Federal Communications Commission
Washington, D.C. 20554

June 28, 2016

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

RE: ***Business Data Services in an Internet Protocol Environment; Investigation of Certain Price Cap Local Exchange; Carrier Business Data Services Tariff Pricing Plans; 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 Nos. 16-143, 15-247, 05-25, RM-10593.**

Dear Ms. Dortch:

On May 2, 2016, the Federal Communications Commission (Commission) released a Tariff Investigation Order and Further Notice of Proposed Rulemaking in the business data services (special access) rulemaking proceeding.[1] The item included a white paper prepared by an outside econometrician hired by the Commission, Dr. Marc Rysman, entitled "Empirics of Business Data Services" (Rysman Paper).[2] The Rysman Paper "studied the market for business data services in the United States," analyzing data collected by the Commission from providers and purchasers of business data services.[3] The Commission sought comment on the validity and strength of Dr. Rysman's analysis and conclusions, and on their relevance to the Commission's analysis, and this proceeding more generally.[4]

Consistent with Office of Management and Budget (OMB) peer review guidelines,[5] the Commission also initiated an external peer review of the Rysman Paper, seeking the analysis of qualified and impartial outside experts to peer review the Rysman Paper.[6] The Commission subsequently received written peer review reports analyzing the Rysman Paper. In this letter, the Commission submits into the record in this proceeding the peer review charge memoranda directing the peer reviewers to conduct their

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[1] *See Business Data Services in an Internet Protocol Environment Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans; 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 Nos. 16-143, 15-247, 05-25, RM-10593, Tariff Investigation Order and Further Notice of Proposed Rulemaking, FCC 16-54 (rel. May 2, 2016) (*Business Data Services Order* or *Business Data Services FNPRM*).

[2] *Id.*, Appx. B, Dr. Marc Rysman, *Empirics of Business Data Services* (Apr. 2016) (Rysman Paper).

[3] The data collected in 2015 is primarily from 2013. *Id.* at paras. 36-37.

[4] Id. at para. 164.

[5] Final Information Quality Bulletin for Peer Review, Office of Management and Budget, Executive Office of the President, 70 Fed. Reg. 2664 (Jan. 14, 2005) (requiring that influential scientific information on which a federal agency relies in a rulemaking proceeding be subject to peer review to enhance the quality and credibility of the government's scientific information).

[6] *See Business Data Services FNPRM* at para. 164.

analysis, the peer review reports that were received by the Commission, the revised Rysman Paper addressing the peer review reports, and a Commission staff memorandum separately addressing additional comments received from the peer reviewers.

The attached documents are also publically available by accessing the Commission's Peer Review Agenda webpage:

http://www.fcc.gov/encyclopedia/peer-review-agenda

As always, we welcome the input of interested parties on matters related to the business data services proceeding.

Respectfully submitted,

William Layton
Assistant Division Chief
Pricing Policy Division
Wireline Competition Bureau
Federal Communications Commission

Attachments

Federal Communications Commission
Washington, D.C. 20554

April 14, 2016

MEMORANDUM

TO: Andrew Sweeting
Associate Professor, University of Maryland

FROM: Matthew S. DelNero MSD
Chief, Wireline Competition Bureau

SUBJECT: *Peer Review of Analysis of the White Paper "Empirics of Business Data Services" by Dr. Marc Rysman (April 2016)*

Overview

The Federal Communications Commission (Commission) is in the process of an ongoing rulemaking evaluating the appropriate regulatory framework for business data service (BDS) industry, i.e., special access, in areas where the incumbent local exchange carrier (ILEC) is subject to price cap regulation (WC Docket No. 05-25, RM-10593).[1] As part of this rulemaking, the Commission collected data and information from providers and purchasers in the industry for an analysis of the marketplace.[2] Through this memorandum, I request that you perform a peer review of the attached White Paper produced by Boston University Professor of Economics Marc Rysman examining the nature of competition and marketplace practices in the supply of BDS.

Background

On December 18, 2012, the Commission released the *Data Collection Order*, outlining a data collection for an analysis of the BDS marketplace.[3] Services covered by the collection included traditional special access service (including DS1s and DS3s), packet-based dedicated service such as Ethernet, and best efforts business broadband Internet access service."[4] Those

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[1] *Special Access Rates for Price Cap Local Exchange Carriers*; *AT&T Corp. Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services*, WC Docket No. 05-25, RM-10593, Order and Notice of Proposed Rulemaking, 20 FCC Rcd 1994, 1998, para. 11 (2005) (*2005 BDS NPRM*); *see also 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 and Further Notice of Proposed Rulemaking, 27 FCC Rcd 16318, 16320, para. 31 (2012) (*Data Collection Order* or *BDS NPRM*).

[2] *Data Collection Order*, 27 FCC Rcd at 16360, App. A.

[3] *Id.*

[4] *Id.* at 16326-27, paras. 16-19.

required to respond included providers and purchasers of BDS and certain entities providing best efforts business broadband Internet access service.[5]

Relying in part on this data collection, the Commission is in the process of conducting a one-time, multi-faceted market analysis of the BDS industry.[6] The analysis will evaluate "how the intensity of competition (or lack thereof), whether actual or potential, affects prices, controlling for all other factors that affect prices" and would provide an evidentiary record for reforming the Commission's BDS rules.[7] The analysis will evaluate market structure and include, to the extent practicable, econometric 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)."[8] Because of the various factors that may influence competition at a particular location, the Commission designed the collection to obtain detailed data at the location level.[9] The Commission also proposed to analyze the information from purchasers, as well as providers, to assess the reasonableness of terms and conditions offered by ILECs for special access service.[10] To assist with its analysis of the collected data, the Commission contracted with Professor Rysman to produce the attached White Paper.

Parameters of Review

Before a federal agency may disseminate influential scientific information, such as the White Paper, as part of a rulemaking, the material must be peer reviewed to enhance the quality and credibility of the government's scientific information.[11] Guidance from the Office of Management and Budget (OMB) requires agencies to provide peer reviewers with "instructions regarding the objective of the peer review and the specific advice sought."[12] The objective of this peer review is to establish whether the White Paper provides a solid foundation for analyzing the data collected in the BDS rulemaking proceeding. Please note that the standards for evaluation are not necessarily the same as those one might apply in evaluating studies for publication in a professional journal. For example, it is not necessary that the study present new or novel theoretical results or empirical techniques. Consistent with the requirements of the OMB Bulletin, we are not asking you to "provide advice on policy" or to evaluate any policy implications that might arise from use of the White Paper.[13]

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[5] *Id.* at 16327-28, para. 22.

[6] *See BDS FNPRM*, 27 FCC Rcd at 16343-49, paras. 66-71.

[7] *See id.* at 16343-47, paras. 66-69.

[8] *Id.* at 16346, para. 68.

[9] *Id.* at 16327, para. 22.

[10] *Id.* at 16354-56, paras. 91-93.

[11] *See* FINAL INFORMATION QUALITY BULLETIN FOR PEER REVIEW, OFFICE OF MANAGEMENT AND BUDGET, EXECUTIVE OFFICE OF THE PRESIDENT, 70 Fed. Reg. 2664 (2005) (OMB Bulletin), *available at* https://www.whitehouse.gov/omb/memoranda_fy2005_m05-03/ (last visited Aug. 2, 2013).

[12] *Id.* at 2668.

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Guidance from OMB further requires that "[r]eviewers shall be informed of applicable access, objectivity, reproducibility and other quality standards under the Federal laws governing information access and quality."[14] The OMB Bulletin also requires that "peer reviewers ensure that scientific uncertainties are clearly identified and characterized."[15] Finally, please be aware of three other aspects of the peer review process. First, the peer review will not be anonymous. Reviewers are identified and reviews placed in the public record. Past peer reviews conducted for the FCC can be found at: http://www.fcc.gov/omd/dataquality/peer-agenda.html. Second, the agency will not be providing any financial compensation to reviewers; your time and effort will be considered as donated in contribution to science and public service.

Third, the OMB Bulletin requires us to assess whether potential peer reviewers have any potential conflicts of interest.[16] In particular, a "conflict of interest" would exist if you have "any financial or other interest that conflicts with the service of an individual . . . because it could impair the individual's objectivity or could create an unfair competitive advantage for a person or organization."[17] To assist our determination of whether there are any potential conflicts, please indicate whether you have participated in this rulemaking proceeding in any capacity. Please provide us any information relevant to evaluating whether you might have a real or perceived conflict of interest, including whether you have participated in the rulemaking in any capacity and whether or not you have financial ties to regulated entities, other stakeholders, and regulatory agencies.[18] We note that the OMB Bulletin makes clear that "work as an expert witness, consulting arrangements, honoria and sources of grants and contracts" could trigger a potential conflict.[19] To evaluate any real or perceived conflicts of interest, potential peer reviewers should consult applicable federal ethics requirements, applicable standards issued by the Office of Government Ethics and the prevailing practices of the National Academy of Sciences (NAS).[20]

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[14] *See id.* at 2675. These standards are discussed in greater detail in OMB's GUIDELINES FOR ENSURING AND MAXIMIZING THE QUALITY, OBJECTIVITY, UTILITY, AND INTEGRITY OF INFORMATION DISSEMINATED BY FEDERAL AGENCIES, 67 Fed. Reg. 8452 (2002).

[15] OMB Bulletin, 70 Fed. Reg. at 2669. The Bulletin further states that since not all uncertainties have an equal effect on the conclusions drawn, reviewers should ensure that the potential implications of the uncertainties for the technical conclusions drawn are clear. In addition, peer reviewers might be asked to consider value-of-information analyses that identify whether more research is likely to decrease key uncertainties. Value-of-information analysis was suggested for this purpose in the report of the Presidential/Congressional Commission on Risk Assessment and Risk Management. A description of additional research that would appreciably influence the conclusions of the assessment can help an agency assess and target subsequent efforts. *Id.*

[16] *Id.* at 2670.

[17] *Id.*

[18] *Id.*

[19] *Id.*

[20] Specifically, peer reviewers who are Federal employees (including special government employees) are subject to Federal requirements governing conflicts of interest. *See, e.g.*, 18 U.S.C. § 208; 5 C.F.R. part 2635 (2004). With respect to reviewers who are not Federal employees, agencies shall adopt or adapt the NAS policy for committee selection with respect to evaluating conflicts of interest. *See* POLICY AND PROCEDURES ON COMMITTEE COMPOSITION AND BALANCE AND CONFLICTS OF INTEREST FOR COMMITTEES USED IN THE DEVELOPMENT OF REPORTS, THE NATIONAL ACADEMIES, NATIONAL ACADEMY OF SCIENCES,

The Commission's Electronic Comment Filing System (ECFS) for WC Docket Nos. 05-25 and 15-247 and RM-10593, will assist you in identifying potential conflicts with parties participating in the BDS rulemaking proceeding.[21]

Report on Findings

I request that you provide a written report of your review that describes the nature and scope of your review and your findings and conclusions with regard to this influential scientific information by **April 29, 2016**. The report shall include a short paragraph on your credentials and relevant experiences.

Because the White Paper contains and relies on information submitted by companies in the underlying rulemaking proceeding that is non-public, commercially sensitive, and protected by a protective order, you previously executed a non-disclosure agreement prior to reviewing the White Paper and any Confidential or Highly Confidential information on file with the FCC for this proceeding. If you have any questions regarding this agreement, please contact William Layton, 202.418.0865, William.Layton@fcc.gov.

Attachments

Dr. Marc Rysman, *Empirics of Business Data Services* (April 2016)

FINAL INFORMATION QUALITY BULLETIN FOR PEER REVIEW, OFFICE OF MANAGEMENT AND BUDGET, EXECUTIVE OFFICE OF THE PRESIDENT, 70 Fed. Reg. 2664 (2005).

NATIONAL ACADEMY OF ENGINEERING, INST. OF MEDICINE, NATIONAL RESEARCH COUNCIL (May 12, 2003), *available at* http://www.nationalacademies.org/coi/bi-coi_form-0.pdf (last visited Aug. 2, 2013).

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Federal Communications Commission
Washington, D.C. 20554

April 14, 2016

MEMORANDUM

TO: Tommaso Valletti
Professor of Economics, Imperial College London

FROM: Matthew S. DelNero MSD
Chief, Wireline Competition Bureau

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Overview

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Review of Dr. Rysman's "Empirics of Business Data Services" White Paper

Andrew Sweeting
University of Maryland College Park

April 26, 2016

1. I am an Associate Professor of Economics (with tenure) at the University of Maryland College Park, and have previously served on the faculties of Northwestern University and Duke University. I received my PhD in Economics from MIT in 2004. My research is focused on empirical Industrial Organization, with a particular focus on market dynamics, market entry and product repositioning, auction design and the effects of mergers, including in media industries. My research has been published in *Econometrica*, the *Journal of Political Economy*, the *American Economic Review* and in several other leading journals. I have taught Ph.D. and undergraduate courses in Industrial Organization, as well as teaching Computational Economics at Ph.D. level and Econometrics to undergraduates. I am currently an editor of the *Journal of Industrial Economics*, a foreign editor of the *Review of Economic Studies*, a leading general interest economics journal, and an Associate Editor of the *Economic Journal*.
2. The market for Business Data Services (BDS) is a complicated mix of wholesale and retail, and regulated and unregulated businesses. In compiling this review I am relying in large part on the descriptions of the industry provided in Dr. Rysman's report as well as answers that FCC staffers have provided to my questions. However, conditional on this understanding, I believe that I am well-placed to comment on Dr. Rysman's analysis and his interpretation of the results. My bottom-line conclusion is that Dr. Rysman has made modeling choices that are generally sensible but that, partly because of the limitations of the data available, the results should be interpreted with some caution (as Dr. Rysman himself suggests in his conclusions), as it is possible that he is either under or overestimating the magnitude of market power. I make some specific suggestions for further analysis.

3. The structure of my report is as follows. In Section A I explain, in simple terms, the logic being used in Dr. Rysman's report and the assumptions being made. In Section B I discuss the possible limitations of the data that has been compiled by the FCC for this study. Some of these limitations follow directly from the complexity of the market that is being analyzed. In Section C I discuss Dr. Rysman's analysis of market structure (revenue and competitive presence at the building and census block level), before discussing his analysis of pricing in Section D. Section E concludes.

A. Framework

4. The objective of the white paper is to understand whether the market for BDS is close to competitive, in the sense that the market power of providers is limited. The focus is on ILECs which remain the dominant providers of BDS, at least for DS1 and DS3 services.
5. Understanding the extent of market power requires finding at what point rival firms will constrain an ILEC's pricing. Given that it is time consuming and costly to develop a copper or fiber network, it is reasonable that a competitor that is not present at all in a geographic area will not be able to compete for customers and will not constrain an ILEC's pricing to any significant extent. For providers that are present in a geographic area, the questions are to what degree they constrain ILEC pricing and how. For example, the mere presence of a rival may constrain an ILEC if it is concerned that the rival will respond to overpricing by aggressively signing up customers and rapidly deploying its services. Of course, if the ILEC is constrained by the threat of `potential entry', the rival may not actually build out its network and pick up many customers. On the other hand, if it is difficult for the rival to add links to its network (either because it is costly or it is slow to secure the required permissions), then even if a competitor serves a firm in an adjoining building it may be less effective at winning a customer, and it may also face a brand name disadvantage to a local ILEC. In either case, ILECs may be able to exercise significant market power, against at least some customers, even when there are competitors in close proximity.
6. As in most settings, the researcher of the BDS market does not observe barriers to rival expansion or the way that customers shop directly. Therefore, Dr. Rysman has

undertaken an approach that is quite standard in competition analysis. In one part of his analysis he has looked at whether rivals are present in close proximity to customers. If they were not present at all, then market power could be assumed in the absence of effective price regulation. However, the descriptive analysis of whether competitors are active in a building or a census block does not directly answer the question of whether this presence affects prices, or how much presence is required to get meaningful constraints on prices. Therefore, in another part of his analysis he looks at whether increases in measured competitive presence nearby is associated with lower ILEC prices.

7. The idea that is being used in the price analysis is straightforward. If the presence of competitors lowers ILEC prices and it is assumed that (a) the entry of competitors does not raise the incumbent ILEC's costs; and (b) the entry of competitors is not correlated with an ILEC having particularly high costs, then one can infer that without the presence of competitors the ILEC is able to raise its prices, i.e., to exercise market power. Given that the analysis uses cross-sectional data it is also necessary to make the assumption that entry of competitors is not more likely to happen where ILEC prices for BDS services would naturally be low, which might happen if there are areas where customers are more likely to purchase a wide range of ILEC products of which BDS services are simply a small part. Of course, if there was no finding that competition reduced prices, this result could be interpreted in various ways, and in the current setting this point is relevant for the high bandwidth services results. For example, no correlation with observed competition measures might be explained either by an ILEC who faces no observed competition actually having very limited market power or by a lot of observed competition actually having little effect on the market power faced by customers who remain with the ILEC.[1]

8. The approach adopted by Dr. Rysman is reasonable, but as this discussion suggests, it depends on assumptions, some of which are very difficult to test with the data available. I will suggest below some additional work that might shed light on some of these assumptions.

[1] It could also, of course, be explained by the measures of competition simply not being very

B. Special Access Data

9. Dr. Rysman's report is based on data that was collected by the FCC from ILECs and their competitors (CPs). The dataset appears to be vast: containing details of all of the locations served by CPs and monthly information on individual accounts served by ILECs and CPs. However, the data has a number of limitations for answering the question at hand. I list them here, although many of them will come up again in subsequent sections.

a. The data comes from a one-year cross-section. This makes it impossible to conduct a `panel data'-type of analysis where one can try to understand how the price paid by a particular customer, or the type of service that a customer chooses to purchase, responds to changes in competition. Instead, the reliance is on cross-sectional variation in the extent of competition in different locations. Dr. Rysman has, sensibly, tried to address the obvious concern that there may be unobservable differences across customers that are correlated with both prices and competition by using census tract or county fixed effects. However, most economists would regard within-customer-over-time changes in prices, that could have been identified and estimated with panel data, as more compelling. In this particular setting, the fact there is only one year of data may create some additional issues. For example, many of the contracts observed are likely to have been negotiated some time prior to 2013, when local competition may have been different.

b. The data comes from 2013. It is likely that since 2013 there has been significant growth of fiber-based cable networks, and increases in the ability of `best efforts' cable service to compete for business customers. There may also have been changes in business demand for BDS as applications used by businesses have changed (for example, businesses may now conduct more activity over wireless networks, or use VoIP for their phone service). It is therefore possible that relationships observed in the 2013 data may hold more or less strongly today.

c. The price data only provide limited information on what end-user businesses pay for services that include BDS. For all three levels of service considered by Dr. Rysman (DS1, DS3 and high bandwidth) over 80% of ILEC customers are `telecommunications providers', who in most cases are likely to be packaging these services with other

products to sell as a `managed services' bundle to a final customer. Wholesale customers may also be buying other products from ILECs for the same locations that are not subject to price caps. From a welfare and regulatory perspective one would also like to know how much of any higher prices that can be subscribed to a lack of competition in the basic BDS market are passed through to final users; how a lack of competition in the basic BDS market may affect competition in the downstream market for managed services[2]; and, whether the prices of other products that telecommunications providers buy from ILECs move with or against the prices of basic BDS services.

d. It is not clear whether the data contain additional information on important terms and conditions that may affect pricing. For example, prices may be lower for longer contracts or with unusually high service guarantees, or they may be higher if the provider was required to install special equipment at the start of the contract that has to be paid for over the life of the contract. The summary statistics suggest huge heterogeneity in prices for the same nominal product (e.g., DS-3 prices range from $0.01 per month to $596,710.55 per month). While the log transformation of price used in the price regressions will tend to mean that extreme price outliers will have less effect on the coefficient estimates than would be the case if the regressions used prices in levels, there remains a concern that the comparisons being done may not be apples-to-apples. If any terms and conditions are available, one should analyze how they differ, within a census tract or county, with the level of competition, and, ideally, additional controls for terms and conditions should be included in the regressions. It may also be possible to identify customers who are buying connections in multiple locations from the same supplier to investigate whether there are volume discounts, and how discounts may vary with the level of competition. It may also be appropriate to control for the date a contract was signed if prices are typically fixed within a contract over time.

e. The data does not tell us directly about the price setting process. For example, customers may issue Requests for Proposals (RFPs), where they invite firms to submit tenders to provide the service. Even a small sample of RFPs and associated tenders may provide

[2] A standard result from the analysis of vertical relationships is that a firm that has monopoly power at one level of a vertical chain would like to promote downstream competition in order to maximize its profits. See, for example, Tirole, *The Theory of Industrial Organization*, 1988, MIT Press, pp. 174-175.

important additional information on: (i) which firms view themselves and are viewed by customers as being potential competitors; (ii) whether CPs are able to meet the complete range of services requested by customers, and how this is affected by their presence in the building, census block or census tract; (iii) whether the decisions of customers about which provider to buy from are primarily driven by prices or by other factors; (iv) the willingness of customers to substitute between different levels of service (e.g., fiber to DS3, or DS3 to DS1). This would be important in assessing whether we would expect competition to have large effects on prices; which customers are likely to be picked up by new competitors that enter a particular geographic market; and whether there is some incumbency advantage for an existing supplier; and, (v) how often customers look to change their providers.

C. Dr. Rysman's Analysis of Market Structure

10. Section IV.A. and IV.B. of Dr. Rysman's report provide evidence on the revenues of BDS providers (at the national level; and, for ILECs, divided into revenues that accrue from their ILEC service areas and from other areas of the country where they are CLECs), and on the extent to which the data indicates that CPs can provide BDS service in individual buildings or individual census blocks.
11. The data indicate that companies that are ILECs account for the vast majority of BDS revenues and that this is also true when one looks at the market for both BDS and services for which BDS is an input (Rysman's Table 3). However, in the market for packet service BDS, which is likely growing, CPs account for a much greater share of revenues than in the market for more traditional circuit-based BDS.
12. Based on the framework discussed above, it is not clear that one can infer from measures of national market concentration that price competition is limited. For example, an ILEC company that is a CLEC in a given geographic area might compete quite aggressively with the incumbent ILEC for customers; or, the potential competition of small providers might discipline ILEC prices even if ILECs, possibly efficiently (because overbuilding networks with excess capacity will typically be inefficient), continue to account for the vast majority of customers served.

13. An important reason why ILEC-affiliated CLECs may not compete aggressively for customers is that they typically lease facilities from local ILECs. In particular, ILEC may be able to charge wholesale prices that are sufficiently high that it is difficult for a CLEC to undercut the ILEC in the downstream market if wholesale regulation is ineffective. However, it is also possible that regulated leased prices are, for some reason, set too low, which would place the leasing CLEC at some competitive advantage in the final market. I agree with Dr. Rysman that more analysis is required to understand whether CPs utilizing UNE or other leased products from ILECs to provide their BDS products are able to discipline ILEC pricing.
14. The reported measures of building and census block competition indicate that CPs do not serve 57% of building locations, and only serve 23% with their own facilities (Rysman, Table 4 and Table 7). Table 6 implies that the majority of service with own facilities comes from two companies, Time Warner Cable and Comcast Cable. These firms may primarily provide fiber connections, although this is not 100% clear from the analysis. At the Census block level, only 30% of blocks have one or more competitive providers (Rysman, Table 9).
15. The question of whether competition from a provider that is currently in the census block but not in a building is sufficient to constrain prices is, ultimately, an empirical question. However, given that many buildings may only have one business customer in them, so that there is only likely to be one connection in use, it is clearly slightly dangerous to infer that a lack of competitor presence at the building level indicates limited competition.
16. I was surprised by the fact that we see that 23% of buildings have CP own-facility presence, and only 30% of blocks have CP own-facility presence.[3] In an environment where there are more than a couple of business locations in a census block and customers do not switch providers or request connections that often, one might have expected that the proportion of buildings with CP presence to be much lower than the proportion of blocks with some CP presence. One might interpret the fact that these numbers are quite close as implying that, once in a census block, CPs are able to gain access to buildings

[3] For example, if all census blocks have the same number of buildings, entered blocks have one CP, and that CP, on average, connects to half of the available locations, then one would expect the building penetration rate to be equal to one-half of the census block penetration rate.

and position themselves to make sales to customers quite effectively. This interpretation, if correct, would matter for how competition should be measured and promoted (i.e., the key would be to promote CPs building out into census blocks). With panel data one would be able to understand how quickly presence in census blocks can be translated into presence in buildings. With the available cross-sectional data it would be appropriate to look at how the build out to individual buildings varies with the size of the census block, possible impediments to build out (e.g., major roads) and the age of the CP connection.

17. It would be natural to extend the analysis of census block vs. building presence to examine how this varies with the geographic area of the block or the number of reported locations purchasing BDS services. In the price regression analysis it should also be possible to interact the block-level competition variables with area of the census block to see whether there is evidence of competition appearing to provide greater discipline on block prices when blocks are small.

