into these regressions.

In the data, we observe an alternative measure of competition to location presence, which is whether the competitor has fiber network in the census block. This variable is drawn from the network maps provided by the CLECs. In Table 15, I include an indicator for whether an independent CLEC has fiber network in the census block.⁴³ The effects are fairly small and insignificant for census tract fixed effects, but are large and important for county fixed effects. More importantly, the coefficients on the first variable, the indicator for a competitor being able to serve the block, do not change much from Table 14 which excludes the effect of Independent CLEC fiber networks in the census block. One might think that the appropriate specification would involve interacting the two competition variables, to see if the presence of competitive fiber in the block caused the effect of having a CP serve a building in the block to decrease. However, Table 16 presents this interaction and it is negative, suggesting that if anything, the effect of competition is stronger when there is competitive fiber in the block. Going forward, I focus on the indicators for competitive location rather than fiber in the block.

Table 17 explores the source of the competitive effect by breaking out the indicator for competition into an indicator for competition in the building and an indicator for competition in the block. The indicator for competition in the block is on only if the competitor is not in the building, so for instance, the building indicator could be on and the block variable could be off simultaneously if the only competitor in the block happens to be in the same building. With census tract fixed effects, we see a fairly large effect for competition in the building variable for DS1 lines, -4.7%, and a smaller but still significant effect for the

⁴¹ I interpret the coefficients on dummy variables as percentage effects, so I interpret a coefficient of -0.05 as implying that competition reduces price by 5%. However, this is not strictly accurate. To see this, define $P = \exp(X\beta + \alpha D)$, where X is a vector of explanatory variables, D is a dummy variable, and β and α are estimated parameters. Let P_1 be the value of P when $D=1$ and P_0 be the value of P when $D=0$. The percentage effect of D is $(P_1 - P_0)/P_1$, which in this case is $\exp(\alpha) - 1$. The formula $\exp(\alpha) - 1$ is approximately equal to α when α is close to zero. For instance, the true percentage increase when $\alpha=0.02$ is 2.02%, and when $\alpha=-0.02$ is -1.98%. For $\alpha=0.05$ and -0.05, these values are 5.12% and -4.88%, and for $\alpha=0.20$ and $\alpha=-0.20$, these values are 22.14% and -18.12%.

⁴² Because my paper emphasized the effect of competition, I do not dwell on the other control variables, but certainly it seems sensible that price increases with increases in the bandwidth of a service. Packet-based service, especially for high-bandwidth options, can often be cheaper to provide, which would explain the negative coefficient there. The demographic variables are difficult to interpret since they are highly collinear, and they capture a mix of demand features and economies of density.

⁴³ This variable ignores whether ILEC-affiliated CLECs have fiber in the block. We know they rarely enter with facilities, and so this variable is meant to guard against ILEC-affiliated CLECs that may have reported their ILEC fiber networks.

block -2.7%. For DS3 lines, we see an important negative effect for the building, -6.3%, and even larger effect for the block at -11.8%. The high bandwidth results are difficult to interpret – insignificant and small for the building and positive for the census block. As with Table 14, the negative price effects for DS1 and DS3 lines are similar and perhaps larger with county fixed effects. For DS1 lines, the building effect is -6.6% and the block effect is -4.4%, and for DS3 lines, these numbers are -4.7% and -12.4%. The results for high-bandwidth lines are again inconclusive.

Overall, it appears that the physical presence of local competition is important for DS1 and DS3 lines for either set of location fixed effects. Effects appear larger and more apparent for DS3 lines than DS1 lines. This result may reflect the increasing willingness of competitors to build out for DS3 lines rather than DS1 lines because DS3 customers represent higher demand. Note that the DS3 regressions suggest that the results cannot be entirely driven by unobserved cost heterogeneity because we would expect to see stronger effects at the building relative to the block if that were the case.⁴⁴

Competition might be important not just in the census block, but over some wider area. Although narrative evidence on build-out strategies suggest that the effects of competition cannot extend too far, it is useful to consider what price regressions say about this. In Table 18, I include separate indicators for competition in the building, the census block and the census tract. Again, these variables are defined so that they indicate further competition in the block or the tract, over and above any competition in a smaller geography. This feature implies that the coefficient on the census tract indicator is identified even when using census tract fixed effects, since the indicator will vary within a census tract based on whether we consider ILEC prices to customers in the same building or block as the rival. For instance, in a census tract with a single CP building, the census tract indicator of competition will be off when we consider ILEC prices in that building and in that block, but the indicator will be on for ILEC prices in the rest of the census tract.

The indicator for a CP in the census tract is negative and significant for DS1 and DS3 lines, and is particularly large for DS3 lines, -21% for census tract fixed effects and -3.6% for county fixed effects. The coefficients on the building and block indicators are similar to those in Table 17. These results suggest that the relevant market may be wider than a census block. It would be interesting to pursue this further. An alternative to using geographic boundaries such as census blocks and census tracts to define markets would be to define a radius around each customer, and count the number of competitors that fall within that radii. An advantage of using census blocks and tracts as I do here is that they often scale in size appropriately with local travel costs, and also we often observe useful demographic data at this level from the census or other sources, such as Dun & Bradstreet. Furthermore, it is easy to impose and interpret location fixed effects. The advantage of using radii to determine markets is that each customer is defined to be in an individualized market, and furthermore, we can scale radius easily to determine the appropriate market size. Pursuing the radius approach is an interesting topic for future research.

Interestingly, the effect is negative and significant for high bandwidth lines under county fixed effects, and large at -7.3%. However, while the parameter for census tract fixed effects appears sizeable, -3.9%, the parameter is not statistically significantly different from zero. Overall, my approach to detecting

⁴⁴ That is, if there were variation within the block, we would expect to see competition attracted to buildings that were low cost, in which case those buildings would have high competition and low prices, which is inconsistent with Table 17. It is still possible that there is unobserved heterogeneity that operates at the level of the census block, but not within census blocks. That seems unlikely, but cannot be ruled out. If I had panel data, it would be interesting to study how a CP entered one building in a block and then spread to others. However, these results suggest that distinguishing between competition in the building and the block is not particularly important.

market power finds inconsistent and insignificant results on local competition for high bandwidth customers. A potential explanation is that multiple CPs are willing to build to high bandwidth customers, so that this market is relatively competitive. Going forward, I focus on DS1 and DS3 lines.

The fact that I do not detect an effect of competition for high bandwidth lines has an important implication for interpreting results. A potential problem for interpreting the results here would be if CPs competed for particularly high quality customers, who also paid high prices. Thus we could observe a negative correlation between price and competition not because competition has a direct effect on price but instead because competition steals high quality customers, leaving the ILEC with low quality, low price customers. However, that explanation is not consistent with our results. DS1 and DS3 lines are relatively homogenous products and yet we see stronger negative effects there than for high bandwidth lines, where we believe the importance of unobserved quality is much more important.

Focusing on an indicator for competition in the same building rather than the number of competitors in the same building is natural because there are so few buildings with multiple competitors. However, at the level of the census block, it is possible to consider different effects for different numbers of competitors. I explore this in Table 19. This table regresses log price on an indicator for a CP in the building, as well as three indicator variables for different numbers of additional CPs in the census block: an indicator for one additional competitor, an indicator for two or three, and an indicator for four or more. For census tract fixed effects, the effect of one competitor is negative and significant, and the effect of two or three is more negative and also significant. Although the parameters on four or more competitors are not larger than two or three for DS1 and DS3, the coefficients in these cases still appear reasonably sized and larger than the case of one CP.