D. Dr. Rysman's Analysis of Pricing

18. Section IV.C. of Dr Rysman's report looks at how ILEC prices are affected by various measures of CP competition using a multivariate regression framework using fixed effects to control for possible confounding heterogeneity at either the census tract or the county level. As explained by Dr. Rysman, the competition coefficients will then indicate whether prices are lower in census blocks or buildings with greater CP presence when we compare blocks within the census tract or county. The results broadly indicate the DS1 and, especially, DS3 prices are significantly lower when there is CP presence in the building and in the block. There are no clear results for high bandwidth connections, and I would be skeptical about trying to read too much into the subset of the coefficients that are significant for this type of service.
19. A cross-sectional price-concentration analysis inherently suffers from the possible problem that there is some unobserved factor that affects prices and is correlated with competition that may lead to a spurious relationship. Dr. Rysman's approach of using fixed effects and trying multiple specifications is exactly what one should do with this type of data, but it does not remove the problem entirely. In this setting one can imagine

scenarios that might mean that the framework employed will overestimate or underestimate the effects of competition on prices. For example, the effect of competition might be underestimated if (a) customers who are willing to pay for fancier products (or shop around less) attract more entry (leading to a positive relationship between price and competition); or (b) ILECs respond to competition by reducing some other component of customers bills while leaving the BDS component unchanged. On the other hand, some factors might work in the opposite direction. For example, CPs might be particularly good at picking off customers who want fancier services from the ILEC, so that in locations with CP competition, ILECs are left serving customers who are purchasing relatively cheap products, even if, for any given customer, the presence of a CP does not reduce the price that they pay for the service that they get. A priori, one cannot sign the biases that may be present.

20. While fixed effects are one (sensible) approach to dealing with the issue of unobserved heterogeneity, other strategies are sometimes possible. For example, in some situations one might be able to find an instrument for the degree of competition in a particular geographic area based on the historical development of CP networks.[4] An alternative approach might be to try to use a method such as propensity score matching so that one is comparing particularly similar customers who differ only in the degree of competition that they face. This technique can be valuable when there is significant heterogeneity in the type of customer that is observed across different geographies, although its implementation may require having more information on customers than is available in the current dataset.

21. A theme in the results is that the price-reducing effects of competition are largest for DS3 (although this is not true for every coefficient in every specification). One interpretation

[4] A valid instrument is another observed variable that it is believed will have a significant effect on the probability that there are local CP competitors but would not be expected to have a direct effect on prices or to be correlated with unobservables that do affect prices. An estimation approach such as two stage least squares can use this instrument to consistently identify the effect of competition. As an example, a number of researchers that have examined how WalMart has affected local labor markets have used the distance of the location from Bentonville, AK as an instrument for when and where WalMart entered a location, reflecting the systematic way in which WalMart expanded across the country. See, for example, Basker, "Job Creation or Destruction? Labor Market Effects of Wal-mart Expansion", *The Review of Economics and Statistics*, 2005, 87(1), 174–183.

of this would be that many DS1 customers (who purchase a relatively low bandwidth/slow product) find substitution to a `best efforts' cable service, which may yield higher speed on average, a viable option; while ILECs have little incumbency advantage for customers who demand high bandwidth which cannot be supplied effectively over copper wire. DS3 customers, who pay for a service that is much more expensive than best efforts cable and much less expensive than business high bandwidth service may have few options available. An analysis of even a small sample of RFPs, as suggested above, might shed light on this issue.

22. For the analysis both the statistical significance and the magnitude of the coefficients may matter, i.e., market power may be too limited to rationalize regulation even without facilities-based competition even if the effects of competition are statistically significant. Dr. Rysman notes (p. 23) that some of the estimated effects (e.g., 28.6% or 23.2% price reductions for DS3 in areas with flexible pricing) may be "implausibly large", and they are certainly larger than the 10 or 11% effects in Table 14. It is not clear what the metric is being used or should be used for what is a reasonable effect of competition. Given that most of the costs of providing BDS are likely to be sunk when an ILEC has existing lines with sufficient capacity available and that facilities-based CPs and ILECs may be capable of providing very similar products to users, it is not implausible that prices should fall quite substantially when competition is introduced.[5] It may make sense to consider the size of the coefficients alongside engineering-based estimates of the costs and margins involved in providing BDS services.

23. A concern with the regressions in Dr. Rysman's report is that the standard errors have not been clustered. The current specification allows for the residuals (the part of log price that cannot be explained by the observed regressors and the fixed effects) to be heteroskedastic (i.e., for some to be much bigger than others) but it assumes that they are independent across observations. But, one might be concerned that there are some common factors, which mean that customers who are very similar or close geographically will get more similar prices than other customers. Clustering could potentially account for this in a way that is not achieved by the inclusion of fixed effects, and the common

[5] In the extreme, benchmark case where marginal costs were zero and the products were completely undifferentiated one could rationalize a 100% price reduction when competition is introduced.

effect of performing clustering is that the standard errors increase. The increase can be small or it can be large, and without further analysis it is impossible for me to tell whether the increase in standard errors in this particular setting would be sufficient to render some of the coefficients statistically insignificant.[6] Dr. Rysman notes the clustering issue in his conclusion. I would recommend verifying that clustering does not have a large effect on the significance of the results before policy conclusions are drawn. The most natural way to cluster would be to choose a geographic unit such as a census block.

24. In the regressions the coefficients for different types of customer are typically highly statistically significant. For example, they indicate that telecommunications customers pay significantly lower prices, on average, for DS1 service. This could indicate either that they are buying different slightly different DS1 services to other customers or that they are better bargainers or negotiators. This might be explained by the knowledge of the market that a telecommunications provider is likely to have, or their ability to extract some type of volume discount if purchasing for many locations from the same provider. However, this bargaining power may also be affected by the level of competition: even a brilliant bargainer is only likely to be able to extract a lower price if they have credible alternatives to the ILEC, which might include facility-based CP competition. I would therefore recommend that a number of additional regressions are run where the sample is limited to different types of customers (e.g., one regression for non-mobile telecommunications provider customers, another for mobile phone customers, another for cable operators, another for non-telecommunicatons customers etc.). These additional regressions would serve to test whether the findings are robust, but it may also shed light on the mechanisms that lie behind the results and their welfare effects. For instance, if customers who are not telecommunications providers (and are therefore more likely to be final users) experience larger competition effects, this would indicate that ILECs are able to exercise much greater market power over these customers. It would also be appropriate to conduct a separate analysis of market shares for these types of customers.[7]

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[6] It is important to note that clustering will not change the coefficients themselves.

[7] Of course, alternative results and interpretations are possible. For example, suppose that the presence of CP competitors in the census block appears to have little effect on the prices paid by non-telecommunications customers. One explanation would be that, even when competitors are

One could also take this logic further. For example, it is likely that users who want a package of services for different locations may both negotiate and experience market power quite differently than single-location businesses. If customers can be separated on these dimensions one could also investigate whether there are differential competition effects.

25. More generally it may also be useful to add additional controls for the terms and conditions that different customers face or choose (e.g., the length of contracts, or the level of service guarantees). It is possible, for example, that these may vary with the level of competition (for example, when facing competition an ILEC may offer a large discount if a customer will sign a longer contract) and this may also, of course, be affected by the prevailing regulatory regime. For example, offering this type of discount may only be possible in markets where pricing has been partially deregulated. Once again, it is not clear to me exactly what terms and conditions are observed in the data, but I would recommend adding additional controls for contract terms if possible.

E. Conclusion

26. In my opinion, Dr. Rysman has made many sensible choices when analyzing the available data. His estimates support a finding that additional local competition reduces the prices of DS1 and DS3 services, and his view that this finding implies that ILECs have significant market power when they do not face local competition is not unreasonable given that there is no obvious reason why the presence of local competitors would increase an ILEC's costs. There are factors that have not been controlled for in Dr. Rysman's study, but it is quite possible that these are attenuating the effects that he has estimated rather than leading him to an incorrect conclusion that market power exists.
27. However, as I have indicated, there are scenarios under which these conclusions might be invalid, or at least limited to small sub-groups of customers. These scenarios include unobserved heterogeneity across geographical areas that is correlated with variation in

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present, ILECs are able to exercise monopoly power over these customers because many of them are not aware that these competitors exist, or they simply have very strong preferences for sticking with providers that they know.

competition; correlation across customers that, because it is ignored, is leading to standard errors that are too small; heterogeneity in how telecommunications providers and end user customers shop for BDS; and variation in the terms and conditions of BDS services that are created by competition but may not necessarily benefit customers (for example, being locked into longer contracts). The additional data analyses that I have suggested would allow the FCC to investigate these issues more thoroughly.

April, 28th, 2016

Dear Mr DelNero,

Thank you for the opportunity to review the White Paper "Empirics of Business Data Services" written by Professor Marc Rysman of Boston University.

Let me first present my academic credentials and relevant experiences. I am currently Professor of Economics at Imperial College London. I am also holder of the Chair in Economics at the University of Rome. I have a M.Sc. and Ph.D. in Economics from the London School of Economics, and a M.Eng. from the University of Turin. My area of specialization is in the field of Industrial Organization, with particular reference to competition and regulation of telecommunications markets. The results of my studies – which embrace both theoretical and empirical approaches – have been published in top academic journals and are cited extensively both in academia and in policy circles (3,400 citations according to Google Scholar). My full list of publications is available at http://www.imperial.ac.uk/people/t.valletti

Over the years I have advised several governmental and inter-governmental agencies on a number of competition and regulation cases, including market definition and remedies in electronic communications for the European Commission (DG Competition and DG Information Society). I was a member of the spectrum advisory board at Ofcom from 2007 to 2012. Since 2013 I have also been a member of the Economic Advisory Group on Competition Policy (EAGCP) of the European Commission DG Competition.

1. The White Paper

This paper has collected and analyzed a very impressive dataset about Business Data Services (BDS). It argues in a convincing way that some considerable parts of this market are concentrated with some providers enjoying a dominant position. This position of dominance can be used to set high prices to users of BDS and therefore some forms of regulation, such as price caps, seem warranted for parts of the market for BDS.

The market of BDS is very complex and I am not familiar with many detailed aspects of it. Given the time available, I have concentrated my response to some economic issues that emerge from reading the current draft of the White Paper. In my discussion, I will follow the same structure of the White Paper that presents empirical evidence in three main sections, related respectively to revenues, locations, and pricing.

2. Revenues

This part of the White Paper presents useful aggregate information, which is particularly valuable to get a sense of who the big players are. In practice, only a few operators - ILECs in particular - have a large market presence. This section is a good starting point for the ensuing analysis, and I only have two minor comments.

First, it would be useful to clarify if there is double counting in the data. To give an example, imagine that the competitive provider Level 3 buys a DS1 service from Verizon for a sum $X, and uses it to provide some service to Citibank for a sum $Y. If I understood it correctly, the data would report revenues, say, of $X for Verizon and $Y for Level 3, a total of $X+Y. This overstates the size of Level 3 in this instance, since total revenues should be $Y, of which $X go to Verizon and $Y-X to Level 3. It would be good to have an idea about the magnitude of this problem. This potential ambiguity seems to be confirmed by results in the locations section, showing that a substantial revenue share flows from CPs to ILEC-affiliated CLECs. In any case, to the extent that smaller firms buy wholesale services from ILECs, the bias introduced by double counting would be to inflate the size of smaller providers who happen to bill the end user. Thus the relative size of the largest ILECs should be even larger in practice, confirming the dominance of such ILECs.

A second and minor comment is related to the Tables that could be made more reader-friendly. I suppose that Table 1 refers to $billions (currently not stated), while figures in Table 3 should be expressed in $000,000 (currently it says $000s). It would be useful to make the initial Tables 1-2-3 homogenous with each other.

3. Locations

The purpose of this section is to understand the presence of several competitors in the relevant market. The relevant market is defined here in terms of the ability of suppliers to reach customers across geographical locations. While most customers will find it hard to change location in case BDS prices change, a supply-side response should be an important force that puts a discipline to prices in case they were too high.

The White Paper presents a very granular view of the presence of competing operators across locations. It manages to give a picture about the presence of the number of competitors per building, as this appears to be often mentioned as the relevant unit for decision-making by suppliers.

According to this analysis, it is first confirmed that ILECs connect most of the buildings (Table 6), while the vast majority of other players are quite small in size. It would be perhaps useful at this stage to have a discussion that compares Table 6 with the previous Tables 1-2-3 based on revenues. It would be reassuring to find comparable shares by provider and by type using two very different approaches. The comparison could also help clarify the issue of double counting mentioned above.

This section also shows that the number of competitors per building is small, with the median building being served by a single operator. I note that the author computes the presence of CPs when they can provide service (with or without UNEs), which seems to be the appropriate way to account for potential supply-side competition.

The situation is instead different for buildings served by fiber, where the playing field seems much more levelled between ILECs and CPs. This is possibly an indication of greater competitive interest in a market with greater demand for bandwidth.

The analysis is also conducted at different level of aggregation, looking at census blocks. While the precise figures change, the picture that emerges is once again one where most census blocks have no competitive provision, and only a few blocks have multiple providers in them.

In some previous work of mine on competition in the UK residential broadband market,[1] the UK regulator adopted a different approach using Local Exchanges as relevant markets, as this is the level where CPs have to sink most of their investments. While BDS are clearly a different market, it would be useful to clarify why this alternative definition, which has been employed elsewhere in the literature, is not particularly relevant in the current context.

I am in agreement with the author's emphasis on the supply side of the market. Nonetheless, it might be useful to comment on some aspects of the demand side. Specifically, it would be good to know how many customers are multi-location (most examples presented presume that to be the case). If these customers can find deals all over the country, this not a particular source of concern. But if instead there is a preference for a single provider, or cross deals are difficult to reach across locations, then it would be possible to argue that the finding that there is little potential competition would be further reinforced.

4. Prices

This is the central part of the White Paper. The author conducts regression analysis where the price paid by a customer is regressed against a set of variables, some of which capture the presence of competition. The main idea being tested is to see if operators in more concentrated markets (that is, markets with few competitors) can exert market power by setting higher prices to their customers. If instead there is a serious entry threat, or if consumers could easily find alternatives, suppliers should not be able to raise prices above competitive levels.

The analysis is primarily done in terms of a building. One might argue that a building is too small to serve as a relevant market, but this choice is based on the narrative descriptions of cases where it was reported exceedingly expensive even to build from one floor of a building to another, in which case the building would possibly be too large to be a relevant market. The author is aware of how crucial the unit of analysis is, and for this reason the author also

[1] M. Nardotto, T. Valletti and F. Verboven "Unbundling the incumbent: Evidence from UK broadband", *Journal of the European Economic Association*, vol. 13, n. 2, 330-362, 2015.

follows alternative approaches. Looking at the results, the coefficients on rivalry in the building are comparable to the coefficients on rivalry in the block, which is reassuring.

I have several observations that might be useful to clarify some outstanding issues.

First, it is important to discuss how prices are calculated. These are obtained from the bills of a customer. As bills report total revenues, that is, prices multiplied by quantities, one has to be careful not to confound the two. I think this is fine in the present study, as prices are calculated by circuit, but it would be good to have some clarifications in this direction. Else one would be subject to the criticism that higher "prices" (= bills) just reflect higher "quantities" (think, for instance, of more inclusive "data bundles" in residential markets). My observation also applies to ancillary services that could come with a circuit. In other words, it was not too clear to me if the currently calculated prices actually follow a "basket" approach where actual prices are calculated for comparable baskets (in previous work, I have followed this basket approach to compare cellular tariffs).[2]

Second, it would be good to understand why competition is expected to play a role on prices at a level as disaggregated as a building. If a service is tariffed, which I understand is true, for instance, of DS1 and DS3 services, then that service must be generally available to all at the same price. I also understand that the carriers can and do under the tariff differentiate services based on geographic locations,[3] and that under the tariff prices can also vary, for instance, with volume, term commitment, and quality of SLAs. But if one could control for all these factors, the prices should *not* change with the number of competitors, as the same conditions must be offered to everyone. So my main point here is to understand why – having controlled for all the "right" factors – competition should have a role for tariffed services. Else the interpretation of the regression results could be substantially different: if, say, regulated prices could *not* react at all to the number of competitors, then the present statistical findings are simply pointing to the spurious correlation that competitors seem to enter in particular

[2] C. Genakos and T. Valletti, "Testing the 'waterbed' effect in mobile telecommunications," *Journal of the European Economic Association*, vol. 9, n. 6, 1114-1142, 2011; C. Genakos and T. Valletti, "Evaluating a decade of mobile termination rate regulation", *Economic Journal*, vol. 125, issue 586, 31-48, 2015.

[3] These are called density zones, with progressively higher prices for a given service as residential density falls; incidentally, I was not too sure if this type of information on density exists in the dataset and is used in the regression analysis.

buildings where particular contractual elements (not observed by the econometrician) are present. Although I understand this is an empirical exercise, it would help to know why regulated prices would be subject to competitive forces, in a setting where the ILEC provider cannot in principle discriminate among its customers – other things equal.

Third, and related to the above, why do CPs not serve buildings where prices seem to be high? Is it because they have to bear some particular kind of entry cost? What are the limits to competition? This would be useful also to inform the regulator as to the effectiveness of possible remedies.

Fourth, the author mentions that his approach relies on some randomness in how the number of CPs is determined in various locations. While he does control for location fixed effects that account for quite a few unobservable factors, the question remains whether it is still possible that unobserved factors that can affect prices (particular demand and supply characteristics) differ within the census tract, and could drive the entry of CPs. While this problem is almost unavoidable in a cross-section like this, I was wondering if any exercise could be done to exploit the time dimension that is still available in the data. One could, for instance, look at the subset of prices for which monthly data exist, and see if over the period some competitive dynamics had the predicted impact on prices. I am not sure if this would be feasible though, as the information about the number of competitors might have been collected only at a single point in time. If that is the case, the FCC might consider collecting additional data on the number of competitors in the near future and conduct an analysis of prices before/after competitive entry in some markets.

Fifth, a similar comment on the possible endogeneity of competitive entry can be made on the interesting results on differences in Price Flexibility Regulation (Table 20). The FCC has allowed greater price flexibility to raise prices above the price cap in some instances. Unless these flexibilities were given randomly, the results would be biased (as it is likely that the regulator allowed price flexibility where it did not expect prices to rise). Again, it would be useful to provide some discussion of what this means in the interpretation of results.

Sixth, the author may want to include an operator-fixed effect in his regression analysis. This would capture, for instance, advertising-related expenses, brand preferences, and so forth. It may also be good to show explicitly in the annex the equation that is being estimated, so it

would be clear for trained economists what fixed effects are being controlled for. Perhaps this type of fixed-effect is already subsumed by the location fixed effects, but it would be useful if the author could clarify this point.

Last, the author acknowledges that it would be interesting to explore the use of cluster standard errors (instead of robust standard errors). I agree with this, which would be doable without having to collect extra data. The correct standard error estimation procedure should be given by the underlying structure of the data and will determine the accuracy of the estimation.

Sincerely,

Tommaso Valletti

EMPIRICS OF BUSINESS DATA SERVICES

WHITE PAPER

By Dr. Marc Rysman[1]
Boston University

April 2016
(Rev. June 2016)

[1] I thank FCC staff for excellent assistance in producing this 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]

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[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 block[5] 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.

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[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 suppled 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 tract[13] 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.

Also, we can see that the reliance of ILECs on circuit-based data are heavily driven by AT&T. The rest of the industry is close to a 50-50 revenue split between circuit and packet, but AT&T, the biggest player by far, has a **[BEGIN HIGHLY CONFIDENTIAL]** [redacted] **[END HIGHLY CONFIDENTIAL]** revenue ratio. Since 2013, industry reports suggest that AT&T has invested substantially in packet-based technology.[16]

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As discussed above, a second important caveat is that these numbers do not include revenues that are earned when a firm sells a managed service in a bundle that uses BDS as an input. If this problem affects CPs more than ILECs, then Tables 1 and 2 might overstate ILEC revenues relative to CP revenues. To investigate this, FCC staff took two approaches. First, using the location and billing data, they determined that ILECs and CPs both make BDS sales in approximately 70% of the locations that they serve, suggesting BDS sale shares may reflect managed service sales.[17] Second, staff collected publically available information on the approximate total BDS and managed service revenues of the largest

[16] *See* Sean Buckley, AT&T's $14B Project VIP: Breaking Out the Business Service, U-verse Numbers, FierceTelecom (Sept. 24, 2013), http://www.fiercetelecom.com/special-reports/atts-14b-project-vip-breaking-out-business-service-u-verse-numbers.

[17] ILECs make BDS sales in approximately 69% of their served locations, assuming ubiquity, while CPs make BDS sales in approximately 73% of the locations they serve (for independent CPs this number is approximately 72%).

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 than 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.

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[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

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[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 Providers[28]

[BEGIN HIGHLY CONFIDENTIAL]

[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]				

[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.

	ILECs assumed everywhere UNE locations assumed ILEC		ILECs assumed everywhere UNE locations assumed CLEC	
Number of providers	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

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[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 a=-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 indictor 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	0.032	0.040	-0.016	-0.023	0.085
	(0.005)*	(0.063)	(0.057)	(0.004)*	(0.032)	(0.041)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.000	0.035	-0.028	-0.038	-0.090	-0.066
	(0.002)	(0.041)	(0.026)	(0.002)*	(0.021)*	(0.018)*
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.151	-0.016	-0.039	-0.088	-0.033
	(0.005)*	(0.066)*	(0.059)	(0.004)*	(0.033)*	(0.042)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	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	0.147	0.194	-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	-0.007	-0.467
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.026)	(0.113)*
Natural Log of Establishments in the Zip Code	0.009	0.033	-0.140	-0.022	0.078	-0.010
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.049	0.074	-0.079	0.128	0.125
	(0.007)*	(0.065)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.004	0.101	0.041	0.043	-0.204	-0.112
	(0.010)	(0.095)	(0.101)	(0.003)*	(0.024)*	(0.020)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.024	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	-0.003	-0.030	-0.059	-0.042
	(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			-0.531			-0.659
			(0.035)*			(0.027)*
Constant	5.513	5.724	5.783	6.214	6.511	6.331
	(0.027)*	(0.277)*	(0.285)*	(0.009)*	(0.069)*	(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	-0.066	-0.065	-0.052
	(0.002)*	(0.016)*	(0.002)*	(0.010)*
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.095	-0.028	-0.070
	(0.002)*	(0.020)*	(0.001)*	(0.011)*
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.154	-0.075	-0.159
	(0.002)*	(0.022)*	(0.002)*	(0.013)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040	-0.132	-0.065	-0.280
	(0.004)*	(0.031)*	(0.003)*	(0.019)*
Customer is a Telecommunications Provider	-0.197	-0.025	-0.132	0.010
	(0.003)*	(0.018)	(0.003)*	(0.016)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.149	0.194
	(0.002)*	(0.013)*	(0.001)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.010
	(0.003)*	(0.027)	(0.003)*	(0.026)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.025	0.063
	(0.005)	(0.048)	(0.002)*	(0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.008	-0.011	-0.068	0.144
	(0.007)	(0.066)	(0.002)*	(0.017)*
Natural Log of Employment in the Zip Code	-0.011	0.057	0.034	-0.209
	(0.010)	(0.096)	(0.003)*	(0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.014	0.023	0.080
	(0.001)*	(0.009)	(0.001)*	(0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.043	-0.028	-0.060
	(0.001)*	(0.008)*	(0.000)*	(0.004)*
Constant	5.486	5.623	6.133	6.331
	(0.027)*	(0.278)*	(0.009)*	(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	0.125	-0.009	0.060
	(0.003)	(0.030)*	(0.003)*	(0.019)*
Phase 1 x Facilities-based Competitor in Census Block	-0.038	-0.337	-0.073	-0.221
	(0.004)*	(0.041)*	(0.003)*	(0.025)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048	-0.265	-0.040	-0.191
	(0.004)*	(0.039)*	(0.003)*	(0.022)*
Customer is a Telecommunications Provider	-0.196	-0.024	-0.130	0.013
	(0.003)*	(0.018)	(0.003)*	(0.016)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.200
	(0.002)*	(0.013)*	(0.001)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.051	-0.054	-0.004
	(0.003)*	(0.027)	(0.003)*	(0.027)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.023	0.069
	(0.005)	(0.048)	(0.002)*	(0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.038	-0.079	0.117
	(0.007)*	(0.065)	(0.002)*	(0.017)*
Natural Log of Employment in the Zip Code	-0.005	0.082	0.043	-0.185
	(0.010)	(0.095)	(0.003)*	(0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.025	0.021	0.063
	(0.001)*	(0.009)*	(0.001)*	(0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.046	-0.030	-0.060
	(0.001)*	(0.008)*	(0.000)*	(0.003)*
Constant	5.510	5.772	6.189	6.467
	(0.027)*	(0.275)*	(0.009)*	(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 it's 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

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[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.

~~APPENDIX B~~

~~Dr. Marc Rysman, Empirics of Business Data Services (April 2016)~~

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EMPIRICS OF BUSINESS DATA SERVICES

WHITE PAPER

By Dr. Marc Rysman[1]
Boston University

April 2016

(Rev. June 2016)

[1] I thank FCC staff for excellent assistance in producing this 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]

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[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, ~~and~~for instance because availability declines as copper is retired and as certain competitive triggers relevant to DS1 and DS3 availability are met. ~~47 U.S.C. § 251(c)(3); 47 C.F.R. § 51.319(a)(4)(i)-(ii), (5)(ii); 47 C.F.R. § 51.309(b).~~*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).

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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 block[5] 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.

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[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 suppled 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.

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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~~, yet~~. I find evidence of ILEC market power ~~is found~~ 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 ~~Unbundled Network Element (~~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).

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

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I divide competitive providers (CPs or CLECs) into three types: ILEC-affiliated CLECs, Cable 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 ~~cable provision~~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 ~~hybrid fiber coaxial cable (HFC)~~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.

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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. ~~Firms~~While firms report all BDS revenue, ~~but~~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. ~~I expect that limitation to affect CP revenue more than ILEC revenue, since in most cases, ILECs are regulated to price BDS separately even if the ILEC also sells managed services. CPs do not face this requirement.~~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 ~~reported~~were required to report all locations with connections owned or leased as an IRU that are connected to a ~~Metro Ethernet (~~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, ~~and~~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

[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.

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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 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 tract[13] 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.

[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.

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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 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. ~~This~~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 $~~100~~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

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

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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]

Also, we can see that the reliance of ILECs on circuit-based data are heavily driven by AT&T. The rest of the industry is close to a 50-50 revenue split between circuit and packet, but AT&T, the biggest player by far, has a **[BEGIN HIGHLY CONFIDENTIAL]** [redacted] **[END HIGHLY CONFIDENTIAL]** revenue ratio. Since 2013, industry reports suggest that AT&T has invested substantially in packet-based technology.[16]

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~~A~~As discussed above, a second important caveat is that these numbers do not include revenues that are earned when a firm sells a managed service in a bundle that uses BDS as an input. ~~As stated above,~~If this

[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.

[16] *See* Sean Buckley, AT&T's $14B Project VIP: Breaking Out the Business Service, U-verse Numbers, FierceTelecom (Sept. 24, 2013), http://www.fiercetelecom.com/special-reports/atts-14b-project-vip-breaking-out-business-service-u-verse-numbers.

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problem affects CPs more than ILECs, ~~and so~~then Tables 1 and 2 might overstate ILEC revenues relative to CP revenues. To investigate this, FCC staff took two approaches. First, using the location and billing data, they determined that ILECs and CPs both make BDS sales in approximately 70% of the locations that they serve, suggesting BDS sale shares may reflect managed service sales.[17] Second, staff collected publically available information on the approximate total BDS and managed service revenues of the largest 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~~,113~~.11	$29~~,523~~.52	$28~~,929~~.93
Verizon	$20~~,716~~.72	$19~~,839~~.84	$18~~,922~~.92
CenturyLink	$11~~,038~~.04	$~~10,999~~11.00	$10~~,561~~.56
Level3	$3~~,011~~.01	$4~~,193~~.19	$4~~,989~~.99
Windstream	$1~~,666~~.67	$1~~,767~~.77	$1~~,863~~.86
Comcast	$3~~,241~~.24	$3~~,951~~.95	$4~~,742~~.74
Time Warner	$1~~,901~~.90	$2~~,312~~.31	$3~~,284~~.28
Frontier	$2~~,276~~.28	$2~~,183~~.18	$2~~,161~~.16
Charter	$~~812~~0.81	$~~993~~0.99	$1~~,127~~.13
Earthlink	$~~945~~0.95	$~~911~~0.91	$~~945~~0.95
Cox*	$1~~,800~~.80		
Total (excl. Cox)	$75~~,719~~.72	$76~~,671~~.67	$77~~,523~~.52

Table 3: Revenues (billions $) for Business Services 2013-2015 ~~($000s)~~

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

[17] ILECs make BDS sales in approximately 69% of their served locations, assuming ubiquity, while CPs make BDS sales in approximately 73% of the locations they serve (for independent CPs this number is approximately 72%).

[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.

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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 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 than 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.

[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/).

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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.

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

[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.

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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 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.

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[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%).

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	As Reported (Locations w/ Customers)	As Reported With CP UNEs Counted as ILEC	Locations if ILEC Assumed Everywhere
ILECs	69.1%	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 Providers[28]

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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]		[redacted]	[redacted]
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[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.

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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.

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	ILECs assumed everywhere UNE locations assumed ILEC		ILECs assumed everywhere UNE locations assumed CLEC	
Number of providers	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.

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	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.

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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

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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.

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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

[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.

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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 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.

[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.

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

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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

[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 ~~are~~ only ~~available~~ for census blocks located in MSAs.

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associated with a 3.2% decline in prices, which is economically significant, although not especially large 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 ~~serving~~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

[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 ~~a~~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 a=-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.

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competition in the building variable for DS1 lines, -4.7%, and a smaller but still significant effect for the 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 indictor 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%,

[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.

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the parameter is not statistically significantly different from zero. Overall, my approach to detecting 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 ~~might~~ 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.

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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 ~~possibly implausibly~~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

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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 ~~the~~ BDS ~~market~~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.

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	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

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	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

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	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	0.032	0.040	-0.016	-0.023	0.085
	(0.005)*	(0.063)	(0.057)	(0.004)*	(0.032)	(0.041)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.000	0.035	-0.028	-0.038	-0.090	-0.066
	(0.002)	(0.041)	(0.026)	(0.002)*	(0.021)*	(0.018)*
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.151	-0.016	-0.039	-0.088	-0.033
	(0.005)*	(0.066)*	(0.059)	(0.004)*	(0.033)*	(0.042)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	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	0.147	0.194	-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	-0.007	-0.467
	(0.003)*	(0.027)	(0.140)*	(0.003)*	(0.026)	(0.113)*
Natural Log of Establishments in the Zip Code	0.009	0.033	-0.140	-0.022	0.078	-0.010
	(0.005)	(0.048)	(0.051)*	(0.002)*	(0.014)*	(0.014)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.049	0.074	-0.079	0.128	0.125
	(0.007)*	(0.065)	(0.074)	(0.002)*	(0.017)*	(0.015)*
Natural Log of Employment in the Zip Code	-0.004	0.101	0.041	0.043	-0.204	-0.112
	(0.010)	(0.095)	(0.101)	(0.003)*	(0.024)*	(0.020)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.024	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	-0.003	-0.030	-0.059	-0.042
	(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			-0.531			-0.659
			(0.035)*			(0.027)*
Constant	5.513	5.724	5.783	6.214	6.511	6.331
	(0.027)*	(0.277)*	(0.285)*	(0.009)*	(0.069)*	(0.075)*

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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

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	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

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	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

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	(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

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	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	-0.066	-0.065	-0.052
	(0.002)*	(0.016)*	(0.002)*	(0.010)*
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.095	-0.028	-0.070
	(0.002)*	(0.020)*	(0.001)*	(0.011)*
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.154	-0.075	-0.159
	(0.002)*	(0.022)*	(0.002)*	(0.013)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040	-0.132	-0.065	-0.280
	(0.004)*	(0.031)*	(0.003)*	(0.019)*
Customer is a Telecommunications Provider	-0.197	-0.025	-0.132	0.010
	(0.003)*	(0.018)	(0.003)*	(0.016)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.149	0.194
	(0.002)*	(0.013)*	(0.001)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.010
	(0.003)*	(0.027)	(0.003)*	(0.026)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.025	0.063
	(0.005)	(0.048)	(0.002)*	(0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.008	-0.011	-0.068	0.144
	(0.007)	(0.066)	(0.002)*	(0.017)*
Natural Log of Employment in the Zip Code	-0.011	0.057	0.034	-0.209
	(0.010)	(0.096)	(0.003)*	(0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.014	0.023	0.080
	(0.001)*	(0.009)	(0.001)*	(0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.043	-0.028	-0.060
	(0.001)*	(0.008)*	(0.000)*	(0.004)*
Constant	5.486	5.623	6.133	6.331
	(0.027)*	(0.278)*	(0.009)*	(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

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	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	0.125	-0.009	0.060
	(0.003)	(0.030)*	(0.003)*	(0.019)*
Phase 1 x Facilities-based Competitor in Census Block	-0.038	-0.337	-0.073	-0.221
	(0.004)*	(0.041)*	(0.003)*	(0.025)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048	-0.265	-0.040	-0.191
	(0.004)*	(0.039)*	(0.003)*	(0.022)*
Customer is a Telecommunications Provider	-0.196	-0.024	-0.130	0.013
	(0.003)*	(0.018)	(0.003)*	(0.016)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.200
	(0.002)*	(0.013)*	(0.001)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.051	-0.054	-0.004
	(0.003)*	(0.027)	(0.003)*	(0.027)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.023	0.069
	(0.005)	(0.048)	(0.002)*	(0.014)*
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.038	-0.079	0.117
	(0.007)*	(0.065)	(0.002)*	(0.017)*
Natural Log of Employment in the Zip Code	-0.005	0.082	0.043	-0.185
	(0.010)	(0.095)	(0.003)*	(0.024)*
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.025	0.021	0.063
	(0.001)*	(0.009)*	(0.001)*	(0.004)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.046	-0.030	-0.060
	(0.001)*	(0.008)*	(0.000)*	(0.003)*
Constant	5.510	5.772	6.189	6.467
	(0.027)*	(0.275)*	(0.009)*	(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

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ATTACHMENT 1 - DATA SET CONSTRUCTION AND DEFINITION OF VARIABLES

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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.[1] 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

[1] 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.

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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

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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.

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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 it's 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

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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.

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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

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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

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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

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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.

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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.

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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.

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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.

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Federal Communications Commission
Washington, D.C. 20554

FROM: **Wireline Competition Bureau**

RE: **Peer Review of *Empirics of Business Data Services* White Paper by Dr. Marc Rysman (April 2016); *Business Data Services in an Internet Protocol Environment; Investigation of Certain Price Cap Local Exchange; Carrier Business Data Services Tariff Pricing Plans; 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 Nos. 16-143, 15-247, 05-25, RM-10593.**

DATE: **June 28, 2016**

On May 2, 2016, the Federal Communications Commission (Commission) released a Tariff Investigation Order and Further Notice of Proposed Rulemaking in the business data services (special access) rulemaking proceeding.[1] The item included a white paper prepared by an outside econometrician hired by the Commission, Dr. Marc Rysman, entitled "Empirics of Business Data Services" (Rysman Paper).[2] The Rysman Paper "studied the market for business data services in the United States," analyzing data collected by the Commission from providers and purchasers of business data services.[3] The Commission sought comment on the validity and strength of Dr. Rysman's analysis and conclusions, and on their relevance to the Commission's analysis, and this proceeding more generally.[4]

Consistent with Office of Management and Budget (OMB) peer review guidelines,[5] the Commission also initiated an external peer review of the Rysman Paper, seeking the analysis of Andrew Sweeting, Associate Professor of Economics, University of Maryland, and Tommaso Valletti, Professor of Economics, Imperial College London.[6] The Commission subsequently received written peer review reports from Professors Sweeting and Valletti analyzing the Rysman Paper.[7]

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[1] *See Business Data Services in an Internet Protocol Environment Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans; 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 Nos. 16-143, 15-247, 05-25, RM-10593, Tariff Investigation Order and Further Notice of Proposed Rulemaking, FCC 16-54 (rel. May 2, 2016) (*Business Data Services Order* or *Business Data Services FNPRM*).

[2] *Id*., Appx. B, Dr. Marc Rysman, *Empirics of Business Data Services* (Apr. 2016) (Rysman Paper).

[3] The data collected in 2015 is primarily from 2013. *Id*. at paras. 36-37.

[4] *Id*. at para. 164.

[5] Final Information Quality Bulletin for Peer Review, Office of Management and Budget, Executive Office of the President, 70 Fed. Reg. 2664 (Jan. 14, 2005) (requiring that influential scientific information on which a federal agency relies in a rulemaking proceeding be subject to peer review to enhance the quality and credibility of the government's scientific information).

[6] *See* Memorandum from Mathew S. DelNero, Chief, Wireline Competition Bureau, to Andrew Sweeting, Associate Professor, University of Maryland (Apr. 14, 2016), http://www.fcc.gov/encyclopedia/peer-review-agenda; Memorandum from Mathew S. DelNero, Chief, Wireline Competition Bureau, to Tommaso Valletti, Associate Professor, University of Maryland (Apr. 14, 2016).

[7] Andrew Sweeting, University of Maryland College Park, "Review of Dr. Rysman's 'Empirics of Business Data Services' White Paper (Apr. 16, 2016) (Sweeting Report), https://www.fcc.gov/general/peer-review-agenda; Letter

Professor Rysman has made revisions to his paper (namely further explanations and clarifications) in response to these peer review reports, which the Commission submits into the record of the proceeding as well as the Commission's peer review agenda website.[8] Separately, attached are three Commission staff papers responding to specific comments from the peer reviewers. Attachment 1 addresses suggestions to explore the use of clustered standard errors.[9] Attachment 2 addresses Professor Valletti's request for a discussion on the interpretation of results of pricing flexibility regulatory framework biases by analyzing the extent to which the effects of facility-based competition vary by regulatory type – price cap (only), Phase I pricing flexibility, and Phase II pricing flexibility.[10] Attachment 3 further addresses the competitive effect of cable network infrastructure.

Additionally, there were some notable comments and suggestions by the peer reviewers, as noted below, that Professor Rysman and Commission staff took under consideration but that did not result in revisions to the Rysman Paper and were not otherwise specifically addressed by Commission staff in Attachments 1 and 2.

- Professor Valletti indicates that it would be useful to know how many customers are multi-location. He then notes that if customers have "a preference for a single provider, or cross deals are difficult to reach across locations, then it would be possible to argue that the finding that there is little potential competition would be further reinforced."[11] We find that 19.2% of customers are located in more than one building. We agree that a better understanding of the preferences of customers will shed additional light on competition in business data service markets.

- Professor Sweeting proposes that "[i]f any terms and conditions are available, one should analyze how they differ, within a census tract or county, with the level of competition, and ideally, additional controls for terms and conditions should be included in regressions."[12] As a first response, the Rysman Paper points out that terms and conditions are endogenous, and thus may be chosen so that lower priced services are more attractive to purchasers that have competitive alternatives, hence the approach taken by Professor Rysman did not seek to control for these. Nonetheless, Commission staff agrees that controlling for as many characteristics of a connection as possible is worth investigating. The data collected by the

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from Tommaso Valletti, Professor of Economics, Imperial College London, to Matthew DelNero, Chief, Wireline Competition Bureau (dated Apr. 28, 2016) (Valletti Report), https://www.fcc.gov/general/peer-review-agenda.

[8] *See* Dr. Marc Rysman, *Empirics of Business Data Services* (Apr. 2016, rev. June 2016) (Revised Rysman Paper); FCC Peer Review Agenda, https://www.fcc.gov/general/peer-review-agenda. In addition, some formatting changes were made (e.g., page numbering added), and some minor non-substantive changes were made to Tables 1-4 (e.g., changed from reporting by millions to billions in Tables 1 and 3, the revenues for Level 3 and tw twlecom and for Birch and Cbeyond were combined in Table 2, and a number was rounded in Table 4).

[9] *See* Sweeting Report at 10-11; Valletti Report at 7; Attach. 1, FCC Memorandum, "Use of Clustered Standard Errors in Business Data Service Regressions" (June 10, 2016).

[10] Valletti Peer Review Report at 6; Attach. 2, FCC Memorandum, "Distinguishing the Effects of Competition on ILEC Prices under Price Cap only Regulation, Phase 1 Pricing Flexibility, and Phase II Pricing Flexibility" (June 10, 2016).

[11] Valletti Report at 4.

[12] Sweeting Report at 5, 11-12.

Commission contains a limited amount of information on term and volume commitments for use with regressions. Preliminary analysis by the Commission of the regressions in the Rysman Paper indicate that controlling for the presence of term and volume commitments has minor effects on the estimated impact of competition on ILEC prices and does not change the interpretation of our results in the Rysman Paper.

- Professor Valletti cautions about the possible endogeneity of the degree of pricing flexibility and its effect on the results of Table 20, and by extension, the attached Commission staff memorandum on distinguishing the effects of competition on ILEC prices under the different pricing flexibility regimes.[13] He indicates that unless flexibility was granted randomly the results are biased. He believes that it is likely that pricing flexibility was granted in locations where the Commission did not expect prices to rise. We agree with Professor Valletti that we should consider how the mechanisms by which flexibility was granted will influence the regression results. We note that under Professor Valletti's proposed mechanism our estimates of the effect of competition on prices in locations with pricing flexibility would likely understate the effect on competition on prices in areas that do not currently have pricing flexibility.

- Professor Sweeting suggests in considering whether estimated effects of competition are "implausibly large" that the analysis account for "the size of the coefficients alongside engineering-based estimates of the costs and margins involved in providing BDS services."[14] Commission staff agree with Professor Sweeting's assessment that such an approach would bolster findings on the estimated effects of competition. However, the Commission has no engineering-based estimates of the cost and margins involved in providing business data services, and, do not consider obtaining such estimates to be feasible.

- Professor Sweeting, noting the distinct impacts of customer type on purchase prices found in the Rysman Paper, recommended additional regressions, one for each customer type.[15] Commission staff are investigating this and related strategies for evaluating the impacts of competition on different customer groups.

- Professors Sweeting and Valletti suggest using panel data.[16] The data collected for analysis is for a single year, 2013, so panel data was unavailable for the analysis. Professor Rysman does note that if he had panel data, it would be interesting to study how a competitive providers entered one building in a block and then spread to others but that the results suggest that distinguishing between competition in the building and the block is not particularly important.[17] As part of the underlying rulemaking proceeding, the Commission is also considering the collection of data periodically going forward, which would result in panel data.

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[13] Valletti Report at 6.

[14] *Id*. at 10.

[15] *Id*. at 11.

[16] Sweeting Report at 4; Valletti Report at 6.

[17] Revised Rysman Paper at 25 n.43.

ATTACHMENT 1

Use of Clustered Standard Errors in Business Data Service Regressions

Federal Communications Commission Staff[1]

June 28, 2016

Professor Marc Rysman's White Paper, "Empirics of Business Data Services" (Rysman Paper), suggests that future work should include the use of clustered standard errors. Both peer reviews concur on this suggestion. In this memo, we explain the purpose behind so-called clustered standard errors and then re-estimate the regression tables from the Rysman Paper.

What are referred to as clustered standard errors are standard errors calculated under less restrictive assumptions than basic standard errors and so-called robust standard errors. With basic standard errors it is assumed that the error terms of the regression model are independent and identically distributed. The identical distribution assumption requires that the error terms be homoscedastic, in other words have the same variance. This assumption can be relaxed by calculating what are commonly called robust standard errors.[2] This estimate of the standard error retains the assumption that the error terms are independent, however, it allows for the relaxation of the homoscedasticity assumption. Clustered, or cluster-robust, standard errors further relax the assumptions about the distribution of error terms by allowing the error terms to be correlated within defined groups of observations. However, the error terms of observations from different groups are assumed to be independent.

These assumptions are issues because the researcher does not know the true properties of the distribution of error terms. If the assumptions about the error terms do not hold, the estimated standard errors, and consequently all hypothesis tests, may have a significant bias. The degree of the bias depends on a number of factors including the amount of intra-group correlation and the size and number of the groups.

The first step in correcting for the potential bias is to determine the groups within which the error terms may not be independent. Such a lack of independence is generally caused by unobserved factors that vary between groups but have the same influence within the group. In the case at hand we can think of several possible factors. Those factors may be associated with the location, the carrier, and the customer. Professor Andrew Sweeting's peer review suggests the census block containing the location as the most natural way to cluster. This unit has the added benefit of clustering together circuits sold by the same carrier as well as a good number of circuits purchased by the same customer in the location.[3] These are likely sources of correlation in the error terms, though the correlation is due to a misspecified model rather than correlation in the underlying distribution of the error terms. We therefore used the census block as the clustering group for the calculation of standard errors.

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[1] We acknowledge and appreciate Tracy Waldon, FCC Economist, for his contributions to this paper.

[2] They are also known as heteroscedasticity-robust standard errors, Huber-White standard errors, sandwich-estimated standard errors, among others.

[3] Using census blocks as the group variable also helps reduce the bias in the standard error estimate by using a large number of groups and not having any single group account for more than 5% of the observations in the dataset.

In the tables that follow, we have replicated Tables 14 through 20 from the Rysman Paper and allowed for correlation in the error terms within census blocks. Use of the common method for calculating cluster-corrected standard error does not change the estimated coefficients; they remain consistent in the statistical sense. The cluster-robust standard errors are substantially larger than the robust standard errors of the original regressions. Despite this, in only a few cases do we find that there are significant changes in the interpretation of the regression results. In the tables that follow, we have highlighted the changes in the standard hypothesis tests on the competition variables. In many instances, even though the point estimates are quite large, they are measured with such imprecision that they are not statistically different from zero. The most extensive changes are found in Tables 16 and 19. Table 16 estimates the effect of having a competitor in the census block and splits that effect into an effect when a fiber network is also in the census block and when one is not. For the DS-1 regression using tract fixed effects, none of the competition variables are statistically different from zero. At first blush this might be considered as indicative that the presence of a competitor does not influence ILEC prices. However, looking at Tables 14 and 15, there is clear evidence that this is not the case. Furthermore, the parameter estimate in Table 16 of the competitive effect when a fiber network is present is close in magnitude to the estimates in Tables 14 and 15.[4] This is evidence that the regression specification in Table 16 is not accounting for any omitted variable bias. Consequently our conclusion is that Table 16 simply pushes the data far enough that we cannot reliably estimate the effect of competition. We would not conclude that there is no competitive effect in light of the findings in Tables 14 and 15, as well as other Tables, such as Table 20, in the Rysman Paper. In Table 19, the regression examining the influence of the numbers of competitors on DS-3 prices is significantly changed. There is minimal evidence that the number of competitors has an influence on ILEC prices for DS-3 services. Again, given the evidence we see in many other specifications, we do not believe that this result is definitive, but simply asks more of the data than it can provide.

Finally, one concern with having so many groups is the presence of singleton groups. A singleton group is a census block which only has one circuit in it. Such a group cannot be used to estimate the intra-group correlation. If these singleton groups constitute a significant portion of the groups such that we are estimating the intra-group correlation on a collection of groups that are geographically isolated, we would have concern that we may not have an unbiased estimate of the intra-group correlation in the entire population. We have examined this issue and find that generally at least 40% of the census blocks in the dataset are used to calculate the intra-group correlation parameter. These census blocks are widely distributed; more than 70% of counties and 90% of states are represented by these census blocks. We would therefore conclude that there are not any significant sources of bias in the estimation of the intra-group correlation parameter.

[4] 87% of DS-1 observations are in census blocks with fiber networks according to Attachment 3 of the Rysman Paper. Accordingly, most of the competitive effect in Tables 14 and 15 is being measured in census blocks with fiber networks.

Table 14a: Regression of Log Price on Competition in the Census Block (Table 14 in Rysman Paper)

	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 is in the Census Block	-0.032	-0.109	0.023	-0.056	-0.114	0.046
	(0.004)*	(0.042)*	(0.030)	(0.007)*	(0.035)*	(0.038)
Customer is a Telecommunications Provider	-0.196	-0.025	0.135	-0.131	0.014	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.199	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.005	-0.472
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.008	0.031	-0.140	-0.023	0.070	-0.011
	(0.015)	(0.107)	(0.070)*	(0.010)*	(0.057)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.052	0.074	-0.082	0.113	0.123
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.105	0.041	0.045	-0.181	-0.111
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.106)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.011	-0.024	0.005	0.021	0.062	0.028
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)
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)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.531			-0.660
			(0.090)*			(0.088)*
Constant	5.513	5.762	5.757	6.202	6.471	6.293
	(0.088)*	(0.728)*	(0.511)*	(0.061)*	(0.309)*	(0.266)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	136.35	5.57	12.71	183.73	4.94	14.53
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 15a: Regression of Log Price on Competition and CLEC Network in the Census Block (Table 15 in Rysman Paper)

	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 is in the Census Block	-0.032	-0.108	0.025	-0.052	-0.104	0.054
	(0.004)*	(0.043)*	(0.030)	(0.007)*	(0.035)*	(0.039)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.003	-0.016	-0.030	-0.046	-0.121	-0.073
	(0.004)	(0.047)	(0.030)	(0.007)*	(0.054)*	(0.047)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.012	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.196	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.006	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.008	0.031	-0.140	-0.022	0.075	-0.010
	(0.015)	(0.107)	(0.070)*	(0.010)*	(0.059)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.051	0.075	-0.081	0.123	0.124
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.104	0.040	0.045	-0.196	-0.111
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.109)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.023	0.006	0.022	0.064	0.029
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)*
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
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.531			-0.660
			(0.090)*			(0.088)*
Constant	5.515	5.776	5.785	6.222	6.539	6.338
	(0.088)*	(0.731)*	(0.513)*	(0.061)*	(0.314)*	(0.265)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	122.72	5.14	11.74	167.43	5.00	13.41
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 16a: Regression of Log Price on Competition interacted with the Presence of Fiber in the Block (Table 16 in Rysman Paper)

	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 is in the Census Block	-0.017	0.032	0.040	-0.016	-0.023	0.085
	(0.010)	(0.103)	(0.071)	(0.016)	(0.109)	(0.102)
An Indep. CLEC Has a Fiber Network in the Census Block	0.000	0.035	-0.028	-0.038	-0.090	-0.066
	(0.005)	(0.054)	(0.032)	(0.008)*	(0.067)	(0.051)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.151	-0.016	-0.039	-0.088	-0.033
	(0.011)	(0.109)	(0.075)	(0.017)*	(0.114)	(0.108)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.011	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.147	0.194	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.007	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.033	-0.140	-0.022	0.078	-0.010
	(0.015)	(0.108)	(0.070)*	(0.010)*	(0.059)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.049	0.074	-0.079	0.128	0.125
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.075)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.101	0.041	0.043	-0.204	-0.112
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.110)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.024	0.006	0.022	0.064	0.029
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.045	-0.003	-0.030	-0.059	-0.042
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.531			-0.659
			(0.090)*			(0.088)*
Constant	5.513	5.724	5.783	6.214	6.511	6.331
	(0.088)*	(0.731)*	(0.513)*	(0.061)*	(0.317)*	(0.265)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	111.67	4.72	10.84	152.55	4.51	12.42
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 17a: Regression of Log Price on Competition in the Building and the Block (Table 17 in Rysman Paper)