The results for county fixed effects appear fairly large. First, the coefficient on the building indicator is large and significant for both DS1 and DS3 lines, at -6.5% and -5.2%. The effect of one additional competitor in the block is significant for DS1 and DS3 lines, and the effect of two or three additional competitors is more negative, and also statistically significant. The effect of four additional competitors is particularly large for DS3 lines, -28%. Overall, these results draw a pattern of increasing price effects with more competition, although with this many parameters, the results do not line up perfectly.

An important feature of the BDS market are price caps, administered by the FCC. We might expect price caps to limit any market power, and thus limit observable effects of market power on pricing because price caps limit pricing flexibility. However, as discussed above, the FCC has allowed for ILEC pricing flexibility in a number of markets. Markets with pricing flexibility can be under Phase 1 or Phase 2 flexibility, where Phase 2 indicates greater flexibility to raise prices above the price cap index (as described earlier). We expect the effect of competition to be larger in markets with pricing flexibility.

I explore this possibility in Table 20. This table returns to the specification in Table 14, which had a single measure of competition, an indicator for competition in the census block. In this case, I further interact that variable with indicators for whether the carrier has Phase 1 or Phase 2 pricing flexibility in that geographic market. Note that this regression does not test whether prices are overall higher in Phase 1 or Phase 2 markets. The FCC's pricing flexibility regime applies Phase 1 and Phase 2 to ILECs at the level of the county, so the level effect on prices will generally be absorbed by county or census tract fixed effects. But still, even with these fixed effects, we can measure whether the effect of competition differs in pricing flexibility. Intuitively, we compare census blocks with and without competition in the same census tract, and then we difference that across census tracts with and without pricing flexibility.

The results appear fairly strong, and suggest that the results up to now masked important heterogeneity across markets with and without pricing flexibility. With census tract fixed effects, DS1 lines show

almost no price change in blocks with competition with no pricing flexibility, and DS3 lines show a 12.5% increase in prices in price cap markets. In contrast, DS1 lines show an effect of -3.8% in Phase 1 markets and -4.8% in Phase 2 markets. Even more striking, DS3 lines show a parameter of -0.337 effect in Phase 1 markets, and -0.265 in Phase 2 markets. As described in Footnote 36, these correspond to percentage effects of -28.6% and -23.2%. These effects are quite large, and time constraints prevent me from further exploring these issues. But I take the main results to be that the census tracts fixed effects columns show little or no competitive effect in price cap markets, with negative effects in pricing flexibility markets.

With county fixed effects, we also see smaller effects than for price cap markets, or even a positive effect for DS3 lines. In contrast, DS1 lines show a -7.3% effect for Phase 1 and -4.0% for Phase 2. DS3 lines are more striking: -22.1% and -19.1% in Phase 2. Thus, regulatory treatment appears to have a large effect on competitive interactions.

V. CONCLUSIONS

Overall, the various sources of data tell a consistent story. The revenue data show that ILECs are an outsized presence in this industry, especially when counting their CLEC operations outside of their ILEC markets. Since most of that operation is over leased lines, it appears from the revenue data that ILECs dominate the market for facilities-based service in their regions.

The location data tell a similar overall story, with ILECs serving many more locations with facilities-based service than CPs. However, that overall story masks important variation by technology. When focusing on buildings served by fiber, CPs serve almost as many buildings as ILECs. The revenue data make clear that non-fiber service is still a major part of the industry, but to the extent that the future is with fiber, this finding could bode well for future competition in this industry, at least for high value BDS, such as high bandwidth services.

Price regressions tell a similar story. Whereas the effects of local competition, such as at the building level or the census blocks, are important for DS1 lines and particularly DS3 lines, they are much less clear for higher end bandwidths. This result holds up across a variety of specifications. There does appear to be some effect of transport fiber in the census block, even if it does not connect to a building, which speaks to CLEC buildout strategies.

The consistency of the results across the location and pricing data are important. In particular, in my approach to price regressions, it is impossible to completely control for unobserved cost and demand heterogeneity. So for instance, it is possible that low cost areas attract competitive entry, which leads to a spurious correlation between competition and price. Location fixed effects should substantially mitigate this problem, and indeed, the results within census blocks suggest that cost heterogeneity is not driving the results. Still, it cannot be ruled out. Thus, it is important that the location data, which allow us to study competition levels at the building and the census block, leads to similar conclusions. Indeed, the location data also suggest that CPs are a more robust presence for higher levels of service.

I did not test for the efficacy of competition at much longer distances both because narrative evidence from CPs on their buildout strategies suggest this is misguided, and because doing so introduces so much cost heterogeneity that it would be difficult to interpret effects. Thus, I do not address the previous regulatory regime, which applied relief from price caps at the level of the county, or even the MSA.

I do not directly control for the presence of competition from cable operators in my regressions. Rather, I use the location fixed effects to address this issue. It may be that the extent of cable provision differs within locations. For instance, in the same census tract, it could be that some areas have access to

upgraded best efforts cable technology (i.e. best efforts DOCSIS) where others do not, depending on the cable buildout strategy. If the presence of cable differs within tracts, but is random or uncorrelated with BDS competition, then accounting for it would not affect my results. It is possible that cable provision is correlated with the presence of BDS competitor provision because both types of provision should be attracted to areas of high demand.⁴⁵ If that correlation is high enough, then best efforts cable could be driving the competition coefficients I find rather than CPs within BDS. However, in that case, there is still an effect of competition on price. Knowing the distribution of cable technology might affect our interpretation of whether that competition is driven by BDS demand or by demand for the broad range of cable services, but it does not change the conclusion in this paper that there is evidence that local competition affects BDS prices.⁴⁶

Importantly, I find that the effect of competition is larger in regions with regulatory pricing flexibility. To be clear, my approach, which relies on location fixed effects and thus within region variation, does not allow me to distinguish whether price levels are higher in areas with price caps or areas with pricing flexibility. Thus, I do not directly test whether regulation is more or less effective than competition in disciplining prices. Rather, my results say that competition has bigger effects on DS1 and DS3 prices in area with pricing flexibility. This is certainly consistent with the notion that areas with pricing flexibility exhibit more market power, either because of the pricing flexibility itself, or because pricing flexibility was somehow applied in areas that exhibit more market power, although that was not the intent of the regulation.

I hope that work with these data and future data collection continue. There are basic statistical issues which would be interesting to explore, such as the use of clustered standard errors (I use robust standard errors in this paper), and specifications that allowed the effect of competition to interact with the regulatory regime. Also, the role of volume and term commitments is difficult to interpret, and deserves further exploration. It would also be interesting to contrast the effects of facilities-based entry with that of UNE entry.

In future data collection, I recommend collecting more data about managed service contracts and leased lines. I assume that price is too complex in these situations to be useful, but tracking customer names and bandwidth levels would still be quite useful. For instance, we might imagine that the market for national customers is different than for local customers. One could match customer names across contracts to see if national customers typically purchase from particular types of firms. However, that network-type analysis is impossible if we do not observe which customers purchase managed services from CLECs.

⁴⁵ Although, industry sources suggest that cable focused on relatively smaller consumers than traditional CLECs, particularly in 2013 relative to now.

⁴⁶ This discussion applies to all forms of HFC-based competition from cable, whether best-efforts, or competition where locations are connected by HFC to a MetroE-capable headend, or other forms of competition that a cable company might effectuate over HFC.

	DS-1 Tract FE	DS-3 Tract FE	Hi-Band Tract FE	DS-1 County FE	DS-3 County FE	Hi-Band County FE
A Facilities-based Competitor Can Serve a Building in the Census Block	-0.032	-0.109	0.023	-0.056	-0.114	0.046
	(0.002)*	(0.021)*	(0.018)	(0.001)*	(0.010)*	(0.011)*
Customer is a Telecommunications Provider	-0.196	-0.025	0.135	-0.131	0.014	0.146
	(0.003)*	(0.018)	(0.017)*	(0.003)*	(0.016)	(0.014)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.199	-0.364
	(0.002)*	(0.013)*	(0.012)*	(0.001)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.005	-0.472
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.027)	(0.113)*
Natural Log of Establishments in the Zip Code	0.008	0.031	-0.140	-0.023	0.070	-0.011
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.052	0.074	-0.082	0.113	0.123
	(0.007)*	(0.065)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.004	0.105	0.041	0.045	-0.181	-0.111
	(0.010)	(0.095)	(0.101)	(0.003)*	(0.024)*	(0.021)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.011	-0.024	0.005	0.021	0.062	0.028
	(0.001)*	(0.009)*	(0.008)	(0.001)*	(0.004)*	(0.005)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.045	-0.003	-0.030	-0.060	-0.042
	(0.001)*	(0.008)*	(0.007)	(0.000)*	(0.003)*	(0.003)*
Natural Log of Mbps			0.247			0.198
			(0.005)*			(0.005)*
Packet-based Connection			-0.531			-0.660
			(0.035)*			(0.027)*
Constant	5.513	5.762	5.757	6.202	6.471	6.293
	(0.027)*	(0.275)*	(0.284)*	(0.009)*	(0.067)*	(0.074)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	1,558.51	42.21	243.42	5,025.12	101.50	415.99
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p < 0.05$
Robust Std Errors in Parentheses

Table 14: Regression of Log Price on Competition in the Census Block

	DS-1 Tract FE	DS-3 Tract FE	Hi Band Tract FE	DS-1 County FE	DS-3 County FE	Hi Band County FE
A Facilities-based Competitor Can Serve a Building in the Census Block	-0.032	-0.108	0.025	-0.052	-0.104	0.054
	(0.002)*	(0.021)*	(0.018)	(0.001)*	(0.010)*	(0.011)*
An Indep. CLEC Has a Fiber Network in the Census Block	-0.003	-0.016	-0.030	-0.046	-0.121	-0.073
	(0.002)	(0.035)	(0.025)	(0.002)*	(0.016)*	(0.017)*
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.012	0.146
	(0.003)*	(0.018)	(0.017)*	(0.003)*	(0.016)	(0.014)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.196	-0.364
	(0.002)*	(0.013)*	(0.012)*	(0.001)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.006	-0.467
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.026)	(0.113)*
Natural Log of Establishments in the Zip Code	0.008	0.031	-0.140	-0.022	0.075	-0.010
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.051	0.075	-0.081	0.123	0.124
	(0.007)*	(0.065)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.004	0.104	0.040	0.045	-0.196	-0.111
	(0.010)	(0.095)	(0.101)	(0.003)*	(0.024)*	(0.021)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.023	0.006	0.022	0.064	0.029
	(0.001)*	(0.009)*	(0.008)	(0.001)*	(0.004)*	(0.005)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.045	-0.004	-0.030	-0.059	-0.042
	(0.001)*	(0.008)*	(0.007)	(0.000)*	(0.003)*	(0.003)*
Natural Log of Mbps			0.247			0.198
			(0.005)*			(0.005)*
Packet-based Connection			-0.531			-0.660
			(0.035)*			(0.027)*
Constant	5.515	5.776	5.785	6.222	6.539	6.338
	(0.027)*	(0.277)*	(0.285)*	(0.009)*	(0.068)*	(0.075)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	1,402.67	38.02	223.50	4,548.82	96.99	382.86
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p < 0.05$

Robust Std Errors in Parentheses

Table15: Regression of Log Price on Competition and CLEC Network in the Block

	DS-1 Tract FE	DS-3 Tract FE	Hi Band Tract FE	DS-1 County FE	DS-3 County FE	Hi Band County FE
A Facilities-based Competitor Can Serve a Building in the Census Block	-0.017 (0.005)*	0.032 (0.063)	0.040 (0.057)	-0.016 (0.004)*	-0.023 (0.032)	0.085 (0.041)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.000 (0.002)	0.035 (0.041)	-0.028 (0.026)	-0.038 (0.002)*	-0.090 (0.021)*	-0.066 (0.018)*
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016 (0.005)*	-0.151 (0.066)*	-0.016 (0.059)	-0.039 (0.004)*	-0.088 (0.033)*	-0.033 (0.042)
Customer is a Telecommunications Provider	-0.196 (0.003)*	-0.025 (0.018)	0.136 (0.017)*	-0.131 (0.003)*	0.011 (0.016)	0.146 (0.014)*
Customer is a Mobile Telecommunications Provider	0.103 (0.002)*	0.194 (0.013)*	-0.201 (0.012)*	0.147 (0.001)*	0.194 (0.010)*	-0.364 (0.010)*
Customer is a Cable Operator	-0.073 (0.003)*	-0.050 (0.027)	-0.464 (0.140)*	-0.055 (0.003)*	-0.007 (0.026)	-0.467 (0.113)*
Natural Log of Establishments in the Zip Code	0.009 (0.005)	0.033 (0.048)	-0.140 (0.051)*	-0.022 (0.002)*	0.078 (0.014)*	-0.010 (0.014)
Natural Log of Annual Payroll in the Zip Code	-0.015 (0.007)*	-0.049 (0.065)	0.074 (0.074)	-0.079 (0.002)*	0.128 (0.017)*	0.125 (0.015)*
Natural Log of Employment in the Zip Code	-0.004 (0.010)	0.101 (0.095)	0.041 (0.101)	0.043 (0.003)*	-0.204 (0.024)*	-0.112 (0.020)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012 (0.001)*	-0.024 (0.009)*	0.006 (0.008)	0.022 (0.001)*	0.064 (0.004)*	0.029 (0.005)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007 (0.001)*	0.045 (0.008)*	-0.003 (0.007)	-0.030 (0.000)*	-0.059 (0.004)*	-0.042 (0.003)*
Natural Log of Mbps			0.247 (0.005)*			0.198 (0.005)*
Packet-based Connection			-0.531 (0.035)*			-0.659 (0.027)*
Constant	5.513 (0.027)*	5.724 (0.277)*	5.783 (0.285)*	6.214 (0.009)*	6.511 (0.069)*	6.331 (0.075)*

Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	1,276.67	34.91	206.30	4,151.66	89.77	353.39
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

Table 16: Regression of Log Price on Competition, Interacted with the Presence of Fiber in the Block