	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 is in the Building	-0.047	-0.063	-0.023	-0.066	-0.047	-0.014
	(0.006)*	(0.047)	(0.038)	(0.011)*	(0.038)	(0.039)
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
	(0.006)*	(0.060)*	(0.034)	(0.009)*	(0.045)*	(0.032)*
Customer is a Telecommunications Provider	-0.197	-0.026	0.135	-0.132	0.012	0.147
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.057)*
Customer is a Mobile Telecommunications Provider	0.104	0.195	-0.201	0.149	0.198	-0.363
	(0.006)*	(0.050)*	(0.103)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.005	-0.466
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.037	-0.143	-0.023	0.066	-0.007
	(0.014)	(0.108)	(0.070)*	(0.010)*	(0.056)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.020	0.064	-0.073	0.120	0.124
	(0.021)	(0.152)	(0.104)	(0.014)*	(0.073)	(0.054)*
Natural Log of Employment in the Zip Code	-0.008	0.067	0.054	0.037	-0.185	-0.114
	(0.029)	(0.205)	(0.146)	(0.018)*	(0.105)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.016	-0.000	0.021	0.071	0.022
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.019)*	(0.014)
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
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.197
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.658
			(0.088)*			(0.088)*
Constant	5.500	5.654	5.785	6.158	6.432	6.279
	(0.087)*	(0.732)*	(0.513)*	(0.060)*	(0.303)*	(0.273)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	125.17	4.50	11.87	165.83	4.50	13.65
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 18a: Regression of Log Price on Competition in the Building, the Block, and the Tract (Table 18 in Rysman Paper)

	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 is in the Building	-0.051	-0.074	-0.026	-0.069	-0.049	-0.022
	(0.007)*	(0.048)	(0.038)	(0.011)*	(0.038)	(0.038)
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
	(0.007)*	(0.062)*	(0.035)	(0.009)*	(0.046)*	(0.032)
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
	(0.007)*	(0.074)*	(0.042)	(0.009)*	(0.046)	(0.049)
Customer is a Telecommunications Provider	-0.197	-0.025	0.135	-0.132	0.011	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.198	-0.366
	(0.006)*	(0.050)*	(0.103)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.005	-0.470
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.008	0.039	-0.143	-0.025	0.065	-0.008
	(0.014)	(0.109)	(0.070)*	(0.009)*	(0.056)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.011	-0.023	0.065	-0.065	0.126	0.135
	(0.021)	(0.153)	(0.104)	(0.014)*	(0.074)	(0.056)*
Natural Log of Employment in the Zip Code	-0.009	0.068	0.053	0.032	-0.189	-0.120
	(0.029)	(0.206)	(0.146)	(0.018)	(0.105)	(0.070)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.020	-0.001	0.021	0.070	0.021
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.019)*	(0.014)
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
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.658
			(0.089)*			(0.088)*
Constant	5.525	5.860	5.815	6.141	6.425	6.264
	(0.087)*	(0.737)*	(0.513)*	(0.059)*	(0.304)*	(0.276)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	113.86	4.42	11.38	154.97	4.29	12.89
Observations	1,399,440	120,129	80,326	1,399,440	120,129	80,326

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 19a: Regression of Log Price on Number of Competitors in the Census Block (Table 19 in Rysman Paper)

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Building	-0.048	-0.066	-0.065	-0.052
	(0.006)*	(0.046)	(0.011)*	(0.037)
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.095	-0.028	-0.070
	(0.005)*	(0.070)	(0.009)*	(0.046)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.154	-0.075	-0.159
	(0.010)*	(0.070)*	(0.014)*	(0.058)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040	-0.132	-0.065	-0.280
	(0.025)	(0.092)	(0.025)*	(0.107)*
Customer is a Telecommunications Provider	-0.197	-0.025	-0.132	0.010
	(0.010)*	(0.043)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.149	0.194
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.010
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.025	0.063
	(0.014)	(0.110)	(0.009)*	(0.055)
Natural Log of Annual Payroll in the Zip Code	-0.008	-0.011	-0.068	0.144
	(0.022)	(0.155)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.011	0.057	0.034	-0.209
	(0.030)	(0.208)	(0.018)	(0.107)
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.014	0.023	0.080
	(0.002)*	(0.022)	(0.004)*	(0.020)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.043	-0.028	-0.060
	(0.002)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.486	5.623	6.133	6.331
	(0.087)*	(0.741)*	(0.061)*	(0.307)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	105.24	4.06	145.87	4.14
Observations	1,399,440	120,129	1,399,440	120,129

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 20a: Regression of Log Price on Competition in the Block, by Price Flex Regulation (Table 20 in Rysman Paper)

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Census Block	0.001	0.125	-0.009	0.060
	(0.008)	(0.059)*	(0.017)	(0.052)
Phase 1 x Facilities-based Competitor in Census Block	-0.038	-0.337	-0.073	-0.221
	(0.010)*	(0.081)*	(0.021)*	(0.076)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048	-0.265	-0.040	-0.191
	(0.013)*	(0.084)*	(0.022)	(0.065)*
Customer is a Telecommunications Provider	-0.196	-0.024	-0.130	0.013
	(0.010)*	(0.042)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.200
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.051	-0.054	-0.004
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.038	-0.023	0.069
	(0.015)	(0.108)	(0.009)*	(0.057)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.038	-0.079	0.117
	(0.022)	(0.148)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.005	0.082	0.043	-0.185
	(0.030)	(0.201)	(0.019)*	(0.106)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.025	0.021	0.063
	(0.002)*	(0.025)	(0.004)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.046	-0.030	-0.060
	(0.001)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.511	5.772	6.189	6.467
	(0.088)*	(0.728)*	(0.061)*	(0.310)*
Adjusted R-Squared	0.33	0.26	0.18	0.10
F Statistic	112.41	6.12	155.33	4.68
Observations	1,399,440	120,129	1,399,440	120,129

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

ATTACHMENT 2

Distinguishing the Effects of Competition on ILEC Prices under Price Cap only Regulation, Phase I Pricing Flexibility, and Phase II Pricing Flexibility

Federal Communications Commission Staff[1]

June 28, 2016

This memo builds upon the analysis of Professor Marc Rysman's White Paper, "Empirics of Business Data Service" (Rysman Paper), in analyzing the extent to which the effects of facility-based competition vary, if at all, across the three types of regulatory treatment applied to DS-1 and DS-3 circuits (and any potential impacts on other less regulated business data services): price cap (only), Phase I pricing flexibility, and Phase II pricing flexibility. This memo considers the interacting indicator approach to this question found in the Rysman Paper (associated with Table 20) and investigates an alternative approach that separately analyzes the data for each regulatory regime. Using the interacting indicator approach, but with zip code business data controls that allow us to make use of more data, and allowing for cluster-robust standard errors, we find that competition in Phase II pricing flexibility areas has a statistically, and in many cases economically, significant effect on incumbent local exchange carrier (ILEC) prices for DS-1 and DS-3 circuits. However, we find little evidence that the presence of competition affects ILEC prices in price cap regions. The alternative method described in this memo comes to a similar conclusion. Our analysis also demonstrates that use of zip code business data controls appear to make use of the Dun & Bradstreet (D&B) business establishment data unnecessary. These conclusions further demonstrate the robustness of the Rysman Paper's findings of ILEC market power, and reinforce the likelihood that the Rysman Paper, where it does not account for the regulatory regime (Tables 14-19), understates the impact of competition on reducing ILEC prices (because it "averages" the price effects that largely appear to occur in Phase II price flexibility areas over all areas).

The Rysman Paper estimates the effect of the presence of facilities-based competition on the prices of ILEC business data services. The sample is broken into three categories, DS-1, DS-3, and connections of at least 45 Mbps, whether circuit- or packet-based, and competitive effects are estimated independently for each of these samples. The competitive effects reported in the Rysman Paper, Tables 14 through 19, are an average of the effects observed under three different regulatory treatments: price cap (only) regulation; Phase I pricing flexibility, which allows for contract tariffs; and Phase II pricing flexibility, which in addition to allowing contract tariffs, removes the price cap constraint. If ILEC price responses to competition do not vary across the three regulatory treatments, then the results reflect the expected ILEC response to competition everywhere. However, if ILEC price responses to competition do materially vary across the regulatory treatments, an average of these responses across the three treatments would mask these variations, and consequently could obscure significant policy implications. ILEC incentives and the ability to respond to competition likely do vary under these different regulatory regimes because ILECs face different constraints on their ability to set profit-maximizing prices in each regime. Because the different regulatory regimes are not well-linked to underlying levels of competition, there will be sufficient variation in the levels of competition within a regime to allow for the separate identification of competitive effects within each regime. Consequently, it is valuable to try and

[1] We acknowledge and appreciate Tracy Waldon, FCC Economist, for his contributions to this memorandum.

determine the extent to which the effects of facility-based competition vary, if at all, across the three types of regulatory treatment.

Several regression specifications allow estimation of separate competitive effects under each of the three different regulatory treatments. Table 20 in the Rysman Paper illustrates one such method. In addition to an indicator variable for the presence of a competitor in the census block, it includes two additional indicator variables, being an interaction between the first indicator, the presence of a competitor in the census block, and respectively indicators for Phase I and Phase II pricing flexibility. This allows for different competitive effects under the different regulatory treatments. Taking this approach, the Rysman Paper finds that the ILEC response to competition is stronger in pricing flexibility areas as compared to price cap areas. This response is indicative that in the absence of competition ILECs are able to charge higher prices for business data services under pricing flexibility than they are under price caps.

This approach using interactions can become cumbersome as the number of competition variables grows. Table 20 uses the same competition measures as Table 14 and the number of competition related variables increases from one to three. A specification such as Table 19 in the Rysman Paper would contain 12 parameters to interpret if interactions based on regulatory status were added. A specification such as Table 16 would contain interactions with interactions. Interpreting these specifications can become difficult and hypothesis tests cannot be easily presented to readers.

The Rysman Paper restricts the sample to Metropolitan Statistical Areas (MSAs), which is dictated by the use of the D&B data supplied by Compass-Lexecon. This has the effect of overweighting Phase I and II areas relative to price cap areas because, with the exception of West Virginia and Idaho, Phase I and II areas are restricted to MSAs while price caps are not. Demographics regarding the presence of businesses is important to have in the regressions as it influences both demand for and costs of business data services. Regressions using zip code demographics allows the use of the full range of data. This memo investigates the use of zip code demographics as the sole source of business density information, thereby expanding the geographic area covered by the regressions, but limiting the amount and precision of the demographic information.

The following sets of tables suggest a complementary framework that address these two issues. The tables follow those as presented in the Rysman Paper. Each table provides the original regression estimates using Census tract fixed effects from the Rysman Paper in the first column, though cluster-robust standard errors are used in accordance with the recommendations in the Rysman Paper as well as the peer reviewers. These regressions include business density controls using both the D&B data at the census block level and Census Bureau data at the zip code level. The second column, labeled "D&B Areas," removes the D&B business density data from the regression and modifies the Census Bureau data to better reflect the way in which business density is likely to affect business data service prices. Otherwise, the D&B Areas specification uses the same set of observations that are restricted to MSAs.[2] Comparing the first and second columns illustrates that the use of the D&B business density data has minor effects on the estimated competitive effects. The differences in the estimated coefficients on the competition variables are minor and only one coefficient changes from being statistically significant to

[2] We do not have surface area for a few zip codes to allow the calculation of business density in a zip code. We lose 275 out of 1.4 million observations in the DS-1 regression, 20 out of 120,129 observations in the DS-3 regressions, and 8 out of 80,326 observations in the high bandwidth regressions.

not statistically significant (*see* Table 17b). The third column, labeled "All Areas," expands the sample to include all available observations, in particular those outside of MSAs. There are material differences in the reported competitive effects in columns 2 and 3. This could arise because something that is related to Census Bureau's decision to give a territory MSA status is related to how firms compete, or because the regulatory status of the territories are systematically different. Because regulatory status has a direct effect on ILEC pricing decisions, it is likely to be the primary driver rather than MSAs. Columns 4, 5, and 6 of the tables explore this effect by separating the sample into observations in each of the three regulatory regimes: Price Cap Areas, Phase I Areas, and Phase II Areas.

There are advantages and disadvantages of using separate regressions for each regulatory area. A significant advantage is ease of interpretation. Rather than having a multitude of parameters to interpret and test one can quickly ascertain whether competition in an area has a statistically significant effect. In addition, separate regressions introduce more flexibility by allowing all of the remaining parameters on variables such as business density and customer types to also vary across the different regulatory areas. The disadvantage with separate regressions is that it is not possible to do a formal statistical test to compare competitive effects in one pricing regime to another.[3]

Tables 14a through 19c replicate the Rysman Paper tables. Sub-tables labeled (a), (b), and (c) cover DS-1, DS-3, and High Bandwidth connections respectively. Table 1 summarizes these regression results in terms of the effect of competition on ILEC prices. Examining the individual regression tables covering DS-1 it seems clear that the regressions in the Rysman Paper are dominated by the competitive effects in Phase II areas and rarely reflect the effect of competition in price cap areas. Consider table 14a for example. The Rysman Paper suggests that the presence of a competitor reduces ILEC DS-1 prices by 3.2%.[4] When the sample is expanded to cover all areas rather than just MSAs, the effect drops to -2.0%, as illustrated in the third column. As mentioned, bringing in observations from outside the MSA serves to increase the number of price cap observations. It is possible that the differences we are observing are due to regulatory status. Columns 4, 5, and 6 restrict the sample to price cap, Phase I, and Phase II regions, respectively. Table 14a shows that the effect of a competitor is -1.4% in price cap regions, -1.2% in Phase I regions, and -4.4% in Phase II regions. This is a clear indication that the effects in the Rysman Paper are driven by Phase II regions. Table 15a provides a nearly identical story in which the competitive effects in price cap and Phase I regions appear similar and substantially smaller than the effects in Phase II regions. Tables 17a through 19a support this story as well as providing some indication that the competitive effects may be steadily increasing as we move from price cap to Phase I to Phase II areas. Table 16a contains an interaction term between the presence of competition and the presence of a fiber network. This makes interpretation more complicated. Competition appears to have an effect on ILEC prices in Phase II areas only when a fiber network is present in the census block, while

[3] This same argument holds for the choice to use separate regression equations for DS-1 and DS-3 circuits. It is not possible to formally conduct a statistical test on the differences between competitive effects on DS-1 circuits and DS-3 circuits, though with the use of interaction terms we could estimate the competitive effects jointly and conduct such a test.

[4] As discussed in the Rysman White Paper at footnote 36, the estimated coefficients on the indicator variables for competition cannot be strictly interpreted as a percentage change. However, to assist the lay reader in following along with the discussion of the results presented in the tables, I will interpret the estimated coefficients as percentage changes. Readers interested in greater precision can apply the transformation $\%\Delta = e^{\beta} + 1$ where β is the estimated coefficient, to obtain one estimate of the percentage change in prices due to competition.

in price cap and Phase I areas the presence of a fiber network does not matter. However, it is the case that in the presence of a fiber network, the competitive effects in Phase II areas are stronger than in price cap and Phase I regions.

The results for DS-3 circuits are similar to those for DS-1 circuits. The Rysman Paper estimates of the competitive effects are largely driven by Phase II areas. When separated out into specific regulatory regimes, the pattern observed in estimated competition parameters in the DS-3 regressions suggest that ILEC market power is steadily increasing with pricing flexibility, however quite commonly the competitive effects in price cap and Phase 1 areas are not statistically different from zero. Consider tables 14b and 15b. The presence of a competitor in price cap areas is associated with DS-3 prices that are 5.5% to 6.0% higher than those in areas without competition, though not statistically different from zero. In a Phase I area, prices in areas with and without competition are 1.7% to 2.8% lower than in areas without competition, though again not statistically different from zero.[5] While in Phase II areas, competition appears to lower prices by approximately 21% and is statistically significant. This pattern continues in tables 16b through 19b.

With respect to high bandwidth connections, the Rysman Paper results appear to be much more of a true average of the three regulatory areas. While there are differences in the competitive effects between regulatory regimes, there is little indication of the presence of market power. Nearly all coefficients on competition are not statistically different from zero.

The separate regressions of tables 14a through 19c provide a means of examining differential competitive effects by regulatory regime. The alternative is to use interaction terms to estimate the effect. Table 20 uses this method. It presents results for DS-1 and DS-3 circuits for all regions in columns 3 and 6, respectively. Interaction terms can be difficult to interpret. The effect of competition in price cap areas is the competition term without the interactions. Table 20 suggests that competition leads to a 0.9% reduction of DS-1 prices and a 9.9% increase of DS-3 prices in price cap regions. This compares with the estimate of -1.4% for DS-1s in price cap areas from table 14a and a 5.5% increase for DS-3 circuits in price cap areas from table 14b. The signs of the coefficients from the different sources match up, though the magnitudes are of some difference. Examining the effect in Phase I areas when using interactions requires the addition of the competitive effect and the interaction effect for Phase I regions. For DS-1 circuits Table 20 indicates that the presence of a competitor lowers prices by 2.1% (-0.9% + -1.2%).[6] The estimate for DS-3 circuits is -9.0% (= 9.9% + -18.9%).[7] Tables 14a and 14b estimate prices for DS-1s are 1.2% lower with competition in Phase I areas and DS-3 prices are reduced by 2.8% by competition in Phase I areas. However in both of those instances the effects are not

[5] This illustrates the drawback of using separate regressions. We would like to compare the difference of the competition parameters in the price cap area to the phase I area, however because they are separate regressions we cannot do so. It is entirely possible that while individually the coefficients are not statistically different from zero, the difference between them is. Table 20 suggests that this is the case.

[6] It is not possible to conduct a statistical test to determine if this value is significantly different from zero with the information available in the table. It requires information about the covariance between the two estimated parameters. The sum of these two parameters is statistically different from zero even though the two parameters individually are not statistically different from zero.

[7] This sum is not statistically different from zero.

statistically different from zero. Summarizing the Phase I comparison, in this instance the two methods differ both in their findings of statistical significance and the magnitude of the competitive effects

Finally, considering Phase II areas, table 20 estimates that DS-1 prices are 3.0% lower and DS-3 prices are 13.7% lower with competition in Phase II areas. Both of these results are statistically different from zero. Returning to tables 14a and 14b, that DS-1 prices are 4.4% lower in areas with competition and DS-3 prices are 20.9% lower in areas with competition. In addition, both estimates are statistically different from zero. While the magnitudes of DS-3 prices are again different, the pattern is similar.

In summary, whether through the use of interaction terms or separate regressions, it appears that DS-1 and DS-3 prices are consistently lower when facing competition in Phase II areas than when facing competition in price cap and Phase I areas.

Table 1: Summary of the Regression Results

Competition Variable	DS-1			DS-3			High Bandwidth		
	Price Cap	Phase I	Phase II	Price Cap	Phase I	Phase II	Price Cap	Phase I	Phase II
A Facilities-based Competitor is in the Census Block	-, -	(-), (-)	-, -	(+), (+)	(-), (-)	-, -	+, +	(+), (+)	(-), (+)
A Facilities-based Competitor is in the Building	-, -, -	-, -, -	-, -, -	(+),(+),(+)	(-),(-),(-)	-, -, -	+, (+), +	(+),(-),(+)	(-),(-),(-)
At Least One Facilities-based Competitor is in the Block But Not the Building	(-), (-)	-, -	-, -	(-), (-)	(-), (-)	(-), (-)	(+), (+)	(-), (-)	(+), (+)
At Least One Facilities-based Competitor is in the Tract But Not the Block	(-)	-	-	(-)	-	(-)	(-)	(-)	(-)
One Facilities-based Competitor is in the Block But Not the Building	(-)	-	(-)	(-)	(-)	(-)	(+)	(+)	(+)
Two or Three Facilities-based Competitors are in the Block But Not the Building	(-)	(-)	-	(-)	(-)	(-)	(+)	(-)	(+)
Four or More Facilities-based Competitors are in the Block But Not the Building	(-)	(+)	(-)	(+)	(-)	(-)	+	(-)	(+)
An Indep. CLEC Has a Fiber Network in the Census Block	(-)	(+)	(+)	(-)	(-)	(+)	(+)	(-)	(-)

+ and – indicate that the estimated coefficient on the competition variable was positive or negative and statistically different from zero at the 95% level of confidence. If enclosed in parenthesis the coefficient was not statistically different from zero at the 95% level of confidence.

This table does not include results from Tables 16 and 20. Due to the interaction terms in these regression specifications, the sign, and statistical significance, may vary depending on the values of other variables in the regression.