* $p < 0.05$
 Robust Std Errors in Parentheses

	DS-1 Tract FE	DS-3 Tract FE	Hi Band Tract FE	DS-1 County FE	DS-3 County FE	Hi Band County FE
A Facilities-based Competitor Can Serve the Building	-0.047	-0.063	-0.023	-0.066	-0.047	-0.014
	(0.002)*	(0.016)*	(0.017)	(0.002)*	(0.010)*	(0.011)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.118	0.053	-0.044	-0.124	0.062
	(0.002)*	(0.018)*	(0.016)*	(0.001)*	(0.010)*	(0.010)*
Customer is a Telecommunications Provider	-0.197	-0.026	0.135	-0.132	0.012	0.147
	(0.003)*	(0.018)	(0.017)*	(0.003)*	(0.016)	(0.014)*
Customer is a Mobile Telecommunications Provider	0.104	0.195	-0.201	0.149	0.198	-0.363
	(0.002)*	(0.013)*	(0.012)*	(0.001)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.005	-0.466
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.027)	(0.113)*
Natural Log of Establishments in the Zip Code	0.009	0.037	-0.143	-0.023	0.066	-0.007
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.020	0.064	-0.073	0.120	0.124
	(0.007)	(0.066)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.008	0.067	0.054	0.037	-0.185	-0.114
	(0.010)	(0.096)	(0.101)	(0.003)*	(0.024)*	(0.020)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.016	-0.000	0.021	0.071	0.022
	(0.001)*	(0.009)	(0.008)	(0.001)*	(0.004)*	(0.005)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.044	0.000	-0.028	-0.061	-0.037
	(0.001)*	(0.008)*	(0.007)	(0.000)*	(0.004)*	(0.003)*
Natural Log of Mbps			0.247			0.197
			(0.005)*			(0.005)*
Packet-based Connection			-0.530			-0.658
			(0.035)*			(0.027)*
Constant	5.500	5.654	5.785	6.158	6.432	6.279
	(0.027)*	(0.277)*	(0.284)*	(0.009)*	(0.067)*	(0.075)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	1,434.20	40.55	223.52	4,538.74	98.73	380.33
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p < 0.05$

Robust Std Errors in Parentheses

Table17: Regression of Log Price on Competition in the Building and the Block

	DS-1 Tract FE	DS-3 Tract FE	Hi Band Tract FE	DS-1 County FE	DS-3 County FE	Hi Band County FE
A Facilities-based Competitor Can Serve the Building	-0.051	-0.074	-0.026	-0.069	-0.049	-0.023
	(0.002)*	(0.016)*	(0.017)	(0.002)*	(0.010)*	(0.011)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.033	-0.136	0.049	-0.049	-0.126	0.058
	(0.002)*	(0.018)*	(0.017)*	(0.001)*	(0.010)*	(0.010)*
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.030	-0.210	-0.039	-0.039	-0.036	-0.073
	(0.003)*	(0.039)*	(0.033)	(0.002)*	(0.013)*	(0.012)*
Customer is a Telecommunications Provider	-0.197	-0.025	0.135	-0.132	0.011	0.146
	(0.003)*	(0.018)	(0.017)*	(0.003)*	(0.016)	(0.014)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.198	-0.366
	(0.002)*	(0.013)*	(0.012)*	(0.001)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.005	-0.470
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.027)	(0.114)*
Natural Log of Establishments in the Zip Code	0.008	0.039	-0.143	-0.025	0.065	-0.008
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.011	-0.023	0.065	-0.065	0.126	0.135
	(0.007)	(0.066)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.009	0.068	0.053	0.032	-0.189	-0.120
	(0.010)	(0.096)	(0.101)	(0.003)*	(0.024)*	(0.021)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.020	-0.001	0.021	0.070	0.021
	(0.001)*	(0.009)*	(0.008)	(0.001)*	(0.004)*	(0.005)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.047	0.000	-0.027	-0.060	-0.036
	(0.001)*	(0.008)*	(0.007)	(0.000)*	(0.004)*	(0.003)*
Natural Log of Mbps			0.247			0.198
			(0.005)*			(0.005)*
Packet-based Connection			-0.530			-0.658
			(0.035)*			(0.027)*
Constant	5.524	5.860	5.815	6.141	6.424	6.264

	(0.027)*	(0.280)*	(0.284)*	(0.009)*	(0.068)*	(0.075)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	1,312.39	38.62	206.73	4,183.88	91.46	361.38
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p < 0.05$
Robust Std Errors in Parentheses

Table18: Regression of Log Price on Competition in the Building, the Block and the Tract

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor Can Serve the Building	-0.048 (0.002)*	-0.066 (0.016)*	-0.065 (0.002)*	-0.052 (0.010)*
One Facilities-based Competitor is in the Block But Not the Building	-0.018 (0.002)*	-0.095 (0.020)*	-0.028 (0.001)*	-0.070 (0.011)*
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051 (0.002)*	-0.154 (0.022)*	-0.075 (0.002)*	-0.159 (0.013)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040 (0.004)*	-0.132 (0.031)*	-0.065 (0.003)*	-0.280 (0.019)*
Customer is a Telecommunications Provider	-0.197 (0.003)*	-0.025 (0.018)	-0.132 (0.003)*	0.010 (0.016)
Customer is a Mobile Telecommunications Provider	0.103 (0.002)*	0.195 (0.013)*	0.149 (0.001)*	0.194 (0.010)*
Customer is a Cable Operator	-0.073 (0.003)*	-0.049 (0.027)	-0.056 (0.003)*	-0.010 (0.026)
Natural Log of Establishments in the Zip Code	0.008 (0.005)	0.038 (0.048)	-0.025 (0.002)*	0.063 (0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.008 (0.007)	-0.011 (0.066)	-0.068 (0.002)*	0.144 (0.017)*
Natural Log of Employment in the Zip Code	-0.011 (0.010)	0.057 (0.096)	0.034 (0.003)*	-0.209 (0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.013 (0.001)*	-0.014 (0.009)	0.023 (0.001)*	0.080 (0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006 (0.001)*	0.043 (0.008)*	-0.028 (0.000)*	-0.060 (0.004)*
Constant	5.486 (0.027)*	5.623 (0.278)*	6.133 (0.009)*	6.331 (0.068)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	1,205.98	34.64	3,799.32	91.43
Observations	1,399,440	120,129	1,399,440	120,129

* $p < 0.05$
Robust Std Errors in Parentheses
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Table19: Regression of Log Price on Number of Competitors in the Census Block

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor Can Serve a Building in the Census Block	0.001 (0.003)	0.125 (0.030)*	-0.009 (0.003)*	0.060 (0.019)*
Phase 1 x Facilities-based Competitor in Census Block	-0.038 (0.004)*	-0.337 (0.041)*	-0.073 (0.003)*	-0.221 (0.025)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048 (0.004)*	-0.265 (0.039)*	-0.040 (0.003)*	-0.191 (0.022)*
Customer is a Telecommunications Provider	-0.196 (0.003)*	-0.024 (0.018)	-0.130 (0.003)*	0.013 (0.016)
Customer is a Mobile Telecommunications Provider	0.103 (0.002)*	0.195 (0.013)*	0.148 (0.001)*	0.200 (0.010)*
Customer is a Cable Operator	-0.073 (0.003)*	-0.051 (0.027)	-0.054 (0.003)*	-0.004 (0.027)
Natural Log of Establishments in the Zip Code	0.008 (0.005)	0.038 (0.048)	-0.023 (0.002)*	0.069 (0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.015 (0.007)*	-0.038 (0.065)	-0.079 (0.002)*	0.117 (0.017)*
Natural Log of Employment in the Zip Code	-0.005 (0.010)	0.082 (0.095)	0.043 (0.003)*	-0.185 (0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012 (0.001)*	-0.025 (0.009)*	0.021 (0.001)*	0.063 (0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006 (0.001)*	0.046 (0.008)*	-0.030 (0.000)*	-0.060 (0.003)*
Constant	5.510 (0.027)*	5.772 (0.275)*	6.189 (0.009)*	6.467 (0.067)*
Adjusted R-Squared	0.33	0.26	0.18	0.10
F Statistic	1,284.75	40.55	4,168.15	89.71
Observations	1,399,440	120,129	1,399,440	120,129

* $p < 0.05$

Robust Std Errors in Parentheses

Table 20: Regression of Log Price on Competition in the Block, by Price Flex Regulation

ATTACHMENT 1 - DATA SET CONSTRUCTION AND DEFINITION OF VARIABLES

Four tables were used to calculate the connection prices. Tables II.A.12 Part 1 and II.B.4 Part 1 are the billing tables for competitor responses and “In-Region ILEC” respondents, respectively.” Tables II.A.13 and II.B.5 are the adjustment tables for competitors and “In-Region ILECs,” respectively. The billing tables contain the billed amounts for each element of a connection. Some connections consist of a single billed element covering all of the components of the connection while others contain multiple billing elements for components of the connection such as mileage, channel termination, facility charges, ports, etc. The adjustment tables contain adjustments to the bills in the billing tables that were not included on the bills in the billing table; so-called out-of-cycle adjustments. These adjustments are identified as applying to a single billing element of a single connection, multiple elements in a single connection, elements in multiple connections, or all connections purchased by a customer. The unadjusted bill for each connection is obtained by summing the total billed field for all elements that share a common value for Circuit ID, Closing Date, and Filer FRN. This yields an unadjusted bill, which is the charge for the connection (defined by Circuit ID and Filer FRN) levied on the closing date. Because a few connections have more than one closing date in a single month, it can be difficult to determine the monthly bill. Therefore all unadjusted bills that have multiple closing dates in the same month are dropped, though other bills for that specific connection are retained if they have a single closing date in the month. A bill is also dropped if the closing date is not in 2013 or if the elements within the connection list different customer ids.

Accounting for the out-of-cycle adjustments is a complicated procedure. The adjustment table lists the time period over which the adjustment was applied as well as the total amount of the adjustment. The total adjustment is distributed equally over each month of the adjustment period. Because the adjustment period commonly covers dates in 2012 for which we do not have bills and because many adjustments for 2013 bills are not issued until 2014 (and therefore not in the dataset), adjustments are tracked by the month but not the year. Therefore an adjustment that applied to a November 2012 bill (which would not be in the dataset) will be applied to the November 2013 bill of that connection. This ensures that bills receive the adjustments they are most likely to have received.

The scope of the adjustment is also indicated. The scope is one of four types: applying to a single element in a single connection, applying to multiple elements in a single connection, applying to multiple elements in multiple connections, and applying to all connections purchased by the customer.⁴⁸ The first two types of scope are relatively easy to account for as they apply to a single connection. The monthly bill for that connection is adjusted by the monthly adjustment. The adjustments that apply to more than one connection are more complicated. The monthly adjustment is distributed across the monthly bills in proportion to the size on the monthly bills of the connections to which the adjustment applies. For example, if an adjustment applies to three connections with monthly bills of \$500, \$700, and \$800 for a total of \$2000, then the bills will get 25%, 35%, and 40% of the monthly adjustment, respectively.

The resulting dataset is one of adjusted monthly billed prices for connections. Because these prices can swing widely from month to month as charges are delayed and then imposed, the simple average of the monthly bills for a connection is calculated and referred to as the “Average Monthly Price.” It was calculated based upon the number of monthly bills in the dataset. For some connections bills for all 12 months were present, while for other connections only a single month was present. Nearly half of all connections were present for the full 12 months.

Before analyzing these data, questionable observations were removed. In particular, when certain

⁴⁸ Some adjustments that are indicated as applying to a single circuit are associated to more than one circuit in the billing table. Those adjustments are assumed to apply to all circuits that they are associated with and that the error occurred in the definition of the scope of the adjustment and not in the assigning of the adjustment to circuits.

characteristics which should be constant for a connection across all elements and all time periods were instead variable, those observations were not analyzed. Those characteristics which should be constant are: circuit type, bandwidth, and customer. Connections that are strictly for transport between wire centers were also removed. These were identified as connections that do not list a location ID for any of the billing elements in the billing table. These connections were removed from the analysis because the cost structure behind providing transport is likely to be substantially different from providing service to end-user premises and therefore would make comparisons of prices less meaningful. Connections for which all of the monthly adjusted bills were exactly zero were also removed. It was determined in consultation with filers that these connections did not actually have a price of zero but rather were paid for by the customer through other means that were not captured in the data request.

A correction for the filing status of some ILECs was made. ILECs filed information in Part A of the data collection instrument that was intended to be filed by competitors for operations of their ILEC-affiliated CLECs. ILEC operations outside of their territories were appropriately filed using this section and would be classified as “Out-of-Region ILEC” operations. However, some ILECs filed this section for connections that were provided within their incumbent territory by their ILEC-affiliated CLEC. The procedure used to reclassify these observations from an “Out-of-Region ILEC” category to an “In-Region ILEC” category was as follows. The FCC identified wire centers that were most likely to serve a location (described in Table II.A.4) using a commercial product providing the boundaries of wire centers. These wire centers were identified by CLLI codes. The CLLI codes of “In-Region ILEC” wire centers were listed in table II.B.7. When an ILEC connection from Table II.A.4 Part A was served by a wire center listed by that ILEC in Table II.B.7 it was reclassified as an “In-Region ILEC” connection. If the connection from Part A was either served by another “In-Region ILEC's” wire center or the FCC was unable to determine the serving wire center, then it remained classified as an “Out-of-Region ILEC” connection.

A number of characteristics of the connections and the provider of the connection were available for analysis. Characteristics of the connections themselves are the type of connection (DS1, DS1-UNE, DS3, DS3-UNE, other circuit-based connection, and packet-based connections) and the bandwidth of the connection. The filers were also categorized. The most basic categorization was whether the filer is a competitor or an “In-Region ILEC”. This categorization was based upon whether the circuit data came from tables in section II.A or tables in section II.B. However, the competitors were further categorized. Seven ILEC filers also filed data as competitors when they were providing service outside their territories. These were referred to as “Out-of-Region ILECs.” “Cable Operators” also filed as competitors and were self-identified on the Filer Identification Information form. The remaining companies that filed as competitors and were classified as “Independent CLECs.” Information which categorized the purchasers of the connections into several categories was also available. Filers indicated whether the customer was a “Telecommunications Provider” or not. In addition, the FCC categorized customers as “Mobile Telecommunications Providers” and “Cable Operators.” If a customer was not placed into one of these categories then it was considered an “Other Customer.”

As previously mentioned, the FCC geocoded service locations (provided in Tables II.A.4 for competitors and Table II.B.3 for “In-Region ILECs”) and then aggregated them into buildings using two methods. Method number two was used to determine the building the connection serves. Not all service locations were successfully geocoded and therefore a number of circuits were excluded from analyses that required location information. Using the information provided about a service location in Table II.A.4, the competitor reporting the location was classified as either serving the location with its own facilities or with unbundled network elements (UNE). Filers reported whether they serve the location with an IRU, a UNE, or an unbundled copper loop (UCL). Filers that reported serving the location only using UNEs and/or UCLs were classified as UNE-only competitors at that location. If the filer indicated that they used an IRU to serve the location, or indicated they did not use an IRU, UNE, or UCL, then it was

classified as a facilities-based competitor at that location. With this information, the number of facilities-based competitors in a building, Census block, Census tract, and county was calculated.