Table 14a: Regression of Log of DS-1 Price on Competition in the Census Block (Table 14 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	-0.032	-0.025	-0.020	-0.014	-0.012	-0.044
	(0.004)*	(0.004)*	(0.004)*	(0.005)*	(0.006)	(0.008)*
Customer is a Telecommunications Provider	-0.196	-0.196	-0.166	-0.089	-0.259	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.034	0.138	0.098
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.159	-0.053	-0.069
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.012)*
Natural Log of Establishments in the Zip Code	0.008					
	(0.015)					
Natural Log of Employment in the Zip Code	-0.004					
	(0.030)					
Natural Log of Annual Payroll in the Zip Code	-0.016					
	(0.022)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.011					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006					
	(0.001)*					
Log of Establishments per Square Mile in the Zip Code		0.007	0.026	0.025	0.017	0.019
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.055	-0.029	-0.013
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.011	0.023	-0.022	0.017	0.064
		(0.021)	(0.025)	(0.021)	(0.043)	(0.034)
Constant	5.513	5.463	5.425	5.752	5.376	5.029
	(0.088)*	(0.082)*	(0.107)*	(0.070)*	(0.220)*	(0.143)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	136.35	168.17	177.65	35.83	142.27	47.78
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 14b: Regression of Log of DS-3 Price on Competition in the Census Block (Table 14 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	-0.109	-0.112	-0.056	0.055	-0.028	-0.209
	(0.042)*	(0.038)*	(0.034)	(0.044)	(0.063)	(0.056)*
Customer is a Telecommunications Provider	-0.025	-0.025	-0.033	-0.132	-0.034	0.086
	(0.043)	(0.042)	(0.039)	(0.070)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.194	0.194	0.198	0.094	0.248	0.223
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.058)*	(0.100)*
Customer is a Cable Operator	-0.050	-0.050	-0.063	0.085	-0.116	-0.036
	(0.046)	(0.046)	(0.043)	(0.075)	(0.077)	(0.045)
Natural Log of Establishments in the Zip Code	0.031					
	(0.107)					
Natural Log of Employment in the Zip Code	0.105					
	(0.200)					
Natural Log of Annual Payroll in the Zip Code	-0.052					
	(0.148)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.024					
	(0.025)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.045					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.019	0.077	0.001	0.127	-0.108
		(0.091)	(0.088)	(0.123)	(0.161)	(0.090)
Log of Employment per Square Mile in the Zip Code		0.022	0.058	0.029	0.003	0.156
		(0.079)	(0.072)	(0.091)	(0.147)	(0.078)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.018	0.213	-0.441	0.557	-0.069
		(0.142)	(0.129)	(0.180)*	(0.196)*	(0.171)
Constant	5.762	6.389	4.870	8.236	3.384	6.171
	(0.728)*	(0.521)*	(0.608)*	(0.710)*	(0.808)*	(0.592)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.24	0.27
F Statistic	5.57	5.16	7.18	2.03	5.85	3.88
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 14c: Regression of Log of High Bandwidth Price on Competition in the Census Block (Table 14 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	0.023	0.026	0.022	0.082	0.003	-0.002
	(0.030)	(0.028)	(0.023)	(0.037)*	(0.037)	(0.036)
Customer is a Telecommunications Provider	0.135	0.135	0.137	0.193	0.005	0.497
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.056)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.202	-0.212	-0.203	-0.132	-0.324
	(0.104)	(0.103)	(0.083)*	(0.035)*	(0.148)	(0.058)*
Customer is a Cable Operator	-0.464	-0.463	-0.352	-0.099	-0.117	-0.679
	(0.256)	(0.256)	(0.204)	(0.216)	(0.250)	(0.323)*
Natural Log of Establishments in the Zip Code	-0.140					
	(0.070)*					
Natural Log of Employment in the Zip Code	0.041					
	(0.147)					
Natural Log of Annual Payroll in the Zip Code	0.074					
	(0.105)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.005					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.003					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.102	0.236	0.397
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.531	-0.531	-0.620	-1.353	-0.020	-0.217
	(0.090)*	(0.090)*	(0.081)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.155	-0.098	0.150	-0.297	-0.039
		(0.082)	(0.094)	(0.175)	(0.109)*	(0.150)
Log of Employment per Square Mile in the Zip Code		0.116	0.085	-0.084	0.221	0.032
		(0.070)	(0.084)	(0.157)	(0.097)*	(0.138)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.092	-0.018	-0.106	0.007	0.113
		(0.105)	(0.083)	(0.130)	(0.168)	(0.165)
Constant	5.757	5.709	6.128	7.723	5.647	4.680
	(0.511)*	(0.475)*	(0.429)*	(0.699)*	(0.734)*	(0.585)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	12.71	15.40	16.68	24.31	11.53	79.21
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 15a: Regression of Log of DS-1 Price on Competition and Indep. CLEC Network in the Census Block (Table 15 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	-0.032	-0.025	-0.020	-0.013	-0.012	-0.045
	(0.004)*	(0.004)*	(0.004)*	(0.005)*	(0.007)	(0.008)*
An Indep. CLEC Has a Fiber Network in the Census Block	-0.003	0.004	-0.003	-0.009	0.003	0.009
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.010)
Customer is a Telecommunications Provider	-0.196	-0.196	-0.166	-0.089	-0.259	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.034	0.138	0.098
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.159	-0.053	-0.069
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.012)*
Natural Log of Establishments in the Zip Code	0.008					
	(0.015)					
Natural Log of Employment in the Zip Code	-0.004					
	(0.030)					
Natural Log of Annual Payroll in the Zip Code	-0.016					
	(0.022)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.012					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007					
	(0.002)*					
Log of Establishments per Square Mile in the Zip Code		0.007	0.026	0.025	0.017	0.019
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.054	-0.029	-0.013
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.011	0.023	-0.022	0.017	0.064
		(0.021)	(0.025)	(0.021)	(0.043)	(0.034)
Constant	5.515	5.460	5.427	5.757	5.374	5.021
	(0.088)*	(0.082)*	(0.106)*	(0.070)*	(0.219)*	(0.143)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	122.72	147.20	155.50	31.53	124.50	42.07
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 15b: Regression of Log of DS-3 Price on Competition and Indep. CLEC Network in the Census Block (Table 15 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	-0.108	-0.109	-0.050	0.060	-0.017	-0.210
	(0.043)*	(0.038)*	(0.035)	(0.044)	(0.064)	(0.058)*
An Indep. CLEC Has a Fiber Network in the Census Block	-0.016	-0.036	-0.076	-0.054	-0.159	0.006
	(0.047)	(0.046)	(0.037)*	(0.048)	(0.082)	(0.070)
Customer is a Telecommunications Provider	-0.025	-0.025	-0.034	-0.134	-0.034	0.086
	(0.043)	(0.042)	(0.039)	(0.070)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.194	0.194	0.199	0.094	0.249	0.223
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.058)*	(0.100)*
Customer is a Cable Operator	-0.050	-0.050	-0.063	0.086	-0.116	-0.036
	(0.046)	(0.046)	(0.043)	(0.075)	(0.077)	(0.045)
Natural Log of Establishments in the Zip Code	0.031					
	(0.107)					
Natural Log of Employment in the Zip Code	0.104					
	(0.200)					
Natural Log of Annual Payroll in the Zip Code	-0.051					
	(0.148)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.023					
	(0.025)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.045					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.019	0.077	0.000	0.125	-0.108
		(0.091)	(0.088)	(0.122)	(0.161)	(0.090)
Log of Employment per Square Mile in the Zip Code		0.022	0.058	0.029	0.002	0.156
		(0.079)	(0.072)	(0.091)	(0.147)	(0.078)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.018	0.214	-0.440	0.562	-0.069
		(0.142)	(0.129)	(0.179)*	(0.196)*	(0.171)
Constant	5.776	6.418	4.936	8.271	3.520	6.165
	(0.731)*	(0.522)*	(0.604)*	(0.710)*	(0.801)*	(0.594)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.24	0.27
F Statistic	5.14	4.70	6.83	1.89	5.48	3.43
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 15c: Regression of Log of High Bandwidth Price on Competition and Indep. CLEC Network in the Census Block (Table 15 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	0.025	0.029	0.024	0.081	0.005	0.007
	(0.030)	(0.029)	(0.024)	(0.037)*	(0.037)	(0.037)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.030	-0.027	-0.023	0.006	-0.017	-0.082
	(0.030)	(0.029)	(0.025)	(0.031)	(0.058)	(0.044)
Customer is a Telecommunications Provider	0.136	0.135	0.137	0.194	0.005	0.498
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.056)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.201	-0.212	-0.203	-0.132	-0.324
	(0.104)	(0.103)	(0.083)*	(0.035)*	(0.148)	(0.058)*
Customer is a Cable Operator	-0.464	-0.463	-0.351	-0.100	-0.117	-0.673
	(0.256)	(0.256)	(0.204)	(0.216)	(0.250)	(0.324)*
Natural Log of Establishments in the Zip Code	-0.140					
	(0.070)*					
Natural Log of Employment in the Zip Code	0.040					
	(0.147)					
Natural Log of Annual Payroll in the Zip Code	0.075					
	(0.105)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.006					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.004					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.102	0.236	0.397
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.531	-0.531	-0.620	-1.353	-0.020	-0.216
	(0.090)*	(0.090)*	(0.081)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.155	-0.098	0.150	-0.296	-0.043
		(0.082)	(0.093)	(0.175)	(0.109)*	(0.151)
Log of Employment per Square Mile in the Zip Code		0.115	0.085	-0.084	0.221	0.036
		(0.070)	(0.083)	(0.157)	(0.097)*	(0.139)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.093	-0.018	-0.107	0.008	0.106
		(0.105)	(0.083)	(0.130)	(0.168)	(0.167)
Constant	5.785	5.731	6.144	7.722	5.660	4.759
	(0.513)*	(0.477)*	(0.431)*	(0.701)*	(0.736)*	(0.589)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	11.74	13.96	15.12	21.89	10.38	71.84
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 16a: Regression of Log of DS-1 Price on Competition interacted with Indep. CLEC Network in the Census Block (Table 16 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	-0.017	-0.013	-0.016	-0.022	-0.027	0.011
	(0.010)	(0.010)	(0.008)	(0.011)*	(0.017)	(0.019)
An Indep. CLEC Has a Fiber Network in the Census Block	0.000	0.006	-0.002	-0.011	0.001	0.021
	(0.005)	(0.005)	(0.004)	(0.006)	(0.006)	(0.012)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.014	-0.005	0.012	0.015	-0.061
	(0.011)	(0.011)	(0.009)	(0.012)	(0.018)	(0.020)*
Customer is a Telecommunications Provider	-0.196	-0.196	-0.166	-0.089	-0.259	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.034	0.138	0.098
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.159	-0.053	-0.069
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.012)*
Natural Log of Establishments in the Zip Code	0.009					
	(0.015)					
Natural Log of Employment in the Zip Code	-0.004					
	(0.030)					
Natural Log of Annual Payroll in the Zip Code	-0.015					
	(0.022)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.012					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007					
	(0.002)*					
Log of Establishments per Square Mile in the Zip Code		0.007	0.026	0.025	0.017	0.020
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.054	-0.029	-0.014
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.010	0.023	-0.022	0.017	0.066
		(0.021)	(0.025)	(0.021)	(0.043)	(0.034)
Constant	5.513	5.458	5.426	5.758	5.376	5.008
	(0.088)*	(0.082)*	(0.106)*	(0.070)*	(0.218)*	(0.143)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	111.67	131.00	138.24	28.15	110.98	38.18
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 16b: Regression of Log of DS-3 Price on Competition interacted with Indep. CLEC Network in the Census Block (Table 16 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	0.032	0.028	0.002	0.153	0.024	-0.218
	(0.103)	(0.104)	(0.077)	(0.106)	(0.224)	(0.111)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.035	0.013	-0.059	-0.019	-0.148	0.004
	(0.054)	(0.052)	(0.043)	(0.058)	(0.067)*	(0.090)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.151	-0.148	-0.057	-0.111	-0.043	0.009
	(0.109)	(0.111)	(0.084)	(0.114)	(0.231)	(0.126)
Customer is a Telecommunications Provider	-0.025	-0.025	-0.034	-0.135	-0.034	0.086
	(0.043)	(0.042)	(0.039)	(0.070)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.194	0.194	0.199	0.094	0.249	0.223
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.058)*	(0.100)*
Customer is a Cable Operator	-0.050	-0.050	-0.063	0.087	-0.116	-0.036
	(0.046)	(0.046)	(0.043)	(0.075)	(0.077)	(0.045)
Natural Log of Establishments in the Zip Code	0.033					
	(0.108)					
Natural Log of Employment in the Zip Code	0.101					
	(0.200)					
Natural Log of Annual Payroll in the Zip Code	-0.049					
	(0.148)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.024					
	(0.025)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.045					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.017	0.078	0.004	0.126	-0.109
		(0.092)	(0.088)	(0.122)	(0.161)	(0.090)
Log of Employment per Square Mile in the Zip Code		0.021	0.058	0.027	0.002	0.156
		(0.079)	(0.072)	(0.090)	(0.147)	(0.078)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.019	0.215	-0.448	0.562	-0.069
		(0.142)	(0.129)	(0.179)*	(0.196)*	(0.171)
Constant	5.724	6.370	4.916	8.283	3.507	6.168
	(0.731)*	(0.523)*	(0.603)*	(0.709)*	(0.799)*	(0.598)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.24	0.27
F Statistic	4.72	4.21	6.07	1.73	5.04	3.19
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 16c: Regression of Log of High Bandwidth Price on Competition interacted with Indep. CLEC Network in the Census Block (Table 16 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Census Block	0.040	0.044	0.124	0.112	0.127	0.161
	(0.071)	(0.071)	(0.067)	(0.067)	(0.206)	(0.114)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.028	-0.024	-0.006	0.011	0.009	-0.051
	(0.032)	(0.031)	(0.025)	(0.034)	(0.038)	(0.046)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.016	-0.109	-0.039	-0.126	-0.165
	(0.075)	(0.075)	(0.071)	(0.076)	(0.210)	(0.119)
Customer is a Telecommunications Provider	0.136	0.135	0.137	0.193	0.005	0.497
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.056)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.201	-0.212	-0.203	-0.132	-0.324
	(0.104)	(0.103)	(0.083)*	(0.035)*	(0.148)	(0.058)*
Customer is a Cable Operator	-0.464	-0.463	-0.352	-0.100	-0.117	-0.675
	(0.256)	(0.256)	(0.204)	(0.216)	(0.250)	(0.324)*
Natural Log of Establishments in the Zip Code	-0.140					
	(0.070)*					
Natural Log of Employment in the Zip Code	0.041					
	(0.147)					
Natural Log of Annual Payroll in the Zip Code	0.074					
	(0.105)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.006					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.003					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.102	0.236	0.397
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.531	-0.531	-0.620	-1.354	-0.019	-0.215
	(0.090)*	(0.090)*	(0.081)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.155	-0.099	0.150	-0.296	-0.047
		(0.082)	(0.093)	(0.175)	(0.109)*	(0.150)
Log of Employment per Square Mile in the Zip Code		0.115	0.085	-0.084	0.221	0.039
		(0.070)	(0.084)	(0.157)	(0.097)*	(0.138)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.093	-0.018	-0.107	0.008	0.103
		(0.105)	(0.083)	(0.130)	(0.168)	(0.166)
Constant	5.783	5.729	6.132	7.722	5.634	4.745
	(0.513)*	(0.478)*	(0.430)*	(0.701)*	(0.734)*	(0.589)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	10.84	12.71	14.19	19.95	9.45	65.68
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 17a: Regression of Log of DS-1 Price on Competition in the Building and the Block (Table 17 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.047	-0.045	-0.039	-0.027	-0.032	-0.059
	(0.006)*	(0.006)*	(0.006)*	(0.009)*	(0.009)*	(0.013)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.018	-0.017	-0.009	-0.017	-0.025
	(0.006)*	(0.006)*	(0.005)*	(0.005)	(0.009)*	(0.010)*
Customer is a Telecommunications Provider	-0.197	-0.197	-0.167	-0.089	-0.260	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.104	0.103	0.090	0.034	0.138	0.098
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.158	-0.054	-0.069
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.012)*
Natural Log of Establishments in the Zip Code	0.009					
	(0.014)					
Natural Log of Employment in the Zip Code	-0.008					
	(0.029)					
Natural Log of Annual Payroll in the Zip Code	-0.012					
	(0.021)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.012					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006					
	(0.002)*					
Log of Establishments per Square Mile in the Zip Code		0.008	0.027	0.025	0.019	0.020
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.054	-0.030	-0.013
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.007	0.026	-0.022	0.021	0.066
		(0.021)	(0.025)	(0.021)	(0.043)	(0.034)
Constant	5.500	5.455	5.419	5.751	5.364	5.021
	(0.087)*	(0.081)*	(0.108)*	(0.070)*	(0.223)*	(0.141)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	125.17	152.88	164.02	31.85	137.72	43.45
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 17b: Regression of Log of DS-3 Price on Competition in the Building and the Block (Table 17 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.063	-0.056	-0.034	0.109	-0.035	-0.138
	(0.047)	(0.047)	(0.044)	(0.075)	(0.080)	(0.058)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.118	-0.118	-0.083	-0.028	-0.112	-0.081
	(0.060)*	(0.061)	(0.054)	(0.067)	(0.098)	(0.075)
Customer is a Telecommunications Provider	-0.026	-0.026	-0.034	-0.132	-0.038	0.088
	(0.043)	(0.042)	(0.039)	(0.070)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.195	0.194	0.198	0.095	0.247	0.225
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.059)*	(0.100)*
Customer is a Cable Operator	-0.049	-0.049	-0.062	0.088	-0.115	-0.035
	(0.046)	(0.046)	(0.043)	(0.074)	(0.077)	(0.045)
Natural Log of Establishments in the Zip Code	0.037					
	(0.108)					
Natural Log of Employment in the Zip Code	0.067					
	(0.205)					
Natural Log of Annual Payroll in the Zip Code	-0.020					
	(0.152)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.016					
	(0.022)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.044					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.011	0.085	0.000	0.148	-0.110
		(0.092)	(0.088)	(0.122)	(0.161)	(0.090)
Log of Employment per Square Mile in the Zip Code		0.016	0.056	0.029	-0.001	0.148
		(0.080)	(0.073)	(0.091)	(0.148)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.046	0.234	-0.442	0.587	-0.047
		(0.148)	(0.131)	(0.180)*	(0.199)*	(0.175)
Constant	5.654	6.292	4.787	8.249	3.241	6.112
	(0.732)*	(0.535)*	(0.621)*	(0.710)*	(0.843)*	(0.620)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.25	0.27
F Statistic	4.50	3.75	5.62	1.90	4.96	2.30
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 17c: Regression of Log of High Bandwidth Price on Competition in the Building and the Block (Table 17 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.023	-0.022	-0.005	0.117	0.003	-0.055
	(0.038)	(0.037)	(0.034)	(0.056)*	(0.043)	(0.042)
At Least One Facilities-based Competitor is in the Block But Not the Building	0.053	0.054	0.041	0.055	-0.006	0.049
	(0.034)	(0.032)	(0.028)	(0.039)	(0.032)	(0.041)
Customer is a Telecommunications Provider	0.135	0.136	0.137	0.193	0.005	0.497
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.056)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.202	-0.212	-0.202	-0.132	-0.325
	(0.103)	(0.103)	(0.083)*	(0.035)*	(0.148)	(0.058)*
Customer is a Cable Operator	-0.462	-0.462	-0.352	-0.105	-0.117	-0.679
	(0.256)	(0.256)	(0.204)	(0.216)	(0.250)	(0.324)*
Natural Log of Establishments in the Zip Code	-0.143					
	(0.070)*					
Natural Log of Employment in the Zip Code	0.054					
	(0.146)					
Natural Log of Annual Payroll in the Zip Code	0.064					
	(0.104)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.000					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.000					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.101	0.236	0.398
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.530	-0.530	-0.620	-1.353	-0.020	-0.219
	(0.088)*	(0.089)*	(0.081)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.156	-0.099	0.149	-0.296	-0.032
		(0.082)	(0.093)	(0.175)	(0.108)*	(0.149)
Log of Employment per Square Mile in the Zip Code		0.118	0.085	-0.084	0.221	0.029
		(0.071)	(0.084)	(0.157)	(0.097)*	(0.137)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.081	-0.022	-0.107	0.009	0.108
		(0.104)	(0.083)	(0.131)	(0.168)	(0.166)
Constant	5.785	5.742	6.139	7.722	5.643	4.689
	(0.513)*	(0.478)*	(0.430)*	(0.699)*	(0.736)*	(0.595)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	11.87	14.28	15.94	22.17	10.20	71.70
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 18a: Regression of Log of DS-1 Price on Competition in the Building, the Block, and the Tract (Table 18 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.051	-0.049	-0.043	-0.029	-0.036	-0.064
	(0.007)*	(0.007)*	(0.007)*	(0.010)*	(0.009)*	(0.013)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.033	-0.025	-0.023	-0.011	-0.024	-0.032
	(0.007)*	(0.007)*	(0.006)*	(0.007)	(0.010)*	(0.011)*
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.030	-0.032	-0.028	-0.005	-0.035	-0.038
	(0.007)*	(0.007)*	(0.007)*	(0.009)	(0.011)*	(0.015)*
Customer is a Telecommunications Provider	-0.197	-0.197	-0.167	-0.089	-0.260	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.034	0.138	0.098
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.158	-0.054	-0.069
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.011)*
Natural Log of Establishments in the Zip Code	0.008					
	(0.014)					
Natural Log of Employment in the Zip Code	-0.009					
	(0.029)					
Natural Log of Annual Payroll in the Zip Code	-0.011					
	(0.021)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.012					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006					
	(0.002)*					
Log of Establishments per Square Mile in the Zip Code		0.008	0.027	0.025	0.020	0.020
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.054	-0.030	-0.014
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.006	0.026	-0.022	0.022	0.068
		(0.021)	(0.025)	(0.021)	(0.044)	(0.034)*
Constant	5.525	5.481	5.440	5.756	5.392	5.051
	(0.087)*	(0.081)*	(0.110)*	(0.070)*	(0.227)*	(0.142)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	113.86	136.14	146.02	28.32	122.74	39.12
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 18b: Regression of Log of DS-3 Price on Competition in the Building, the Block, and the Tract (Table 18 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.074	-0.067	-0.046	0.098	-0.045	-0.150
	(0.048)	(0.048)	(0.045)	(0.075)	(0.081)	(0.059)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.136	-0.136	-0.101	-0.047	-0.127	-0.098
	(0.062)*	(0.063)*	(0.056)	(0.072)	(0.100)	(0.079)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.210	-0.198	-0.187	-0.092	-0.273	-0.174
	(0.074)*	(0.074)*	(0.063)*	(0.069)	(0.125)*	(0.117)
Customer is a Telecommunications Provider	-0.025	-0.025	-0.034	-0.128	-0.040	0.088
	(0.043)	(0.043)	(0.039)	(0.071)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.194	0.193	0.198	0.095	0.246	0.224
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.059)*	(0.100)*
Customer is a Cable Operator	-0.049	-0.048	-0.061	0.088	-0.114	-0.033
	(0.046)	(0.046)	(0.043)	(0.074)	(0.077)	(0.046)
Natural Log of Establishments in the Zip Code	0.039					
	(0.109)					
Natural Log of Employment in the Zip Code	0.068					
	(0.206)					
Natural Log of Annual Payroll in the Zip Code	-0.023					
	(0.153)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.020					
	(0.022)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.047					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.005	0.090	0.003	0.151	-0.107
		(0.093)	(0.088)	(0.122)	(0.161)	(0.090)
Log of Employment per Square Mile in the Zip Code		0.015	0.056	0.028	0.004	0.146
		(0.081)	(0.073)	(0.091)	(0.149)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.040	0.233	-0.445	0.569	-0.041
		(0.148)	(0.132)	(0.180)*	(0.200)*	(0.175)
Constant	5.860	6.485	4.943	8.336	3.516	6.251
	(0.737)*	(0.543)*	(0.633)*	(0.714)*	(0.859)*	(0.633)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.25	0.27
F Statistic	4.42	3.74	5.70	1.91	4.73	2.20
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 18c: Regression of Log of High Bandwidth Price on Competition in the Building, the Block, and the Tract (Table 18 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.026	-0.025	-0.010	0.114	-0.002	-0.058
	(0.038)	(0.038)	(0.034)	(0.059)	(0.044)	(0.043)
At Least One Facilities-based Competitor is in the Block But Not the Building	0.049	0.049	0.034	0.052	-0.013	0.044
	(0.035)	(0.034)	(0.030)	(0.044)	(0.034)	(0.044)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.039	-0.040	-0.046	-0.013	-0.078	-0.039
	(0.042)	(0.042)	(0.037)	(0.068)	(0.053)	(0.051)
Customer is a Telecommunications Provider	0.135	0.136	0.137	0.193	0.005	0.496
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.056)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.202	-0.212	-0.202	-0.132	-0.325
	(0.103)	(0.103)	(0.083)*	(0.035)*	(0.148)	(0.058)*
Customer is a Cable Operator	-0.462	-0.462	-0.352	-0.105	-0.117	-0.679
	(0.256)	(0.256)	(0.204)	(0.216)	(0.250)	(0.324)*
Natural Log of Establishments in the Zip Code	-0.143					
	(0.070)*					
Natural Log of Employment in the Zip Code	0.053					
	(0.146)					
Natural Log of Annual Payroll in the Zip Code	0.065					
	(0.104)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.001					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.000					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.101	0.236	0.398
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.530	-0.530	-0.620	-1.352	-0.020	-0.219
	(0.089)*	(0.089)*	(0.081)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.156	-0.098	0.149	-0.296	-0.033
		(0.082)	(0.093)	(0.175)	(0.108)*	(0.148)
Log of Employment per Square Mile in the Zip Code		0.118	0.085	-0.084	0.221	0.029
		(0.071)	(0.084)	(0.157)	(0.097)*	(0.136)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.082	-0.020	-0.107	0.012	0.109
		(0.104)	(0.083)	(0.131)	(0.169)	(0.165)
Constant	5.815	5.774	6.174	7.733	5.702	4.720
	(0.513)*	(0.479)*	(0.430)*	(0.697)*	(0.742)*	(0.594)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	11.38	13.45	15.16	20.21	9.78	66.32
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 19a: Regression of Log of DS-1 Price on Number of Competitors in the Census Block (Table 19 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.048	-0.045	-0.039	-0.027	-0.031	-0.061
	(0.006)*	(0.006)*	(0.006)*	(0.009)*	(0.009)*	(0.013)*
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.010	-0.010	-0.010	-0.022	0.000
	(0.005)*	(0.005)*	(0.005)*	(0.006)	(0.007)*	(0.009)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.039	-0.034	-0.002	-0.016	-0.073
	(0.010)*	(0.009)*	(0.009)*	(0.012)	(0.013)	(0.018)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040	-0.023	-0.020	-0.053	0.007	-0.061
	(0.025)	(0.024)	(0.023)	(0.027)	(0.034)	(0.033)
Customer is a Telecommunications Provider	-0.197	-0.197	-0.167	-0.089	-0.259	-0.087
	(0.010)*	(0.010)*	(0.008)*	(0.011)*	(0.014)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.034	0.138	0.097
	(0.006)*	(0.006)*	(0.005)*	(0.005)*	(0.009)*	(0.010)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.158	-0.053	-0.070
	(0.009)*	(0.009)*	(0.008)*	(0.040)*	(0.010)*	(0.012)*
Natural Log of Establishments in the Zip Code	0.008					
	(0.014)					
Natural Log of Employment in the Zip Code	-0.011					
	(0.030)					
Natural Log of Annual Payroll in the Zip Code	-0.008					
	(0.022)					
Natural Log of Number of Establishments in the Census Block (D&B)	0.013					
	(0.002)*					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006					
	(0.002)*					
Log of Establishments per Square Mile in the Zip Code		0.008	0.027	0.025	0.020	0.019
		(0.015)	(0.015)	(0.014)	(0.030)	(0.023)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039	-0.054	-0.031	-0.014
		(0.012)	(0.010)*	(0.011)*	(0.019)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.004	0.028	-0.022	0.020	0.076
		(0.021)	(0.025)	(0.021)	(0.043)	(0.033)*
Constant	5.486	5.443	5.411	5.752	5.371	4.991
	(0.087)*	(0.081)*	(0.108)*	(0.070)*	(0.221)*	(0.138)*
Adjusted R-Squared	0.33	0.33	0.38	0.44	0.29	0.38
F Statistic	105.24	123.47	131.75	25.98	111.54	36.80
Observations	1,399,440	1,399,165	1,806,659	579,119	679,520	548,020

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 19b: Regression of Log of DS-3 Price on Number of Competitors in the Census Block (Table 19 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.066	-0.060	-0.035	0.106	-0.025	-0.152
	(0.046)	(0.046)	(0.043)	(0.072)	(0.080)	(0.057)*
One Facilities-based Competitor is in the Block But Not the Building	-0.095	-0.092	-0.064	-0.020	-0.102	-0.046
	(0.070)	(0.071)	(0.063)	(0.054)	(0.128)	(0.075)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.154	-0.154	-0.112	-0.087	-0.157	-0.080
	(0.070)*	(0.070)*	(0.064)	(0.133)	(0.099)	(0.105)
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.132	-0.136	-0.085	0.351	-0.048	-0.249
	(0.092)	(0.092)	(0.089)	(0.307)	(0.124)	(0.147)
Customer is a Telecommunications Provider	-0.025	-0.025	-0.034	-0.133	-0.034	0.087
	(0.043)	(0.043)	(0.039)	(0.071)	(0.064)	(0.059)
Customer is a Mobile Telecommunications Provider	0.195	0.194	0.198	0.098	0.250	0.227
	(0.050)*	(0.050)*	(0.045)*	(0.051)	(0.058)*	(0.100)*
Customer is a Cable Operator	-0.049	-0.049	-0.062	0.092	-0.113	-0.034
	(0.046)	(0.046)	(0.043)	(0.074)	(0.076)	(0.045)
Natural Log of Establishments in the Zip Code	0.038					
	(0.110)					
Natural Log of Employment in the Zip Code	0.057					
	(0.208)					
Natural Log of Annual Payroll in the Zip Code	-0.011					
	(0.155)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.014					
	(0.022)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.043					
	(0.019)*					
Log of Establishments per Square Mile in the Zip Code		-0.009	0.087	0.004	0.157	-0.107
		(0.094)	(0.089)	(0.122)	(0.160)	(0.091)
Log of Employment per Square Mile in the Zip Code		0.016	0.056	0.021	-0.005	0.134
		(0.081)	(0.073)	(0.092)	(0.148)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.053	0.238	-0.441	0.586	-0.035
		(0.150)	(0.132)	(0.181)*	(0.200)*	(0.179)
Constant	5.623	6.263	4.758	8.277	3.225	6.173
	(0.741)*	(0.542)*	(0.626)*	(0.710)*	(0.853)*	(0.669)*
Adjusted R-Squared	0.26	0.26	0.28	0.42	0.25	0.27
F Statistic	4.06	3.39	4.92	1.74	4.56	1.99
Observations	120,129	120,109	138,158	27,253	58,790	52,115