Competitors were requested to supply a fiber network map in question II.A.5. These maps were used to determine the census blocks that the fiber networks passed through.

The location data allowed for the incorporation of information about the area served by the connection. The Census Bureau's data on businesses at the ZIP code level is used to enhance the information on the economic conditions at the location by introducing the total number of establishments, total mid-March employees, and annual payroll by ZIP code of the service location into the dataset. In addition, data collected by Dun & Bradstreet estimating the number of establishments in Census blocks within MSAs were submitted into the record and incorporated into the regression dataset.

Finally, using FCC records, the regulatory status of special access prices was determined for each ILEC in each county in the U.S. Each ILEC connection in the database that was successfully geocoded was categorized as being under price cap regulation, phase I pricing flexibility regulation, or phase II pricing flexibility regulation.

ATTACHMENT 2 - VARIABLES

Average Monthly Price

A continuous variable of the average monthly price. Constructed as discussed earlier in this document.

A Facilities-based Competitor Can Serve the Building

An indicator variable that is 1 when at least one competitor can serve the building. Competitors that listed a location in Table II.A.4 and did not provide the name of a UNE or UCL supplier, or indicated they had an IRU, are considered facilities-based. This is intended to indicate competitors that have their own facilities, either through ownership or an IRU, in the building. They may not be providing service at this time or they may be providing a service not captured by the data request (e.g., managed services). Locations are based upon the geo-coding and clustering method 2 implemented by FCC staff. This is necessary in order to determine when locations provided by different filers are the same building.

A Facilities-based Competitor Can Serve a Building in the Census Block

An indicator variable that is 1 when at least one competitor can serve a building located in the Census block.

At Least One Facilities-based Competitor is in the Block But Not the Building

An indicator variable that is 1 when there are more facilities-based competitors in the census block than in the building

One Facilities-based Competitor is in the Block But Not the Building

An indicator variable that is 1 when there is exactly one facilities-based competitor in the census block that is not serving the building (with its own facilities).

Two or Three Facilities-based Competitors are in the Block But Not the Building

An indicator variable that is 1 when there are two or three facilities-based competitors in the census block that are not serving the building (with their own facilities).

Four or More Facilities-based Competitors are in the Block But Not the Building

An indicator variable that is 1 when there are four or more facilities-based competitors in the census block that are not serving the building (with their own facilities).

At Least One Facilities-based Competitor is in the Tract But Not the Block

An indicator variable that is 1 when there are more facilities-based competitors in the census tract than in the census block.

An Indep. CLEC Has a Fiber Network in the Census Block

An indicator variable that is 1 when an independent CLEC, which excludes out-of-region ILECs, has a fiber network in the census block

Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB

An indicator variable that is 1 when there is an independent CLEC fiber network in the census block AND a facilities-based competitor can serve a building in the census block.

The Carrier Has Phase 1 Pricing Flexibility in the Wire Center

An indicator variable that is 1 when the ILEC has Phase 1 pricing flexibility at the location

The Carrier Has Phase 2 Pricing Flexibility in the Wire Center

An indicator variable that is 1 when the ILEC has Phase 1 pricing flexibility at the location

Phase 1 x Facilities-based Competitor in Census Block

An indicator variable that is 1 when the ILEC has Phase 1 pricing flexibility at the location AND a facilities-based competitor can serve a building in the census block.

Phase 2 x Facilities-based Competitor in Census Block

An indicator variable that is 1 when the ILEC has Phase 2 pricing flexibility at the location AND a facilities-based competitor can serve a building in the census block.

Customer is a Telecommunications Provider

An indicator variable that is 1 when the purchaser of the connection is a telecommunications provider

Customer is a Mobile Telecommunications Provider

An indicator variable that is 1 when the purchaser of the connection is a mobile telecommunications provider

Customer is a Cable Operator

An indicator variable that is 1 when the purchaser of the connection is a cable operator

Establishments in the Zip Code

The number of establishments in the ZIP code for 2013 as measured by the Census Bureau. An establishment is a single location within the ZIP code that engages in business activities. Note that a single company that has multiple locations within a ZIP code would have each of those locations counted as a separate establishment.

Annual Payroll (\$1,000) in the Zip Code

The total payroll, in thousands of dollars, in the ZIP code for 2013 as measured by the Census Bureau.

Employment in the Zip Code

The number of mid-March 2013 employees in the ZIP code as measured by the Census Bureau.

Number of Establishments in the Census Block (D&B)

The number of establishments in the census block as estimated by Dun & Bradstreet

Establishments (D&B) per Square Mile in the Census Block

The number of establishments in the census block as estimated by Dun & Bradstreet divided by the land area, in square miles, of the census block

Mbps

The reported bandwidth of the connection in Mbps as listed in tables II.A.12 Part 1 and II.B.4 Part 1.

Packet-based Connection

An indicator variable that takes on the value of 1 if the connection provides a packet-based distribution service. The source of this information is the reported circuit type in tables II.A.12 Part 1 and II.B.4 Part 1.

**ATTACHMENT 3 – DESCRIPTIVE STATISTICS ABOUT VARIABLES
USED IN REGRESSIONS**

DS-1 Connections

	Mean	Std. Dev.	Min	Median	Max
Average Monthly Price	218.96	252.36	0	159.97	116,353.12
A Facilities-based Competitor Can Serve the Building	0.24	0.43	0	0	1
A Facilities-based Competitor Can Serve a Building in the Census Block	0.54	0.5	0	1	1
At Least One Facilities-based Competitor is in the Block But Not the Building	0.42	0.49	0	0	1
One Facilities-based Competitor is in the Block But Not the Building	0.23	0.42	0	0	1
Two or Three Facilities-based Competitors are in the Block But Not the Building	0.14	0.34	0	0	1
Four or More Facilities-based Competitors are in the Block But Not the Building	0.05	0.22	0	0	1
At Least One Facilities-based Competitor is in the Tract But Not the Block	0.81	0.39	0	1	1
An Indep. CLEC Has a Fiber Network in the Census Block	0.87	0.34	0	1	1
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	0.52	0.5	0	1	1
The Carrier Has Phase 1 Pricing Flexibility in the Wire Center	0.45	0.5	0	0	1
The Carrier Has Phase 2 Pricing Flexibility in the Wire Center	0.36	0.48	0	0	1
Phase 1 x Facilities-based Competitor in Census Block	0.25	0.43	0	0	1
Phase 2 x Facilities-based Competitor in Census Block	0.21	0.4	0	0	1
Customer is a Telecommunications Provider	0.91	0.28	0	1	1
Customer is a Mobile Telecommunications Provider	0.24	0.43	0	0	1
Customer is a Cable Operator	0.03	0.16	0	0	1
Establishments in the Zip Code	1,121	820	3	961	8,080
Annual Payroll (\$1,000) in the Zip Code	1,374,864	2,182,729	30	706,153	27,812,942
Employment in the Zip Code	21,989	20,939	1	16,206	181,730
Number of Establishments in the Census Block (D&B)	48	85.46	1	20	2,057
Establishments (D&B) per Square Mile	3,596	14,190	0.01	591	603,238

in the Census Block					
Mbps	1.54	0	1.5	1.54	1.54
Packet-based Connection	0	0	0	0	0