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

Table 19c: Regression of Log of High Bandwidth Price on Number of Competitors in the Census Block (Similar to Table 19 in Rysman Paper)

	Rysman Paper	D&B Areas	All Areas	Price Cap Areas	Phase I Areas	Phase II Areas
A Facilities-based Competitor is in the Building	-0.024	-0.023	-0.006	0.123	0.002	-0.054
	(0.038)	(0.038)	(0.034)	(0.055)*	(0.043)	(0.042)
One Facilities-based Competitor is in the Block But Not the Building	0.045	0.045	0.038	0.030	0.007	0.069
	(0.029)	(0.028)	(0.025)	(0.039)	(0.031)	(0.044)
Two or Three Facilities-based Competitors are in the Block But Not the Building	0.074	0.074	0.052	0.145	-0.006	0.022
	(0.052)	(0.049)	(0.046)	(0.094)	(0.046)	(0.063)
Four or More Facilities-based Competitors are in the Block But Not the Building	0.040	0.040	0.023	0.321	-0.037	0.011
	(0.063)	(0.060)	(0.057)	(0.159)*	(0.063)	(0.100)
Customer is a Telecommunications Provider	0.136	0.136	0.137	0.196	0.005	0.497
	(0.049)*	(0.049)*	(0.042)*	(0.049)*	(0.057)	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.201	-0.202	-0.212	-0.202	-0.132	-0.326
	(0.104)	(0.104)	(0.083)*	(0.035)*	(0.148)	(0.057)*
Customer is a Cable Operator	-0.463	-0.462	-0.353	-0.107	-0.120	-0.683
	(0.256)	(0.256)	(0.204)	(0.212)	(0.251)	(0.324)*
Natural Log of Establishments in the Zip Code	-0.143					
	(0.069)*					
Natural Log of Employment in the Zip Code	0.058					
	(0.146)					
Natural Log of Annual Payroll in the Zip Code	0.061					
	(0.105)					
Natural Log of Number of Establishments in the Census Block (D&B)	-0.001					
	(0.013)					
Natural Log of Establishments (D&B) per Square Mile in the Census Block	0.000					
	(0.012)					
Natural Log of Mbps	0.247	0.247	0.240	0.100	0.237	0.398
	(0.051)*	(0.051)*	(0.045)*	(0.034)*	(0.074)*	(0.021)*
Packet-based Connection	-0.529	-0.529	-0.619	-1.346	-0.020	-0.218
	(0.088)*	(0.088)*	(0.080)*	(0.119)*	(0.077)	(0.164)
Log of Establishments per Square Mile in the Zip Code		-0.157	-0.099	0.148	-0.297	-0.032
		(0.082)	(0.094)	(0.175)	(0.108)*	(0.151)
Log of Employment per Square Mile in the Zip Code		0.119	0.086	-0.084	0.223	0.027
		(0.071)	(0.084)	(0.157)	(0.097)*	(0.138)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		0.078	-0.022	-0.106	0.012	0.108
		(0.104)	(0.084)	(0.130)	(0.168)	(0.167)
Constant	5.785	5.747	6.135	7.711	5.620	4.705
	(0.520)*	(0.485)*	(0.435)*	(0.699)*	(0.746)*	(0.570)*
Adjusted R-Squared	0.45	0.45	0.52	0.71	0.41	0.48
F Statistic	10.32	12.07	13.43	19.92	8.73	60.29
Observations	80,326	80,318	100,513	30,553	48,499	21,461

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

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

	DS-1 Rysman Paper	DS-1 D&B Areas	DS-1 All Areas	DS-3 Rysman Paper	DS-3 D&B Areas	DS-3 All Areas
A Facilities-based Competitor is in the Census Block	0.001	0.008	-0.009	0.125	0.119	0.099
	(0.008)	(0.008)	(0.006)	(0.059)*	(0.057)*	(0.044)*
Phase 1 x Facilities-based Competitor in Census Block	-0.038	-0.037	-0.012	-0.337	-0.337	-0.189
	(0.010)*	(0.010)*	(0.009)	(0.081)*	(0.081)*	(0.077)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048	-0.047	-0.021	-0.265	-0.259	-0.236
	(0.013)*	(0.013)*	(0.011)	(0.084)*	(0.084)*	(0.073)*
Customer is a Telecommunications Provider	-0.196	-0.196	-0.166	-0.024	-0.023	-0.033
	(0.010)*	(0.010)*	(0.008)*	(0.042)	(0.042)	(0.039)
Customer is a Mobile Telecommunications Provider	0.103	0.103	0.090	0.195	0.194	0.198
	(0.006)*	(0.006)*	(0.005)*	(0.050)*	(0.050)*	(0.045)*
Customer is a Cable Operator	-0.073	-0.073	-0.078	-0.051	-0.051	-0.064
	(0.009)*	(0.009)*	(0.008)*	(0.046)	(0.046)	(0.043)
Natural Log of Establishments in the Zip Code	0.009			0.038		
	(0.015)			(0.108)		
Natural Log of Employment in the Zip Code	-0.005			0.082		
	(0.030)			(0.201)		
Natural Log of Annual Payroll in the Zip Code	-0.015			-0.038		
	(0.022)			(0.148)		
Natural Log of Number of Establishments in the Census Block (D&B)	0.012			-0.025		
	(0.002)*			(0.025)		
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006			0.046		
	(0.001)*			(0.019)*		
Log of Establishments per Square Mile in the Zip Code		0.007	0.026		-0.006	0.084
		(0.015)	(0.015)		(0.092)	(0.088)
Log of Employment per Square Mile in the Zip Code		-0.020	-0.039		0.014	0.057
		(0.012)	(0.010)*		(0.080)	(0.073)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code		-0.010	0.023		0.024	0.222
		(0.021)	(0.025)		(0.142)	(0.128)
Constant	5.511	5.461	5.424	5.772	6.386	4.833
	(0.088)*	(0.081)*	(0.106)*	(0.728)*	(0.521)*	(0.602)*
Adjusted R-Squared	0.33	0.33	0.38	0.26	0.26	0.28
F Statistic	112.41	131.99	139.74	6.12	6.02	7.49
Observations	1,399,440	1,399,165	1,806,659	120,129	120,109	138,158

* $p<0.05$

Standard errors in parentheses allow for correlated error terms within a census block

Census Tract Fixed Effects

ATTACHMENT 3

Competitive Effect of Cable Network Infrastructure

Federal Communications Commission Staff[1]

June 28, 2016

Competition in the provision of business data services (BDS) uses many technologies. Cable operators are increasing their capacity to provide BDS over hybrid fiber-coax cable (HFC) infrastructure. We examine whether, in 2013, these deployments and the resulting potential to compete in BDS markets had an influence on ILEC prices. Regression analysis is used to measure this effect. If this cable infrastructure was having an influence on the ability to exercise market power, we would expect to observe that for products and areas where there is evidence of incumbent local exchange company (ILEC) market power (a statistically significant negative effect of facilities-based competition variables on ILEC prices) that the presence of the cable infrastructure has a statistically negative effect on prices. In those locations, the effect of facilities-based competition would be attenuated if there were a positive correlation between cable infrastructure and competitive entry (though the cumulative effect might still be larger than when only facilities-based competition is used in the regressions, as would be the case if cable and facilities-based competition were not perfectly correlated, and if facilities-based competition was not always sufficient to drive price down to competitive levels). We would also observe competitive effects from cable where it is present but facilities-based competition is not.

Two comparisons are made to address the question of whether in 2013 cable presence placed competitive pressures on BDS prices. We first modify the regression specifications of Professor Marc Rysman's White Paper, "Empirics of Business Data Services" (Rysman Paper) to capture competition from cable as measured by a report that a provider had deployed HFC network infrastructure. We find that inclusion of the cable infrastructure has no appreciable effect on the previously estimated effects of facilities-based competition. In addition, we find that the presence of the potential cable competition generally does not have a statistically significant effect on its own. Second, we also estimate the effect of potential cable competition using three regression specifications for each of the three types of price cap regulations (pure price cap, Phase I, and Phase II) for each of the three types of connections. With these alternative specifications, we also find that potential cable competition has relatively minor effects on ILEC prices and generally did not appear to be a significant source of competition in 2013. In addition, potential cable competition does not significantly change the estimated effect of actual facilities-based competition, including the presence of fiber networks, on ILEC prices.

Cable operators typically use the DOCSIS 3.0 protocol over their HFC network infrastructure to provide bidirectional broadband services to business and residential locations at variable bandwidth speeds and quality controls.[2] In addition, certain cable companies have upgraded their headends to provide Metro Ethernet-capabilities both over their fiber and HFC network connections that are linked to such headends. According to Comcast, Metro Ethernet-enabled headends are a precondition to the

[1] We acknowledge and appreciate Tracy Waldon, FCC Economist, for his contributions to this paper.

[2] We understand that BDS offerings are not practicable on earlier versions of DOCSIS.

provision of Ethernet services to locations, i.e., BDS.[3] From the National Broadband Map (NBM), we obtained a list of census blocks where the DOCSIS 3.0 (or higher) technology protocol was deployed in December 2013 by each reporting cable provider.[4] For purposes of this analysis, we assume the cable provider's DOCSIS 3.0 (or higher) coverage is coterminous with the extent of a cable company's HFC network coverage. Separately, Comcast, Charter, Cox, and Time Warner have provided the FCC with information to allow us to identify census blocks served by HFC network infrastructure linked by Metro Ethernet-enabled headends in 2013.[5] Using this information, we construct three different measures to indicate whether HFC-delivered services, including BDS, could have potentially been available in a census block: 1) DOCSIS 3.0 deployment, 2) an expansive definition of Metro Ethernet deployment, and 3) a narrow definition of Metro Ethernet deployment.

The first measure, DOCSIS 3.0 deployment, is the most expansive and yields a list of 5,110,078 census blocks where DOCSIS 3.0 has been deployed. This is the most liberal measure of potential BDS competition over HFC network infrastructure that we use. To further refine the areas where HFC-delivered services may be closer substitutes to traditional BDS, we develop two measures, which indicate census blocks that are served by Metro Ethernet-enabled headends, a narrower and expansive measure. The narrow definition of Metro Ethernet deployment assumes that all cable operators other than Comcast, Charter, Time Warner, and Cox have not deployed Metro Ethernet. The expansive definition of Metro Ethernet deployment assumes with limited exception that the census blocks served by HFC network linked to Metro Ethernet-enabled headends are the same as the census blocks with DOCSIS 3.0 (or higher) coverage according to the NBM data for 2013. Of the 658,486 census blocks with a location in the dataset, 79% have DOCSIS 3.0 HFC available, 64% have Metro Ethernet available using the expansive definition, and 51% have Metro Ethernet available using the narrow definition.[6]

Using these three definitions of BDS-comparable HFC infrastructure, we examine whether potential cable competition constrained ILEC prices. We begin by examining the influence of the measure of potential cable competition by including each of the three measures of competition individually in the regressions from the Rysman Paper. In the Rysman Paper, these tables are numbered 14 through 20 and we retain the convention here. We present the original regression results table followed by three tables presenting the regression results from the exact same specification but that include the DOCSIS measure (sub-table a), the expansive Metro Ethernet variable (sub-table b), and the limited Metro Ethernet variable (sub-table c). To evaluate the impact of these variables, we look at two

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[3] *See* Letter from Matthew Brill, Counsel to Comcast, to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25, at 1 (filed Mar. 25, 2016) ("Ethernet services delivered over Comcast's HFC network require access to the HFC network as well as service from an Ethernet-capable headend.").

[4] NBM/ State Broadband Initiative (December 2013, accessible at http://www2.ntia.doc.gov/broadband-data).

[5] *See* Letter from Matthew Brill, Counsel to Comcast Corp. (Comcast), to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25 (filed June 1, 2016); Letter from Samuel Feder, Counsel to Charter Communications, Inc. (Charter), to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25 (filed May 27, 2016); Letter from Michael Pryor, Counsel to Cox Communications, Inc. (Cox), to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25 (filed May 18, 2016); Letter from Matthew Brill, Counsel to Time Warner Cable (Time Warner), to Marlene H. Dortch, Secretary, FCC, WC Docket No. 05-25 (filed May 12, 2016).

[6] Of the 1.7 million geocoded locations in the data, 83% are located in census blocks with DOCSIS 3.0, 71% are located in census blocks with the expansive definition of Metro Ethernet, and 60% are located in census blocks with the limited definition of Metro Ethernet.

things: 1) what is the change in the estimated parameters of the facilities-based competition variables from the original Rysman Paper when including the potential cable competition measures, and 2) what are the effects of the potential cable competition measures on prices.

For Tables 14 through 20 the inclusion of the HFC variables has no substantial effect on the parameters of the facilities-based competition variables used in the Rysman Paper. There are no changes in statistical significance and the changes in the values of the parameters are quite small. For Table 15 there is a relatively small reduction in the competitive impact of a fiber network. Otherwise, differences are not noticeable. The effect of the measures of cable competition are not statistically significant for DS-1 and DS-3 circuits when estimated using census tract fixed effects. However, when using county fixed effects, they are on occasion statistically significant. When they are statistically significant, they are uniformly negative, as expected from variables measuring competition. However, the fact that they are not statistically significant when using tract fixed effects leads me to conclude that these measures are correlated with characteristics that are not varying at the tract level, but do vary at the county level, rather than being an actual competitive effect. It is unlikely that this potential competition would work over the larger area of a county, yet be invisible at the smaller distances involved in a census tract.

Table 20 presents more interesting changes that require careful interpretation due to the inclusion of interaction effects between the regulatory status and competition variables. A regression of this form allows for the estimation of different competitive effects under the three forms of price cap regulation. The regressions for DS-1 circuits using tract fixed effects in Tables 20 through 20c estimate the effect on ILEC prices of facilities-based competition in the census block in pure price cap areas ranges to be between 0.1% and -0.7%, though these estimates are not significantly different from zero.[7] The estimates of the difference between the effects of facilities-based competition in pure price cap areas and Phase I areas ranges from -3.8% when potential cable competition is not included (Table 20) to -2.6% when potential competition from Metro Ethernet is included. The effect of a facilities-based competitor in Phase I areas, calculated by summing the stand-alone competition variable with the competition and Phase I interaction term ranges from -3.3% to -3.7%, all of which are significantly different from zero at the 95% level of confidence.[8] Similarly, the estimates of the effect of facilities-based competition in Phase II areas for DS-1 circuits are unaffected by the inclusion of potential cable competition, The estimated effect of facilities-based competition ranges from -4.6% to -4.8% in Phase II areas. Clearly the presence of potential cable competition does not meaningfully attenuate the effect of facilities-based competition on ILEC DS-1 prices.

Potential cable competition may also have a competitive effect on DS-1 prices, though that effect varies widely depending on how potential cable competition is defined. When potential cable competition is defined as the presence of DOCSIS 3.0 (Table 20a) the effect is not statistically different from zero in pure price cap areas. When the definition is based on the presence of Metro Ethernet

[7] We retain the convention of interpreting the coefficients as percent changes. However as discussed in the Rysman Paper at footnote 36 (in the April 2016 version), this calculation is only an approximation. A more appropriate approximation would be exp(-0.007)-1 = -0.00698 or a 0.698% decrease in ILEC prices. As can be seen, this finer approximation has little effect when the parameter estimates are close to zero. The approximations can diverge more substantially for parameters that are farther from zero.

[8] We do not report the relevant test statistics for this and similar significance tests.

infrastructure, the effect in pure price cap areas ranges from 3.7% to 6.7% and is statistically different from zero. In Phase I areas the effect of potential cable competition exhibits a bit more stability ranging from -2.9% to -4.3% and is statistically significant. The estimates of the effect of potential cable competition on ILEC DS-1 prices in Phase II areas are not statistically different from zero.

Turning to the DS-3 regressions using census tract fixed effects, the estimates of the effect of facilities-based competition in pure price cap regions are influenced by the inclusion of potential cable competition. When potential cable competition is not accounted for, it is estimated that the presence of a facilities-based competitor in a census block increases prices by a statistically significant 12.6% in pure price cap areas. A similar effect occurs when potential cable competition is measured using the narrow definition for Metro Ethernet deployment. However, the expansive Metro Ethernet measure and the DOCSIS measure substantially reduce this effect on DS-3 prices and hypothesis testing indicates that the effect is not statistically different from zero. There is also some attenuation of the effect of facilities-based competition in Phase I areas (summing the standalone competition and the competition and Phase I interaction terms). The effect ranges from -11.2% to -18.4% when accounting for potential cable competition as compared to an effect of -21.1% when potential cable competition is not included. In Phase II areas similar changes exist, though they are in the opposite direction. Inclusion of potential cable competition appears to enhance the competitive effects of facilities-based competition. When potential cable competition is not accounted for, facilities-based competition changes DS-3 prices by -13.9%, compared to effects of -17.0% to -19.5% when potential cable competition is included.

In these census tract fixed effect regressions, the estimates of the effect of potential cable competition on DS-3 prices vary widely. In price cap areas they vary from 7.0% to 16.2%, though at no point are these estimates statistically significant. In Phase I areas, the estimates range from -11.3% to an astounding -53.2%, while in Phase II areas the effect is of the opposite sign and the range is a narrower 20.6% to 27.6%.[9] In both areas, the effects vary between being statistically significant and insignificant. For the DS-3 regressions, the effects of potential cable competition appear unreliable due to the wide variation that exists in the estimated effects (in contrast to the estimates for DS-1 circuits as well as the estimates in previous tables).

Overall, for both DS-1 and DS-3 circuits, the effect of facilities-based competition is reasonably stable to the inclusion of potential cable competition. When potential cable competition is influencing these estimates, the estimates remain large and in some instances become even larger. The effect of potential cable competition on prices are relatively small, but stable, for DS-1 circuits, particularly compared to the estimates for DS-3 circuits. In summary, Tables 20 through 20c lead us to conclude that while potential cable competition may have some impact on ILEC prices (strengthening the conclusion that where competition is present it can reduce prices, implying the presence of greater market power where competition is not present than suggested by the Rysman Paper's original regressions), facilities-based competition is providing the most significant and reliable effect to limit market power where it exists.

Interpreting Tables 20 through 20c illustrate the difficulties of working with multiple interaction terms to sort out differences in competitive effects under different forms of price regulation. We

[9] Using the finer approximation discussed previously, these effects are -10.8%, -41.3%, -18.6%, and -24.1%.

therefore follow previous methods and run separate regressions for each of the pricing regulations: pure price cap, Phase I, and Phase II. Tables 1.1a through 3.3c use this framework to estimate the effect of potential cable competition for each of the three types of connections (DS-1, DS-3, high bandwidth[10]) for three regression models and the three measures of HFC competition. Tables 1.1a through 1.1c examine the influence on DS-1 prices for regression model 1 in the three regulatory areas. Tables 2.1a through 2.1c and Tables 3.1a through 3.1c similarly examine DS-3 and high bandwidth connections, respectively. Regression model 2 is examined in Tables 1.2a – 1.2c, 2.2a-2.2c, and 3.2a-3.2c for DS-1, DS-3, and high bandwidth connections and regression model 3 is in Tables 1.3a – 1.3c, 2.3a-2.3c, and 3.3a-3.3c.

Examining Table 1.1a illustrates the effect of potential cable competition for DS-1 circuits in pure price cap areas using regression model 1, which closely corresponds to Table 14 in the Rysman Paper. The first column estimates the effect of facilities-based competition in the block without accounting for potential cable competition, while the remaining three columns estimate the effect while accounting for potential cable competition using the three measures: DOCSIS, the expansive Metro Ethernet definition, and the limited Metro Ethernet definition. The first clear result from Table 1.1a is that inclusion of potential cable competition does not materially impact the estimated effect of facilities-based competition. The parameters on the variable labeled "A Facilities-based Competitor is in the Census Block" are virtually unchanged across the four regression specifications. Further, the effect of potential cable competition based on the two measures of Metro Ethernet deployment does not have a statistically significant effect on ILEC DS-1 prices in pure price cap areas, though the measure of DOCSIS deployment does have a negative and statistically significant effect similar in magnitude to the presence of facilities-based competition. Turning to the effect in Phase I areas using Table 1.1b, neither facilities-based competition nor potential cable competition has an effect on prices. As with pure price cap areas, the inclusion of potential cable competition does not change the estimated effect of facilities-based competition. Table 1.1c estimates the effect in Phase II areas and the pattern is similar; no change in the estimates effect of facilities-based competition and potential cable competition does not have a statistically significant effect.

Looking at the same regression model but with respect to DS-3 circuits (Tables 2.1a-2.1c) we do see some differences arising, which should not be surprising given what was seen in Tables 20 through 20c. In pure price cap areas the estimate of the effect of facilities-based competitors ranges from 8.8% to 10.4% depending on which measure of potential cable competition is used. While there is some movement, the differences do not change the overall conclusions. In Phase I areas, we find no statistically significant effect from facilities-based competition or from potential cable competition using Metro Ethernet. However, when DOCSIS 3.0 is available in the census block it appears that prices are 42.2% lower. This result is anomalous when taken as a whole and likely represents another factor that is correlated with DOCSIS deployment in Phase I areas rather than the deployment itself. For example, it is possible that DOCSIS deployment tends to follow demand until household density falls below a certain level at which point it is no longer economically feasible to upgrade the cable infrastructure. This might be matched by price for BDS services, that is, BDS prices may noticeably jump, perhaps due to cost characteristics, but maybe also due to market power or the existence of density pricing zones, when population density falls enough. In Phase II areas, we find a strong and consistent effect (-20.9% to -21.6%) for facilities-based competition and positive and statistically insignificant effects for potential

[10] High bandwidth connections are defined as those connections with a bandwidth greater than 45 Mbps

cable competition. However, even if the result is taken at face value, that is that it suggests DOCSIS deployment lowers BDS prices on top of any lowering due to fiber competition, this strengthens rather than undermines the earlier analysis. In particular, it indicates prices are even higher, absent competition, than the earlier analysis suggested

As evidenced by the Rysman Paper, high bandwidth connections tend to show little difference between the different regulatory areas. The parameters on the effect of facilities-based competition are relatively stable to the inclusion of potential cable competition across all three pricing areas. With the exception of the Metro Ethernet indicators in pure price cap areas, there is no evidence that potential cable competition influences ILEC prices. In pure price cap areas the estimate is negative as expected. However, because the facilities-based competition variable is not statistically significant, this result is questionable. It is difficult to believe that potential cable competition, with its limited bandwidth, has an effect on high bandwidth prices, yet facilities-based competitors with actual connections in the census block do not. Because it is highly unlikely that potential competition from low bandwidth BDS is constraining prices for high bandwidth BDS, we conclude that this effect is picking up another factor that influences prices, such as costs.

We estimate two more regression models to further examine how competition may be evidenced. In regression model 2 (Tables 1.2a-1.2c, 2.2a-2.2c, and 3.2a-3.2c), we include the presence of independent CLEC fiber as was done in Rysman Paper, Table 15. Regression model 3 is similar to Rysman Paper, Table 18, which examines the effect of competition at the building, block, and tract. The results for DS-1 circuits using regression models 2 and 3 are the same as those found with regression model 1. Inclusion of potential cable competition has no influence on the estimated effect of facilities-based competition in any of the three pricing areas. Potential cable competition is only statistically significant when measured as DOCSIS deployment in price cap areas. These regression models also yield similar results for DS-3 circuits as those from regression model 1. Some variation in the estimated facilities-based competition parameters is introduced, mostly in Phase I areas. However, with the exception of the DOCSIS measure in Phase I areas, there is no statistical evidence that potential cable competition is influencing ILEC prices. There is little evidence that ILEC prices of high bandwidth connections are influenced by facilities-based competition in the two additional regression models. At no point is there any evidence that facilities-based competition in the census block has an influence on high bandwidth prices. The only instance of a statistically significant effect of potential cable competition is from Metro Ethernet-enabled headends in price cap areas. However, it is difficult to believe that when actual facilities-based competition does not have an effect that we would see potential competition having an effect.

This analysis demonstrates that, at least in 2013, potential cable competition from BDS-comparable HFC infrastructure did not constrain ILEC prices in areas where there was evidence that facilities-based competition was doing so. Overall, we conclude that inclusion of potential cable competition is not necessary to properly model these markets at this time. As cable competition grows it may become an important component but in 2013, it was not.