DS-3 Connections

	Mean	Std. Dev.	Min	Median	Max
Average Monthly Price	1,314.03	4,400.74	0.01	785	596,710.55
A Facilities-based Competitor Can Serve the Building	0.44	0.5	0	0	1
A Facilities-based Competitor Can Serve a Building in the Census Block	0.74	0.44	0	1	1
At Least One Facilities-based Competitor is in the Block But Not the Building	0.56	0.5	0	1	1
One Facilities-based Competitor is in the Block But Not the Building	0.25	0.43	0	0	1
Two or Three Facilities-based Competitors are in the Block But Not the Building	0.21	0.41	0	0	1
Four or More Facilities-based Competitors are in the Block But Not the Building	0.09	0.29	0	0	1
At Least One Facilities-based Competitor is in the Tract But Not the Block	0.87	0.34	0	1	1
An Indep. CLEC Has a Fiber Network in the Census Block	0.93	0.26	0	1	1
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	0.72	0.45	0	1	1
The Carrier Has Phase 1 Pricing Flexibility in the Wire Center	0.45	0.5	0	0	1
The Carrier Has Phase 2 Pricing Flexibility in the Wire Center	0.41	0.49	0	0	1
Phase 1 x Facilities-based Competitor in Census Block	0.36	0.48	0	0	1
Phase 2 x Facilities-based Competitor in Census Block	0.3	0.46	0	0	1
Customer is a Telecommunications Provider	0.9	0.3	0	1	1
Customer is a Mobile Telecommunications Provider	0.23	0.42	0	0	1
Customer is a Cable Operator	0.02	0.14	0	0	1
Establishments in the Zip Code	1,243	808	3	1,117	8,080
Annual Payroll (\$1,000) in the Zip Code	1,848,712	2,489,452	30	983,186	27,812,942
Employment in the Zip Code	26,487	22,059	2	19,877	181,730
Number of Establishments in the Census Block (D&B)	47	87.74	1	19	2,057
Establishments (D&B) per Square Mile in the Census Block	4,298	14,106	0.16	890	603,238

Mbps	44.74	0.03	44.18	44.74	45
Packet-based Connection	0	0	0	0	0

High Bandwidth Connections

	Mean	Std. Dev.	Min	Median	Max
Average Monthly Price	3,002.09	9,138.56	0.01	1,149.26	1,304,076.50
A Facilities-based Competitor Can Serve the Building	0.45	0.5	0	0	1
A Facilities-based Competitor Can Serve a Building in the Census Block	0.69	0.46	0	1	1
At Least One Facilities-based Competitor is in the Block But Not the Building	0.47	0.5	0	0	1
One Facilities-based Competitor is in the Block But Not the Building	0.22	0.41	0	0	1
Two or Three Facilities-based Competitors are in the Block But Not the Building	0.16	0.37	0	0	1
Four or More Facilities-based Competitors are in the Block But Not the Building	0.09	0.28	0	0	1
At Least One Facilities-based Competitor is in the Tract But Not the Block	0.83	0.38	0	1	1
An Indep. CLEC Has a Fiber Network in the Census Block	0.93	0.26	0	1	1
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	0.68	0.47	0	1	1
The Carrier Has Phase 1 Pricing Flexibility in the Wire Center	0.57	0.5	0	1	1
The Carrier Has Phase 2 Pricing Flexibility in the Wire Center	0.25	0.43	0	0	1
Phase 1 x Facilities-based Competitor in Census Block	0.41	0.49	0	0	1
Phase 2 x Facilities-based Competitor in Census Block	0.17	0.38	0	0	1
Customer is a Telecommunications Provider	0.81	0.39	0	1	1
Customer is a Mobile Telecommunications Provider	0.35	0.48	0	0	1
Customer is a Cable Operator	0	0.05	0	0	1
Establishments in the Zip Code	1,237	1,005	3	1,032	8,080
Annual Payroll (\$1,000) in the Zip Code	1,796,848	2,905,725	44	872,477	27,812,942
Employment in the Zip Code	25,312	24,597	9	18,119	181,730
Number of Establishments in the Census Block (D&B)	45	77.55	1	21	2,057
Establishments (D&B) per Square Mile in the Census Block	5,112	15,795	0.05	896	455,646
Mbps	745.48	6,352.81	48	155.52	1,024,000
Packet-based Connection	0.86	0.34	0	1	1

ATTACHMENT 4 - FCC BACKGROUND ON BUSINESS DATA SERVICES

Business data service (special access) refers to the transmission of information between network points at certain guaranteed speeds and service levels. This service utilizes dedicated, high-capacity connections sold, either on a stand-alone basis or embedded in a package of communications services, to businesses, government institutions, hospitals, educational institutions, and libraries, i.e., not to residential end users. Wireless providers use this service to backhaul voice and data from cell towers to wired telephone and broadband networks; small businesses, governmental branches, hospitals and medical offices, and even schools and libraries also use business data service for the first leg of communications with the home office; branch banks and gas stations use such connections for ATMs and credit card readers; and even other communications providers purchase business data service as an input for their own communication service offerings to retail customers. The primary suppliers of business data service include traditional phone companies, i.e., incumbent local exchange carriers (ILECs) like AT&T and Verizon, cable companies like Comcast and Cox, and other competitive local exchange carriers (CLECs) like Level 3 and XO Communications.

The FCC has historically subjected ILECs to rate regulation and tariffing requirements, i.e., dominant carrier safeguards, for the provision of their business data service. Other providers of business data service are largely unregulated except for the basic just and reasonable requirements applicable to all carriers under sections 201 and 202 of the Communications Act of 1934.

The FCC has two forms of rate regulation – price cap and rate-of-return. The focus here is on those ILECs subject to price cap regulation (price cap ILECs) where a ceiling is set on the overall rates charged and carriers are theoretically incentivized to operate more efficiently to lower costs and maximize profits. The FCC has a process (established in 1999) for granting price cap ILECs a certain degree of pricing flexibility when specified regulatory triggers are satisfied. These triggers, which were designed as a proxy for potential competition in the given geographic area, are based on the collocations of non-ILEC providers in an ILEC's wire centers. Depending on the level of pricing flexibility, ILECs can “offer special access services at unregulated rates through generally available and individually negotiated tariffs.”⁴⁹

In January 2005, the FCC initiated a rulemaking to broadly examine the regulatory framework going forward for the provision of interstate special access services by price cap ILECs.⁵⁰ This proceeding remains pending today. Then, in a series of actions taken in the late 2000s, the FCC removed rate regulation and tariffing requirements for many of the emerging business data services offered by price-cap ILECs. Accordingly, many of the packet-based services, using an Ethernet technology protocol for example, and optical carrier transmission services offered by ILECs are largely free of regulation as is the case with other non-ILEC providers. The portfolio of ILEC business data service offerings still subject to dominant carrier safeguards consist mainly of time-division multiplexing (TDM)-based services. These legacy services include DS1s and DS3s, which have a symmetrical bandwidth of about 1.5 Mbps and 45 Mbps, respectively.

In August 2012, the FCC suspended its rules for the further grant of pricing flexibility to ILECs for the remaining regulated business data services in areas subject to price cap regulation.⁵¹ The FCC took this step based on “significant evidence that these rules . . . are not working as predicted, and widespread

⁴⁹ *Pricing Flexibility Suspension Order*, 27 FCC Rcd at 10563, para. 11.

⁵⁰ *See 2005 Special Access NPRM*, 20 FCC Rcd at 1994, para. 1.

⁵¹ *See Pricing Flexibility Suspension Order*, 27 FCC Rcd at 10557-58, para. 1.

agreement across industry sectors that these rules fail to accurately reflect competition in today's special access markets."⁵² The FCC found that the pricing flexibility triggers "are a poor proxy for the presence of competition sufficient to constrain special access prices or deter anticompetitive practices"⁵³ The FCC then set course for a one-time data collection "to identify a permanent reliable replacement approach to measure the presence of competition for special access services."⁵⁴

On December 18, 2012, the Commission released an Order calling for the mandatory collection of data for an analysis of the marketplace for business data services. The FCC then collected data and information in early 2015 for its analysis from entities providing or purchasing business data services in price cap areas and from larger entities that provide "best efforts" business broadband Internet access services.

The stated goal of the FCC's multi-faceted market analysis is to evaluate, among other things, "how the intensity of competition (or lack thereof), whether actual or potential, affects prices, controlling for all other factors that affect prices."⁵⁵ The FCC intends to include "econometrically sound panel regressions . . . of the prices for special access on characteristics such as 1) the number of facilities-based competitors (both actual and potential); 2) the availability of, pricing of, and demand for best efforts business broadband Internet access services; 3) the characteristics of the purchased service; and 4) other factors that influence the pricing decisions of special access providers, including cost determinants (*e.g.*, density of sales) and factors that deliver economies of scale and scope (*e.g.*, level of sales)."⁵⁶ The FCC also intends to assess the reasonableness of terms and conditions offered by ILECs for business data service.⁵⁷ The FCC will use the results of its analysis to evaluate "whether it is appropriate to make changes to its existing pricing flexibility rules to better target regulatory relief in competitive areas and evaluate whether remedies are appropriate to address any potentially unreasonable terms and conditions."⁵⁸

Data Collection Overview. The FCC required all providers of "dedicated service" in areas where the ILEC is subject to price cap regulation (*i.e.*, price cap areas) to respond to the data collection regardless of size. Providers included any entity subject to the FCC's jurisdiction that provides dedicated service in a price cap area or provides a connection that is capable of providing a dedicated service in a price cap area. For purposes of the collection, the FCC defined dedicated service as a service that:

transports data between two or more designated points, *e.g.*, between an *End User's* premises and a point-of-presence, between the central office of a local exchange carrier (LEC) and a point-of-presence, or between two *End User* premises, at a rate of at least 1.5 Mbps in both directions (upstream/downstream) with prescribed performance requirements that include bandwidth-, latency-, or error-rate guarantees or other parameters that define delivery under a *Tariff* or in a service-level agreement. *Dedicated Service* includes, but is not limited to, [circuit-based dedicated service (DS1s and DS3s)] and [packet-based dedicated service (such as Ethernet)]. For the purpose of this data

⁵² *Id.*

⁵³ *Pricing Flexibility Suspension Order*, 27 FCC Rcd at 10560, para. 5.

⁵⁴ *Id.* at 10560, para. 6.

⁵⁵ *Id.* at 16346-47, paras. 68-69.

⁵⁶ *Id.* at 16346, para. 68.

⁵⁷ *Id.* at 16354-56, paras. 91-93.

⁵⁸ *Data Collection Implementation Order*, 28 FCC Rcd at 13192, para. 5.

collection, *Dedicated Service* does not include “best effort” services, *e.g.*, mass market broadband services such as DSL and cable modem broadband access.

Purchasers of dedicated service subject to the FCC’s jurisdiction were also required to respond to the collection unless, among other exceptions, they purchased less than \$5 million in dedicated services in 2013. Entities that provide best efforts business broadband Internet access services in price cap areas were required to respond to the data collection unless they had fewer than 15,000 customers and fewer than 1,500 business broadband customers as of December 18, 2012.

The general categories of data and information collected by the FCC concern: market structure, pricing, demand, terms and conditions, and competition and pricing decisions.⁵⁹ For example, the market structure data included, among other things, data from providers on last-mile facilities used to provide dedicated service to end user locations, non-price factors affecting deployment, collocations, and network maps.⁶⁰ The pricing information included data from providers on the “quantities sold and prices charged for special access services, by circuit element” and required ILECs to “list the form of price regulation that applies . . . on a wire-center-by-wire-center basis.”⁶¹ The demand data included not only information on the bandwidth of special access sold and revenues earned by providers but also on the expenditures made by purchasers.⁶² The terms and conditions collected from both providers and purchasers, included details on topics such as the discounts and benefits associated with tariff plans and the business rationale for those plans.⁶³ The FCC also collected information on Requests for Proposals and advertised and marketed services to help evaluate competition and pricing decisions for special access services. Lastly, the FCC collected coverage area and pricing information from entities providing best efforts business broadband Internet access service.⁶⁴ The large majority of information collected, especially the locations and billing information, is from the year 2013.

⁵⁹ *Id.* at 16331, para. 30.

⁶⁰ *Id.* at 16331-33, paras. 31-35.

⁶¹ *Id.* at 16333, paras. 36-37.

⁶² *Id.* at 16333-34, para. 38.

⁶³ *Id.* at 16334, para. 39.

⁶⁴ *Id.* at 16335-37, paras. 40-46.

ATTACHMENT 5 - SOURCES FOR TABLE 3, 2013-2015 BUSINESS REVENUES.

Verizon's business revenues include all Global Wholesale and Global Enterprise revenues, from the Verizon year-end 2014 10-K filing, under "Consolidated Revenues".

AT&T's business revenues include all "AT&T Business Services wireline operating revenues", from the AT&T 2014 Annual Report, page 19.

Our estimate of CenturyLink's business revenues applies CenturyLink's percentage of total revenues from business services to their total revenue figure, from the "Segments" subsection of the "Operations" section of the CenturyLink year-end 2014 10-K filing.

Level 3's business revenue estimate for 2014 includes Level 3's North American wholesale and North American enterprise revenues, as well as tw telecom's wholesale and enterprise revenues, from the Level 3 year-end 2014 10-K filing, page 71. For 2012 and 2013, Level 3's business revenues, add the listed figure for North American Wholesale and North American enterprise revenues for each respective year from the Level3 year-end 2014 10-K filing to tw telecom's "Data and Internet" and "Network" revenues for each respective year from tw telecom's year-end 2013 10-K filing, page 7.

Windstream's business revenue estimate includes "Enterprise", "Carrier", and "Wholesale" revenues, from the Windstream year-end 2014 10-K filing, page F-5.

Comcast business revenues from the Time Warner year-end 2014 10-K filing, page 57.

Time Warner Cable business revenues from the Time Warner Cable year-end 2014 10-K filing, page 42.

Frontier business revenues from item listed as "Consolidated Business" revenues, from the Frontier year-end 2014 10-K filing, page 30.

Charter business revenues from item listed as "Commercial" revenues, from Charter year-end 2014 10-K filing, page 46.

Earthlink business revenue estimate includes revenues from "Business Retail" and "Business Wholesale" services, from Earthlink year-end 2014 10-K filing, page 35.

Business revenue estimates for Cox for years 2014 and 2012 were unavailable. Cox's 2013 Business revenue estimate came from a Cox press release regarding business services: newsroom.cox.com/download/Cox+Business+New.pdf.