Table 14: Regression of Log Price on Competition in the Census Block (Rysman Paper)

	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 is in the Census Block	-0.032	-0.109	0.023	-0.056	-0.114	0.046
	(0.004)*	(0.042)*	(0.030)	(0.007)*	(0.035)*	(0.038)
Customer is a Telecommunications Provider	-0.196	-0.025	0.135	-0.131	0.014	0.145
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.199	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.006	-0.472
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.008	0.030	-0.141	-0.023	0.070	-0.010
	(0.015)	(0.108)	(0.070)*	(0.010)*	(0.057)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.052	0.073	-0.082	0.113	0.123
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.106	0.043	0.045	-0.182	-0.111
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.106)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.011	-0.024	0.005	0.021	0.062	0.028
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)
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)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.532			-0.660
			(0.090)*			(0.088)*
Constant	5.518	5.763	5.765	6.203	6.468	6.293
	(0.089)*	(0.749)*	(0.516)*	(0.061)*	(0.310)*	(0.266)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	136.35	5.53	12.71	183.62	4.95	14.53
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 14a: Regression of Log Price on Competition in the Census Block with DOCSIS 3.0 Indicator

	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 is in the Census Block	-0.032	-0.108	0.024	-0.056	-0.117	0.046
	(0.004)*	(0.042)*	(0.029)	(0.007)*	(0.035)*	(0.038)
DOCSIS 3.0 Available in the Census Block	-0.018	-0.189	-0.110	-0.047	-0.204	0.013
	(0.009)	(0.137)	(0.052)*	(0.014)*	(0.081)*	(0.061)
Customer is a Telecommunications Provider	-0.196	-0.026	0.135	-0.131	0.013	0.145
	(0.010)*	(0.042)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.149	0.201	-0.363
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.054	0.000	-0.472
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.026	-0.144	-0.019	0.079	-0.011
	(0.015)	(0.109)	(0.071)*	(0.010)	(0.057)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.064	0.065	-0.085	0.094	0.124
	(0.022)	(0.148)	(0.104)	(0.014)*	(0.071)	(0.054)*
Natural Log of Employment in the Zip Code	-0.004	0.119	0.052	0.047	-0.169	-0.111
	(0.030)	(0.200)	(0.146)	(0.018)*	(0.104)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.013	0.009	0.022	0.068	0.027
	(0.002)*	(0.022)	(0.013)	(0.004)*	(0.019)*	(0.014)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.043	-0.002	-0.029	-0.057	-0.042
	(0.001)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.532			-0.661
			(0.090)*			(0.088)*
Constant	5.533	5.984	5.882	6.245	6.700	6.279
	(0.090)*	(0.752)*	(0.520)*	(0.056)*	(0.293)*	(0.277)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	122.67	5.03	12.25	165.26	4.84	13.44
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 14b: Regression of Log Price on Competition in the Census Block with Expansive Metro Ethernet Indicator

	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 is in the Census Block	-0.032	-0.108	0.025	-0.056	-0.115	0.050
	(0.004)*	(0.042)*	(0.029)	(0.007)*	(0.035)*	(0.039)
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.011	-0.086	-0.107	-0.051	-0.070	-0.078
	(0.007)	(0.116)	(0.032)*	(0.010)*	(0.062)	(0.059)
Customer is a Telecommunications Provider	-0.196	-0.026	0.136	-0.131	0.012	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.055)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.148	0.198	-0.367
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.005	-0.473
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.033	-0.132	-0.019	0.076	-0.008
	(0.015)	(0.109)	(0.072)	(0.010)	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.017	-0.058	0.073	-0.086	0.106	0.119
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.073)	(0.053)*
Natural Log of Employment in the Zip Code	-0.003	0.110	0.036	0.048	-0.177	-0.109
	(0.030)	(0.199)	(0.147)	(0.018)*	(0.106)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.018	0.011	0.023	0.066	0.032
	(0.002)*	(0.023)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.043	-0.004	-0.029	-0.059	-0.042
	(0.001)*	(0.020)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.531			-0.658
			(0.090)*			(0.088)*
Constant	5.527	5.860	5.830	6.241	6.533	6.350
	(0.089)*	(0.750)*	(0.516)*	(0.057)*	(0.312)*	(0.261)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	122.79	4.98	13.17	165.97	4.76	13.25
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 14c: Regression of Log Price on Competition in the Census Block with Narrow Metro Ethernet Indicator

	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 is in the Census Block	-0.032	-0.109	0.025	-0.056	-0.113	0.049
	(0.004)*	(0.042)*	(0.029)	(0.007)*	(0.035)*	(0.039)
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.008	0.039	-0.103	-0.042	-0.034	-0.052
	(0.007)	(0.065)	(0.031)*	(0.010)*	(0.057)	(0.059)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.013	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.199	-0.366
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.005	-0.473
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.028	-0.131	-0.020	0.073	-0.009
	(0.015)	(0.107)	(0.072)	(0.010)*	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.051	0.074	-0.085	0.111	0.120
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.073)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.106	0.036	0.047	-0.181	-0.109
	(0.030)	(0.199)	(0.147)	(0.018)*	(0.106)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.026	0.011	0.023	0.064	0.030
	(0.002)*	(0.026)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.047	-0.005	-0.030	-0.060	-0.042
	(0.001)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.532			-0.659
			(0.090)*			(0.088)*
Constant	5.523	5.730	5.809	6.233	6.504	6.327
	(0.089)*	(0.752)*	(0.515)*	(0.057)*	(0.311)*	(0.262)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	122.72	5.07	13.36	165.56	4.70	13.27
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 15: Regression of Log Price on Competition and CLEC Network in the Census Block (Rysman Paper)

	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 is in the Census Block	-0.032	-0.108	0.025	-0.052	-0.104	0.054
	(0.004)*	(0.043)*	(0.030)	(0.007)*	(0.035)*	(0.039)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.003	-0.014	-0.030	-0.046	-0.121	-0.073
	(0.004)	(0.048)	(0.030)	(0.007)*	(0.054)*	(0.047)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.012	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.196	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.006	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.008	0.030	-0.141	-0.022	0.075	-0.010
	(0.015)	(0.108)	(0.070)*	(0.010)*	(0.059)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.052	0.074	-0.081	0.124	0.124
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.105	0.042	0.045	-0.196	-0.111
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.109)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.024	0.006	0.022	0.064	0.029
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.045	-0.003	-0.030	-0.059	-0.043
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.532			-0.660
			(0.090)*			(0.088)*
Constant	5.520	5.775	5.792	6.223	6.536	6.337
	(0.089)*	(0.753)*	(0.518)*	(0.061)*	(0.315)*	(0.265)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	122.71	5.10	11.74	167.33	5.00	13.41
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 15a: Regression of Log Price on Competition and CLEC Network in the Census Block with DOCSIS 3.0 Indicator

	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 is in the Census Block	-0.032	-0.108	0.026	-0.052	-0.109	0.054
	(0.004)*	(0.042)*	(0.030)	(0.007)*	(0.035)*	(0.039)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.002	-0.002	-0.026	-0.043	-0.100	-0.074
	(0.004)	(0.049)	(0.030)	(0.007)*	(0.056)	(0.046)
DOCSIS 3.0 Available in the Census Block	-0.017	-0.189	-0.109	-0.042	-0.195	0.018
	(0.009)	(0.137)	(0.052)*	(0.014)*	(0.081)*	(0.060)
Customer is a Telecommunications Provider	-0.196	-0.026	0.135	-0.131	0.011	0.146
	(0.010)*	(0.042)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.148	0.199	-0.363
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.054	-0.001	-0.468
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.026	-0.144	-0.019	0.083	-0.011
	(0.015)	(0.109)	(0.071)*	(0.010)	(0.059)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.064	0.066	-0.084	0.103	0.126
	(0.022)	(0.148)	(0.104)	(0.014)*	(0.071)	(0.054)*
Natural Log of Employment in the Zip Code	-0.004	0.118	0.051	0.046	-0.182	-0.112
	(0.030)	(0.200)	(0.146)	(0.019)*	(0.107)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.013	0.010	0.023	0.069	0.029
	(0.002)*	(0.022)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.043	-0.002	-0.029	-0.056	-0.043
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.531			-0.660
			(0.090)*			(0.088)*
Constant	5.534	5.986	5.905	6.259	6.747	6.319
	(0.089)*	(0.752)*	(0.521)*	(0.057)*	(0.303)*	(0.277)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	111.52	4.68	11.39	152.01	4.67	12.56
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 15b: Regression of Log Price on Competition and CLEC Network in the Census Block with Expansive Metro Ethernet Indicator

	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 is in the Census Block	-0.032	-0.108	0.027	-0.052	-0.105	0.057
	(0.004)*	(0.042)*	(0.030)	(0.007)*	(0.034)*	(0.040)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.002	-0.008	-0.026	-0.042	-0.114	-0.065
	(0.004)	(0.049)	(0.030)	(0.007)*	(0.054)*	(0.044)
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.011	-0.086	-0.107	-0.048	-0.063	-0.076
	(0.007)	(0.116)	(0.032)*	(0.010)*	(0.063)	(0.059)
Customer is a Telecommunications Provider	-0.196	-0.026	0.136	-0.132	0.011	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.147	0.196	-0.367
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.005	-0.469
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.032	-0.132	-0.018	0.080	-0.008
	(0.015)	(0.109)	(0.072)	(0.010)	(0.058)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.017	-0.058	0.074	-0.085	0.116	0.120
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.109	0.036	0.047	-0.192	-0.109
	(0.030)	(0.199)	(0.147)	(0.019)*	(0.109)	(0.067)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.018	0.012	0.024	0.067	0.033
	(0.002)*	(0.023)	(0.013)	(0.004)*	(0.019)*	(0.015)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.042	-0.005	-0.029	-0.059	-0.042
	(0.001)*	(0.020)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.531			-0.657
			(0.090)*			(0.088)*
Constant	5.528	5.867	5.853	6.258	6.592	6.388
	(0.089)*	(0.752)*	(0.518)*	(0.058)*	(0.318)*	(0.262)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	111.63	4.64	12.24	153.00	4.68	12.29
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 15c: Regression of Log Price on Competition and CLEC Network in the Census Block with Narrow Metro Ethernet Indicator

	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 is in the Census Block	-0.032	-0.108	0.027	-0.052	-0.104	0.056
	(0.004)*	(0.043)*	(0.030)	(0.007)*	(0.035)*	(0.040)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.002	-0.017	-0.026	-0.043	-0.117	-0.067
	(0.004)	(0.048)	(0.030)	(0.007)*	(0.054)*	(0.044)
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.008	0.040	-0.102	-0.039	-0.026	-0.048
	(0.007)	(0.065)	(0.031)*	(0.010)*	(0.057)	(0.058)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.131	0.011	0.145
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.147	0.196	-0.365
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.006	-0.468
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.028	-0.131	-0.019	0.077	-0.008
	(0.015)	(0.107)	(0.072)	(0.010)	(0.058)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.051	0.074	-0.084	0.121	0.121
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.106	0.036	0.046	-0.196	-0.109
	(0.030)	(0.199)	(0.147)	(0.019)*	(0.109)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.026	0.011	0.024	0.065	0.032
	(0.002)*	(0.026)	(0.013)	(0.004)*	(0.019)*	(0.015)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.046	-0.005	-0.030	-0.059	-0.043
	(0.001)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.532			-0.658
			(0.090)*			(0.088)*
Constant	5.525	5.744	5.832	6.249	6.561	6.366
	(0.089)*	(0.755)*	(0.517)*	(0.058)*	(0.316)*	(0.263)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	111.57	4.72	12.41	152.33	4.64	12.34
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 16: Regression of Log Price on Competition interacted with the Presence of Fiber in the Block (Rysman Paper)

	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 is in the Census Block	-0.017	0.030	0.040	-0.016	-0.024	0.085
	(0.010)	(0.104)	(0.071)	(0.016)	(0.109)	(0.102)
An Indep. CLEC Has a Fiber Network in the Census Block	0.000	0.035	-0.028	-0.038	-0.090	-0.066
	(0.005)	(0.054)	(0.032)	(0.008)*	(0.067)	(0.051)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.148	-0.016	-0.040	-0.087	-0.033
	(0.011)	(0.110)	(0.075)	(0.017)*	(0.115)	(0.108)
Customer is a Telecommunications Provider	-0.196	-0.025	0.135	-0.131	0.011	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.147	0.194	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.055	-0.007	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.032	-0.141	-0.022	0.078	-0.010
	(0.015)	(0.108)	(0.070)*	(0.010)*	(0.059)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.049	0.074	-0.079	0.128	0.125
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.075)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.102	0.042	0.043	-0.204	-0.112
	(0.030)	(0.200)	(0.147)	(0.019)*	(0.110)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.024	0.006	0.022	0.064	0.029
	(0.002)*	(0.025)	(0.013)	(0.004)*	(0.019)*	(0.014)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.045	-0.003	-0.030	-0.059	-0.042
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.532			-0.659
			(0.090)*			(0.088)*
Constant	5.518	5.726	5.790	6.215	6.510	6.330
	(0.089)*	(0.753)*	(0.519)*	(0.061)*	(0.318)*	(0.265)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	111.67	4.68	10.84	152.46	4.51	12.41
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 16a: Regression of Log Price on Competition interacted with the Presence of Fiber in the Block with DOCSIS 3.0 Indicator

	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 is in the Census Block	-0.017	0.045	0.042	-0.015	-0.005	0.084
	(0.010)	(0.104)	(0.071)	(0.016)	(0.112)	(0.102)
An Indep. CLEC Has a Fiber Network in the Census Block	0.001	0.052	-0.023	-0.034	-0.060	-0.067
	(0.005)	(0.057)	(0.032)	(0.008)*	(0.073)	(0.050)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.164	-0.017	-0.041	-0.113	-0.032
	(0.011)	(0.109)	(0.075)	(0.017)*	(0.117)	(0.108)
DOCSIS 3.0 Available in the Census Block	-0.018	-0.191	-0.109	-0.042	-0.198	0.018
	(0.009)	(0.137)	(0.052)*	(0.014)*	(0.081)*	(0.060)
Customer is a Telecommunications Provider	-0.196	-0.027	0.135	-0.131	0.010	0.146
	(0.010)*	(0.042)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.148	0.196	-0.364
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.464	-0.054	-0.001	-0.468
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.027	-0.144	-0.018	0.086	-0.011
	(0.015)	(0.109)	(0.071)*	(0.010)	(0.059)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.061	0.066	-0.083	0.108	0.126
	(0.022)	(0.148)	(0.104)	(0.014)*	(0.072)	(0.054)*
Natural Log of Employment in the Zip Code	-0.004	0.115	0.051	0.044	-0.192	-0.112
	(0.030)	(0.200)	(0.146)	(0.018)*	(0.108)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.013	0.010	0.023	0.069	0.029
	(0.002)*	(0.022)	(0.013)	(0.004)*	(0.019)*	(0.015)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.043	-0.002	-0.029	-0.056	-0.043
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.531			-0.659
			(0.090)*			(0.088)*
Constant	5.532	5.933	5.903	6.251	6.716	6.313
	(0.089)*	(0.752)*	(0.522)*	(0.057)*	(0.308)*	(0.277)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	102.33	4.34	10.59	139.66	4.32	11.72
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 16b: Regression of Log Price on Competition interacted with the Presence of Fiber in the Block with Expansive Metro Ethernet Indicator

	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 is in the Census Block	-0.017	0.032	0.041	-0.014	-0.022	0.091
	(0.010)	(0.104)	(0.070)	(0.016)	(0.109)	(0.102)
An Indep. CLEC Has a Fiber Network in the Census Block	0.001	0.042	-0.024	-0.033	-0.081	-0.058
	(0.005)	(0.055)	(0.032)	(0.008)*	(0.068)	(0.048)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.151	-0.015	-0.041	-0.091	-0.037
	(0.011)	(0.109)	(0.075)	(0.017)*	(0.114)	(0.107)
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.011	-0.087	-0.107	-0.049	-0.064	-0.076
	(0.007)	(0.116)	(0.032)*	(0.010)*	(0.062)	(0.059)
Customer is a Telecommunications Provider	-0.196	-0.026	0.136	-0.132	0.010	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.195	-0.201	0.147	0.194	-0.367
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.006	-0.469
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.034	-0.132	-0.018	0.082	-0.008
	(0.015)	(0.109)	(0.072)	(0.010)	(0.058)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.017	-0.055	0.074	-0.084	0.121	0.121
	(0.022)	(0.148)	(0.104)	(0.014)*	(0.074)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.106	0.036	0.045	-0.199	-0.110
	(0.030)	(0.200)	(0.147)	(0.018)*	(0.110)	(0.067)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.018	0.012	0.024	0.067	0.033
	(0.002)*	(0.023)	(0.013)	(0.004)*	(0.019)*	(0.015)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.042	-0.005	-0.029	-0.059	-0.042
	(0.001)*	(0.020)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.531			-0.656
			(0.090)*			(0.088)*
Constant	5.526	5.817	5.851	6.250	6.565	6.381
	(0.089)*	(0.752)*	(0.518)*	(0.058)*	(0.321)*	(0.263)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	102.43	4.30	11.38	140.58	4.30	11.45
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 16c: Regression of Log Price on Competition interacted with the Presence of Fiber in the Block with Narrow Metro Ethernet Indicator

	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 is in the Census Block	-0.017	0.030	0.040	-0.015	-0.025	0.087
	(0.010)	(0.104)	(0.070)	(0.016)	(0.109)	(0.102)
An Indep. CLEC Has a Fiber Network in the Census Block	0.001	0.033	-0.023	-0.034	-0.086	-0.060
	(0.005)	(0.054)	(0.032)	(0.008)*	(0.067)	(0.048)
Ind. CLEC Fiber Network in CB x Facilities-based CLEC in Building in CB	-0.016	-0.148	-0.013	-0.040	-0.086	-0.033
	(0.011)	(0.110)	(0.075)	(0.017)*	(0.114)	(0.108)
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.008	0.040	-0.102	-0.039	-0.025	-0.048
	(0.007)	(0.065)	(0.031)*	(0.010)*	(0.057)	(0.058)
Customer is a Telecommunications Provider	-0.196	-0.025	0.136	-0.132	0.011	0.145
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.147	0.194	-0.366
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.050	-0.461	-0.054	-0.007	-0.469
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.174)*
Natural Log of Establishments in the Zip Code	0.009	0.030	-0.131	-0.019	0.079	-0.008
	(0.015)	(0.108)	(0.072)	(0.010)	(0.058)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.048	0.074	-0.083	0.126	0.122
	(0.022)	(0.148)	(0.105)	(0.014)*	(0.075)	(0.053)*
Natural Log of Employment in the Zip Code	-0.004	0.102	0.036	0.044	-0.203	-0.110
	(0.030)	(0.199)	(0.147)	(0.019)*	(0.110)	(0.067)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.026	0.011	0.024	0.065	0.032
	(0.002)*	(0.026)	(0.013)	(0.004)*	(0.019)*	(0.015)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.046	-0.005	-0.030	-0.059	-0.042
	(0.001)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.532			-0.657
			(0.090)*			(0.088)*
Constant	5.523	5.695	5.830	6.241	6.535	6.359
	(0.089)*	(0.755)*	(0.518)*	(0.058)*	(0.320)*	(0.263)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	102.37	4.36	11.54	139.94	4.25	11.50
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 17: Regression of Log Price on Competition in the Building and the Block (Rysman Paper)

	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 is in the Building	-0.047	-0.063	-0.023	-0.066	-0.047	-0.014
	(0.006)*	(0.047)	(0.038)	(0.011)*	(0.038)	(0.039)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.118	0.054	-0.044	-0.124	0.062
	(0.006)*	(0.060)*	(0.034)	(0.009)*	(0.045)*	(0.032)*
Customer is a Telecommunications Provider	-0.197	-0.026	0.135	-0.132	0.012	0.147
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.057)*
Customer is a Mobile Telecommunications Provider	0.104	0.195	-0.202	0.149	0.198	-0.363
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.005	-0.466
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.037	-0.145	-0.023	0.066	-0.007
	(0.015)	(0.109)	(0.070)*	(0.010)*	(0.056)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.021	0.063	-0.073	0.121	0.124
	(0.021)	(0.153)	(0.105)	(0.014)*	(0.073)	(0.054)*
Natural Log of Employment in the Zip Code	-0.008	0.068	0.056	0.037	-0.186	-0.114
	(0.029)	(0.205)	(0.146)	(0.018)*	(0.105)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.016	-0.000	0.021	0.071	0.022
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.019)*	(0.014)
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
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.197
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.659
			(0.089)*			(0.088)*
Constant	5.505	5.651	5.791	6.159	6.429	6.279
	(0.088)*	(0.754)*	(0.518)*	(0.060)*	(0.304)*	(0.273)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	125.15	4.47	11.87	165.73	4.51	13.65
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 17a: Regression of Log Price on Competition in the Building and the Block with DOCSIS 3.0 Indicator

	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 is in the Building	-0.047	-0.062	-0.021	-0.066	-0.048	-0.015
	(0.006)*	(0.047)	(0.038)	(0.011)*	(0.038)	(0.039)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.112	0.056	-0.043	-0.122	0.062
	(0.006)*	(0.056)*	(0.034)	(0.009)*	(0.044)*	(0.032)*
DOCSIS 3.0 Available in the Census Block	-0.017	-0.178	-0.111	-0.047	-0.196	0.012
	(0.009)	(0.129)	(0.052)*	(0.014)*	(0.078)*	(0.061)
Customer is a Telecommunications Provider	-0.197	-0.027	0.135	-0.132	0.011	0.147
	(0.010)*	(0.042)	(0.049)*	(0.012)*	(0.037)	(0.057)*
Customer is a Mobile Telecommunications Provider	0.104	0.195	-0.201	0.150	0.200	-0.363
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.041)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.463	-0.055	0.000	-0.466
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.032	-0.148	-0.020	0.075	-0.008
	(0.014)	(0.110)	(0.071)*	(0.010)*	(0.057)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.013	-0.034	0.055	-0.076	0.101	0.125
	(0.021)	(0.152)	(0.104)	(0.014)*	(0.071)	(0.055)*
Natural Log of Employment in the Zip Code	-0.008	0.083	0.065	0.038	-0.173	-0.114
	(0.029)	(0.204)	(0.146)	(0.018)*	(0.104)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.007	0.004	0.022	0.076	0.022
	(0.002)*	(0.021)	(0.013)	(0.003)*	(0.019)*	(0.014)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.042	0.001	-0.027	-0.058	-0.038
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.197
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.659
			(0.089)*			(0.087)*
Constant	5.519	5.864	5.910	6.201	6.655	6.266
	(0.088)*	(0.753)*	(0.522)*	(0.055)*	(0.291)*	(0.283)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.11	0.29
F Statistic	113.77	4.06	11.73	151.16	4.44	12.65
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 17b: Regression of Log Price on Competition in the Building and the Block with Expansive Metro Ethernet Indicator

	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 is in the Building	-0.047	-0.063	-0.024	-0.067	-0.048	-0.012
	(0.006)*	(0.047)	(0.038)	(0.011)*	(0.038)	(0.039)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.116	0.056	-0.042	-0.123	0.065
	(0.006)*	(0.057)*	(0.034)	(0.008)*	(0.046)*	(0.032)*
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.012	-0.080	-0.109	-0.053	-0.065	-0.079
	(0.007)	(0.111)	(0.032)*	(0.010)*	(0.062)	(0.059)
Customer is a Telecommunications Provider	-0.197	-0.027	0.136	-0.133	0.010	0.145
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.104	0.195	-0.201	0.149	0.198	-0.366
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.459	-0.055	-0.004	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.039	-0.135	-0.019	0.071	-0.005
	(0.014)	(0.110)	(0.072)	(0.010)*	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.013	-0.027	0.063	-0.077	0.114	0.120
	(0.021)	(0.152)	(0.104)	(0.014)*	(0.073)	(0.053)*
Natural Log of Employment in the Zip Code	-0.008	0.073	0.050	0.039	-0.182	-0.111
	(0.029)	(0.204)	(0.146)	(0.018)*	(0.105)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.011	0.006	0.023	0.074	0.026
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.018)*	(0.015)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.042	-0.001	-0.027	-0.061	-0.037
	(0.002)*	(0.020)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.656
			(0.089)*			(0.087)*
Constant	5.514	5.743	5.859	6.198	6.490	6.338
	(0.088)*	(0.752)*	(0.518)*	(0.056)*	(0.307)*	(0.267)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	113.79	4.15	12.43	151.21	4.35	12.63
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 17c: Regression of Log Price on Competition in the Building and the Block with Narrow Metro Ethernet Indicator

	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 is in the Building	-0.047	-0.062	-0.024	-0.067	-0.048	-0.013
	(0.006)*	(0.047)	(0.038)	(0.011)*	(0.038)	(0.039)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.027	-0.118	0.055	-0.043	-0.124	0.064
	(0.006)*	(0.060)*	(0.034)	(0.009)*	(0.046)*	(0.032)*
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.009	0.037	-0.104	-0.044	-0.036	-0.052
	(0.007)	(0.065)	(0.031)*	(0.010)*	(0.057)	(0.059)
Customer is a Telecommunications Provider	-0.197	-0.025	0.136	-0.133	0.011	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.104	0.194	-0.201	0.149	0.198	-0.365
	(0.006)*	(0.050)*	(0.103)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.459	-0.055	-0.005	-0.467
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.035	-0.134	-0.020	0.069	-0.005
	(0.015)	(0.108)	(0.072)	(0.010)*	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.013	-0.020	0.063	-0.076	0.118	0.121
	(0.021)	(0.153)	(0.104)	(0.014)*	(0.073)	(0.054)*
Natural Log of Employment in the Zip Code	-0.008	0.069	0.050	0.038	-0.186	-0.112
	(0.029)	(0.205)	(0.147)	(0.018)*	(0.105)	(0.068)
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.019	0.005	0.023	0.073	0.025
	(0.002)*	(0.023)	(0.013)	(0.003)*	(0.018)*	(0.015)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.046	-0.001	-0.028	-0.062	-0.037
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.657
			(0.089)*			(0.087)*
Constant	5.511	5.619	5.837	6.189	6.466	6.314
	(0.087)*	(0.756)*	(0.518)*	(0.056)*	(0.306)*	(0.268)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	113.83	4.17	12.59	151.63	4.43	12.58
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 18: Regression of Log Price on Competition in the Building, the Block, and the Tract (Rysman Paper)

	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 is in the Building	-0.051	-0.074	-0.026	-0.069	-0.049	-0.023
	(0.007)*	(0.048)	(0.038)	(0.011)*	(0.038)	(0.038)
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
	(0.007)*	(0.062)*	(0.035)	(0.009)*	(0.046)*	(0.032)
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
	(0.007)*	(0.074)*	(0.042)	(0.009)*	(0.046)	(0.049)
Customer is a Telecommunications Provider	-0.197	-0.025	0.135	-0.133	0.011	0.146
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.202	0.148	0.198	-0.366
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.049	-0.462	-0.055	-0.006	-0.469
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.008	0.039	-0.144	-0.025	0.065	-0.008
	(0.014)	(0.109)	(0.070)*	(0.009)*	(0.056)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.011	-0.023	0.064	-0.065	0.126	0.134
	(0.021)	(0.153)	(0.104)	(0.014)*	(0.074)	(0.056)*
Natural Log of Employment in the Zip Code	-0.009	0.069	0.055	0.032	-0.189	-0.120
	(0.029)	(0.206)	(0.146)	(0.018)	(0.105)	(0.070)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.020	-0.001	0.021	0.070	0.021
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.019)*	(0.014)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.047	0.001	-0.027	-0.060	-0.036
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.658
			(0.089)*			(0.088)*
Constant	5.529	5.857	5.822	6.142	6.422	6.263
	(0.088)*	(0.759)*	(0.518)*	(0.059)*	(0.306)*	(0.276)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	113.85	4.39	11.37	154.89	4.29	12.89
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 18a: Regression of Log Price on Competition in the Building, the Block, and the Tract with DOCSIS 3.0 Indicator

	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 is in the Building	-0.051	-0.074	-0.024	-0.069	-0.050	-0.023
	(0.007)*	(0.048)	(0.038)	(0.011)*	(0.038)	(0.037)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.033	-0.129	0.052	-0.048	-0.124	0.058
	(0.007)*	(0.058)*	(0.035)	(0.009)*	(0.045)*	(0.032)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.030	-0.211	-0.034	-0.041	-0.041	-0.073
	(0.007)*	(0.074)*	(0.041)	(0.009)*	(0.046)	(0.049)
DOCSIS 3.0 Available in the Census Block	-0.017	-0.178	-0.110	-0.049	-0.197	0.011
	(0.009)	(0.128)	(0.052)*	(0.014)*	(0.078)*	(0.061)
Customer is a Telecommunications Provider	-0.197	-0.026	0.135	-0.133	0.010	0.146
	(0.010)*	(0.042)	(0.049)*	(0.012)*	(0.037)	(0.056)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.148	0.199	-0.365
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.048	-0.462	-0.055	-0.000	-0.470
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.034	-0.147	-0.021	0.074	-0.009
	(0.014)	(0.110)	(0.071)*	(0.009)*	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.037	0.056	-0.069	0.107	0.135
	(0.021)	(0.152)	(0.104)	(0.014)*	(0.072)	(0.057)*
Natural Log of Employment in the Zip Code	-0.009	0.083	0.064	0.034	-0.177	-0.120
	(0.029)	(0.205)	(0.146)	(0.018)	(0.104)	(0.070)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.010	0.003	0.021	0.075	0.020
	(0.002)*	(0.021)	(0.013)	(0.003)*	(0.019)*	(0.014)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.045	0.002	-0.026	-0.057	-0.036
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.012)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.036)*
Packet-based Connection			-0.530			-0.658
			(0.089)*			(0.087)*
Constant	5.543	6.072	5.936	6.185	6.649	6.251
	(0.089)*	(0.763)*	(0.522)*	(0.055)*	(0.292)*	(0.286)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.11	0.29
F Statistic	104.35	4.03	11.23	142.42	4.27	12.03
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 18b: Regression of Log Price on Competition in the Building, the Block, and the Tract with Expansive Metro Ethernet Indicator

	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 is in the Building	-0.051	-0.075	-0.027	-0.070	-0.050	-0.020
	(0.007)*	(0.048)	(0.038)	(0.011)*	(0.038)	(0.038)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.033	-0.133	0.051	-0.048	-0.125	0.061
	(0.007)*	(0.059)*	(0.035)	(0.009)*	(0.046)*	(0.032)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.030	-0.211	-0.040	-0.040	-0.036	-0.074
	(0.007)*	(0.074)*	(0.042)	(0.009)*	(0.046)	(0.048)
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.012	-0.081	-0.109	-0.053	-0.065	-0.079
	(0.007)	(0.110)	(0.032)*	(0.010)*	(0.062)	(0.059)
Customer is a Telecommunications Provider	-0.197	-0.026	0.136	-0.133	0.010	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.055)*
Customer is a Mobile Telecommunications Provider	0.103	0.194	-0.201	0.147	0.197	-0.369
	(0.006)*	(0.050)*	(0.104)	(0.008)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.048	-0.459	-0.055	-0.005	-0.471
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.041	-0.135	-0.021	0.070	-0.005
	(0.014)	(0.110)	(0.072)	(0.009)*	(0.055)	(0.043)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.029	0.064	-0.070	0.119	0.130
	(0.021)	(0.152)	(0.104)	(0.014)*	(0.074)	(0.055)*
Natural Log of Employment in the Zip Code	-0.008	0.073	0.049	0.035	-0.185	-0.118
	(0.029)	(0.205)	(0.146)	(0.018)	(0.105)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.015	0.005	0.022	0.074	0.024
	(0.002)*	(0.022)	(0.013)	(0.003)*	(0.019)*	(0.015)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.045	-0.001	-0.026	-0.060	-0.035
	(0.002)*	(0.020)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.530			-0.656
			(0.089)*			(0.087)*
Constant	5.538	5.951	5.890	6.181	6.484	6.323
	(0.088)*	(0.761)*	(0.518)*	(0.056)*	(0.309)*	(0.270)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	104.37	4.13	11.90	142.52	4.21	11.93
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 18c: Regression of Log Price on Competition in the Building, the Block, and the Tract with Narrow Metro Ethernet Indicator

	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 is in the Building	-0.051	-0.074	-0.027	-0.070	-0.050	-0.021
	(0.007)*	(0.048)	(0.038)	(0.011)*	(0.038)	(0.038)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.033	-0.136	0.051	-0.048	-0.126	0.060
	(0.007)*	(0.062)*	(0.035)	(0.009)*	(0.046)*	(0.032)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.030	-0.209	-0.040	-0.040	-0.036	-0.074
	(0.007)*	(0.074)*	(0.042)	(0.009)*	(0.046)	(0.049)
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.009	0.035	-0.104	-0.044	-0.036	-0.053
	(0.007)	(0.065)	(0.031)*	(0.010)*	(0.057)	(0.058)
Customer is a Telecommunications Provider	-0.197	-0.025	0.136	-0.133	0.010	0.144
	(0.010)*	(0.043)	(0.049)*	(0.012)*	(0.037)	(0.055)*
Customer is a Mobile Telecommunications Provider	0.103	0.193	-0.201	0.147	0.198	-0.368
	(0.006)*	(0.050)*	(0.104)	(0.009)*	(0.042)*	(0.062)*
Customer is a Cable Operator	-0.073	-0.048	-0.459	-0.055	-0.005	-0.470
	(0.009)*	(0.046)	(0.256)	(0.010)*	(0.047)	(0.175)*
Natural Log of Establishments in the Zip Code	0.009	0.037	-0.134	-0.022	0.068	-0.006
	(0.014)	(0.109)	(0.072)	(0.009)*	(0.056)	(0.044)
Natural Log of Annual Payroll in the Zip Code	-0.012	-0.022	0.064	-0.068	0.123	0.131
	(0.021)	(0.153)	(0.104)	(0.014)*	(0.074)	(0.055)*
Natural Log of Employment in the Zip Code	-0.009	0.069	0.049	0.034	-0.189	-0.118
	(0.029)	(0.205)	(0.147)	(0.018)	(0.105)	(0.069)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.022	0.005	0.022	0.072	0.023
	(0.002)*	(0.023)	(0.013)	(0.003)*	(0.019)*	(0.015)
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.048	-0.001	-0.027	-0.060	-0.036
	(0.002)*	(0.019)*	(0.012)	(0.002)*	(0.015)*	(0.011)*
Natural Log of Mbps			0.247			0.198
			(0.051)*			(0.035)*
Packet-based Connection			-0.530			-0.657
			(0.089)*			(0.087)*
Constant	5.535	5.827	5.869	6.172	6.460	6.299
	(0.088)*	(0.761)*	(0.518)*	(0.056)*	(0.308)*	(0.271)*
Adjusted R-Squared	0.33	0.26	0.45	0.18	0.10	0.29
F Statistic	104.41	4.12	12.06	143.04	4.33	11.95
Observations	1,399,170	120,110	80,318	1,399,170	120,110	80,318

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 19: Regression of Log Price on Number of Competitors in the Census Block (Rysman Paper)

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Building	-0.048	-0.066	-0.065	-0.052
	(0.006)*	(0.046)	(0.011)*	(0.037)
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.095	-0.028	-0.070
	(0.005)*	(0.070)	(0.009)*	(0.046)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.154	-0.075	-0.160
	(0.010)*	(0.070)*	(0.015)*	(0.058)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.040	-0.132	-0.065	-0.280
	(0.025)	(0.092)	(0.025)*	(0.107)*
Customer is a Telecommunications Provider	-0.197	-0.025	-0.132	0.010
	(0.010)*	(0.043)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.149	0.194
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.010
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.008	0.038	-0.025	0.064
	(0.014)	(0.110)	(0.009)*	(0.055)
Natural Log of Annual Payroll in the Zip Code	-0.008	-0.011	-0.068	0.144
	(0.022)	(0.155)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.011	0.057	0.034	-0.209
	(0.030)	(0.208)	(0.018)	(0.107)
Natural Log of Number of Establishments in the Census Block (D&B)	0.013	-0.014	0.023	0.080
	(0.002)*	(0.022)	(0.004)*	(0.020)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.043	-0.028	-0.060
	(0.002)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.490	5.619	6.135	6.327
	(0.088)*	(0.763)*	(0.061)*	(0.308)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	105.22	4.04	145.77	4.15
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 19a: Regression of Log Price on Number of Competitors in the Census Block with DOCSIS 3.0 Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Building	-0.048	-0.064	-0.065	-0.053
	(0.006)*	(0.046)	(0.011)*	(0.037)
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.090	-0.028	-0.068
	(0.005)*	(0.065)	(0.009)*	(0.046)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.147	-0.074	-0.158
	(0.010)*	(0.069)*	(0.014)*	(0.057)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.039	-0.117	-0.064	-0.274
	(0.025)	(0.091)	(0.025)*	(0.106)*
DOCSIS 3.0 Available in the Census Block	-0.017	-0.178	-0.047	-0.192
	(0.009)	(0.132)	(0.014)*	(0.078)*
Customer is a Telecommunications Provider	-0.197	-0.026	-0.132	0.009
	(0.010)*	(0.043)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.104	0.196	0.149	0.196
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.055	-0.005
	(0.009)*	(0.046)	(0.010)*	(0.046)
Natural Log of Establishments in the Zip Code	0.008	0.033	-0.021	0.072
	(0.014)	(0.111)	(0.010)*	(0.056)
Natural Log of Annual Payroll in the Zip Code	-0.009	-0.025	-0.072	0.125
	(0.022)	(0.154)	(0.014)*	(0.072)
Natural Log of Employment in the Zip Code	-0.011	0.073	0.036	-0.196
	(0.030)	(0.207)	(0.018)*	(0.105)
Natural Log of Number of Establishments in the Census Block (D&B)	0.014	-0.005	0.024	0.085
	(0.002)*	(0.021)	(0.003)*	(0.020)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.041	-0.027	-0.057
	(0.002)*	(0.019)*	(0.002)*	(0.014)*
Constant	5.504	5.830	6.177	6.551
	(0.088)*	(0.763)*	(0.056)*	(0.292)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	97.11	3.74	134.99	4.08
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 19b: Regression of Log Price on Number of Competitors in the Census Block with Expansive Metro Ethernet Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Building	-0.048	-0.066	-0.066	-0.053
	(0.006)*	(0.046)	(0.011)*	(0.037)
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.092	-0.027	-0.069
	(0.005)*	(0.066)	(0.009)*	(0.046)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.153	-0.075	-0.159
	(0.010)*	(0.070)*	(0.014)*	(0.058)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.039	-0.126	-0.063	-0.278
	(0.025)	(0.091)	(0.025)*	(0.109)*
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	-0.012	-0.082	-0.053	-0.064
	(0.007)	(0.111)	(0.010)*	(0.062)
Customer is a Telecommunications Provider	-0.197	-0.026	-0.133	0.009
	(0.010)*	(0.043)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.194
	(0.006)*	(0.050)*	(0.008)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.009
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.040	-0.021	0.068
	(0.014)	(0.111)	(0.009)*	(0.055)
Natural Log of Annual Payroll in the Zip Code	-0.009	-0.017	-0.073	0.137
	(0.022)	(0.154)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.011	0.062	0.037	-0.205
	(0.030)	(0.207)	(0.018)*	(0.107)
Natural Log of Number of Establishments in the Census Block (D&B)	0.014	-0.009	0.025	0.083
	(0.002)*	(0.022)	(0.003)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.041	-0.027	-0.060
	(0.002)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.499	5.711	6.174	6.389
	(0.088)*	(0.762)*	(0.057)*	(0.314)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	97.16	3.74	135.00	4.13
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 19c: Regression of Log Price on Number of Competitors in the Census Block with Narrow Metro Ethernet Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Building	-0.048	-0.066	-0.066	-0.053
	(0.006)*	(0.046)	(0.011)*	(0.037)
One Facilities-based Competitor is in the Block But Not the Building	-0.018	-0.096	-0.027	-0.070
	(0.005)*	(0.070)	(0.009)*	(0.046)
Two or Three Facilities-based Competitors are in the Block But Not the Building	-0.051	-0.154	-0.075	-0.160
	(0.010)*	(0.070)*	(0.014)*	(0.058)*
Four or More Facilities-based Competitors are in the Block But Not the Building	-0.039	-0.134	-0.063	-0.279
	(0.025)	(0.092)	(0.025)*	(0.108)*
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	-0.009	0.035	-0.044	-0.034
	(0.007)	(0.066)	(0.010)*	(0.057)
Customer is a Telecommunications Provider	-0.197	-0.025	-0.133	0.009
	(0.010)*	(0.043)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.194
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.056	-0.010
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.036	-0.022	0.066
	(0.014)	(0.110)	(0.010)*	(0.055)
Natural Log of Annual Payroll in the Zip Code	-0.009	-0.010	-0.072	0.142
	(0.022)	(0.155)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.011	0.058	0.036	-0.209
	(0.030)	(0.208)	(0.018)*	(0.107)
Natural Log of Number of Establishments in the Census Block (D&B)	0.014	-0.016	0.025	0.082
	(0.002)*	(0.023)	(0.003)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.044	-0.028	-0.060
	(0.002)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.496	5.591	6.165	6.363
	(0.087)*	(0.765)*	(0.057)*	(0.312)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	97.20	3.81	135.89	4.12
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

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

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Census Block	0.001	0.126	-0.009	0.060
	(0.008)	(0.059)*	(0.017)	(0.052)
Phase 1 x Facilities-based Competitor in Census Block	-0.038	-0.337	-0.073	-0.221
	(0.010)*	(0.081)*	(0.021)*	(0.076)*
Phase 2 x Facilities-based Competitor in Census Block	-0.048	-0.265	-0.040	-0.191
	(0.013)*	(0.084)*	(0.022)	(0.065)*
Customer is a Telecommunications Provider	-0.196	-0.024	-0.130	0.012
	(0.010)*	(0.042)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.148	0.200
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.051	-0.054	-0.004
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.037	-0.024	0.069
	(0.015)	(0.109)	(0.009)*	(0.057)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.039	-0.079	0.118
	(0.022)	(0.148)	(0.014)*	(0.074)
Natural Log of Employment in the Zip Code	-0.005	0.083	0.043	-0.185
	(0.030)	(0.200)	(0.019)*	(0.107)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.025	0.021	0.063
	(0.002)*	(0.025)	(0.004)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.046	-0.030	-0.060
	(0.001)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.515	5.775	6.190	6.465
	(0.089)*	(0.749)*	(0.061)*	(0.311)*
Adjusted R-Squared	0.33	0.26	0.18	0.10
F Statistic	112.41	6.10	155.25	4.68
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 20a: Regression of Log Price on Competition in the Block, by Price Flex Regulation with DOCSIS 3.0 Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Census Block	-0.005	0.064	-0.025	0.035
	(0.007)	(0.056)	(0.015)	(0.057)
Phase 1 x Facilities-based Competitor in Census Block	-0.029	-0.177	-0.049	-0.172
	(0.009)*	(0.088)*	(0.018)*	(0.080)*
Phase 2 x Facilities-based Competitor in Census Block	-0.043	-0.260	-0.023	-0.176
	(0.012)*	(0.082)*	(0.019)	(0.071)*
DOCSIS 3.0 Available in the Census Block	0.028	0.162	0.017	-0.022
	(0.018)	(0.116)	(0.019)	(0.080)
Phase 1 x DOCSIS 3.0 in Census Block	-0.070	-0.694	-0.105	-0.317
	(0.022)*	(0.175)*	(0.026)*	(0.113)*
Phase 2 x DOCSIS 3.0 in Census Block	-0.026	0.114	-0.038	-0.011
	(0.023)	(0.128)	(0.021)	(0.088)
Customer is a Telecommunications Provider	-0.195	-0.023	-0.129	0.013
	(0.010)*	(0.042)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.194	0.149	0.202
	(0.006)*	(0.050)*	(0.009)*	(0.041)*
Customer is a Cable Operator	-0.072	-0.049	-0.051	0.002
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.010	-0.021	0.075
	(0.015)	(0.112)	(0.010)*	(0.057)
Natural Log of Annual Payroll in the Zip Code	-0.015	-0.032	-0.084	0.095
	(0.022)	(0.145)	(0.013)*	(0.071)
Natural Log of Employment in the Zip Code	-0.005	0.082	0.046	-0.171
	(0.030)	(0.199)	(0.018)*	(0.105)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.012	0.022	0.071
	(0.002)*	(0.022)	(0.003)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.006	0.049	-0.028	-0.058
	(0.001)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.524	5.898	6.233	6.698
	(0.089)*	(0.726)*	(0.055)*	(0.293)*
Adjusted R-Squared	0.33	0.26	0.18	0.11
F Statistic	88.57	6.22	127.36	4.44
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 20b: Regression of Log Price on Competition in the Block, by Price Flex Regulation with Expansive Metro Ethernet Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Census Block	-0.005	0.086	-0.031	0.044
	(0.008)	(0.056)	(0.015)*	(0.056)
Phase 1 x Facilities-based Competitor in Census Block	-0.029	-0.235	-0.042	-0.194
	(0.009)*	(0.087)*	(0.018)*	(0.085)*
Phase 2 x Facilities-based Competitor in Census Block	-0.041	-0.263	-0.014	-0.177
	(0.012)*	(0.082)*	(0.019)	(0.070)*
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)	0.037	0.122	0.028	0.023
	(0.016)*	(0.104)	(0.016)	(0.065)
Phase 1 x Metro Ethernet (Expansive) in Census Block	-0.066	-0.483	-0.117	-0.139
	(0.019)*	(0.180)*	(0.022)*	(0.117)
Phase 2 x Metro Ethernet (Expansive) in Census Block	-0.037	0.084	-0.063	-0.051
	(0.021)	(0.118)	(0.019)*	(0.076)
Customer is a Telecommunications Provider	-0.195	-0.026	-0.129	0.012
	(0.010)*	(0.042)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.147	0.199
	(0.006)*	(0.050)*	(0.008)*	(0.041)*
Customer is a Cable Operator	-0.073	-0.049	-0.051	-0.003
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.032	-0.021	0.075
	(0.015)	(0.111)	(0.009)*	(0.056)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.015	-0.084	0.109
	(0.022)	(0.146)	(0.014)*	(0.073)
Natural Log of Employment in the Zip Code	-0.004	0.059	0.047	-0.180
	(0.030)	(0.200)	(0.018)*	(0.106)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.016	0.023	0.067
	(0.002)*	(0.022)	(0.003)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.043	-0.029	-0.060
	(0.001)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.518	5.762	6.229	6.532
	(0.089)*	(0.729)*	(0.056)*	(0.311)*
Adjusted R-Squared	0.33	0.26	0.18	0.10
F Statistic	89.47	5.73	128.44	4.28
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 20c: Regression of Log Price on Competition in the Block, by Price Flex Regulation with Narrow Metro Ethernet Indicator

	DS-1 Tract FE	DS-3 Tract FE	DS-1 County FE	DS-3 County FE
A Facilities-based Competitor is in the Census Block	-0.007	0.125	-0.043	0.059
	(0.008)	(0.057)*	(0.014)*	(0.054)
Phase 1 x Facilities-based Competitor in Census Block	-0.026	-0.309	-0.031	-0.215
	(0.010)*	(0.083)*	(0.018)	(0.082)*
Phase 2 x Facilities-based Competitor in Census Block	-0.039	-0.294	0.003	-0.191
	(0.013)*	(0.083)*	(0.019)	(0.067)*
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)	0.067	0.070	0.080	-0.014
	(0.016)*	(0.093)	(0.017)*	(0.053)
Phase 1 x Metro Ethernet (Narrow) in Census Block	-0.096	-0.183	-0.158	-0.042
	(0.018)*	(0.120)	(0.023)*	(0.102)
Phase 2 x Metro Ethernet (Narrow) in Census Block	-0.065	0.163	-0.121	0.005
	(0.021)*	(0.113)	(0.021)*	(0.071)
Customer is a Telecommunications Provider	-0.195	-0.024	-0.130	0.012
	(0.010)*	(0.042)	(0.012)*	(0.037)
Customer is a Mobile Telecommunications Provider	0.103	0.195	0.147	0.200
	(0.006)*	(0.050)*	(0.008)*	(0.041)*
Customer is a Cable Operator	-0.072	-0.051	-0.051	-0.004
	(0.009)*	(0.046)	(0.010)*	(0.047)
Natural Log of Establishments in the Zip Code	0.009	0.036	-0.021	0.072
	(0.015)	(0.110)	(0.009)*	(0.056)
Natural Log of Annual Payroll in the Zip Code	-0.016	-0.011	-0.084	0.113
	(0.022)	(0.148)	(0.013)*	(0.073)
Natural Log of Employment in the Zip Code	-0.004	0.054	0.047	-0.183
	(0.030)	(0.201)	(0.017)*	(0.106)
Natural Log of Number of Establishments in the Census Block (D&B)	0.012	-0.026	0.023	0.065
	(0.002)*	(0.026)	(0.003)*	(0.019)*
Natural Log of Establishments (D&B) per Square Mile in the Census Block	-0.007	0.047	-0.029	-0.061
	(0.001)*	(0.019)*	(0.002)*	(0.015)*
Constant	5.513	5.644	6.224	6.505
	(0.089)*	(0.753)*	(0.056)*	(0.311)*
Adjusted R-Squared	0.33	0.26	0.18	0.10
F Statistic	91.00	5.61	135.73	3.99
Observations	1,399,170	120,110	1,399,170	120,110

* $p<0.05$

Clustered standard errors in parentheses allow for correlated error terms within a census block

Table 1.1a: Regression of Log of ILEC DS-1 Price on Competition in the Block including Cable Indicators
Price Cap Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.024	-0.023	-0.024	-0.024
	(0.005)*	(0.005)*	(0.005)*	(0.005)*
Customer is a Telecommunications Provider	-0.195	-0.195	-0.195	-0.195
	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Customer is a Mobile Telecommunications Provider	0.119	0.119	0.119	0.119
	(0.007)*	(0.007)*	(0.007)*	(0.007)*
Customer is a Cable Operator	-0.061	-0.061	-0.061	-0.061
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
Log of Establishments per Square Mile in the Zip Code	0.019	0.019	0.019	0.019
	(0.021)	(0.021)	(0.021)	(0.021)
Log of Employment per Square Mile in the Zip Code	-0.023	-0.023	-0.023	-0.023
	(0.014)	(0.014)	(0.014)	(0.014)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.029	0.029	0.029	0.029
	(0.031)	(0.031)	(0.031)	(0.031)
DOCSIS 3.0 Available in the Census Block		-0.020		
		(0.009)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.004	
			(0.007)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.001
				(0.007)
Constant	5.266	5.285	5.270	5.266
	(0.146)*	(0.146)*	(0.146)*	(0.146)*
Adjusted R-Squared	0.33	0.33	0.33	0.33
F Statistic	166.49	145.69	145.90	146.21
Observations	1,227,540	1,227,540	1,227,540	1,227,540

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.1b: Regression of Log of ILEC DS-1 Price on Competition in the Block including Cable Indicators
Phase I Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.012	-0.011	-0.012	-0.012
	(0.006)	(0.007)	(0.007)	(0.006)
Customer is a Telecommunications Provider	-0.259	-0.259	-0.259	-0.259
	(0.014)*	(0.014)*	(0.014)*	(0.014)*
Customer is a Mobile Telecommunications Provider	0.138	0.138	0.138	0.138
	(0.009)*	(0.009)*	(0.009)*	(0.009)*
Customer is a Cable Operator	-0.053	-0.053	-0.053	-0.053
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Log of Establishments per Square Mile in the Zip Code	0.017	0.017	0.017	0.017
	(0.030)	(0.030)	(0.030)	(0.030)
Log of Employment per Square Mile in the Zip Code	-0.029	-0.030	-0.029	-0.029
	(0.019)	(0.019)	(0.019)	(0.019)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.017	0.016	0.016	0.017
	(0.043)	(0.043)	(0.043)	(0.043)
DOCSIS 3.0 Available in the Census Block		-0.016		
		(0.010)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.005	
			(0.008)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.002
				(0.008)
Constant	5.376	5.392	5.381	5.375
	(0.220)*	(0.219)*	(0.220)*	(0.220)*
Adjusted R-Squared	0.29	0.29	0.29	0.29
F Statistic	142.27	127.21	128.17	129.63
Observations	679,520	679,520	679,520	679,520

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.1c: Regression of Log of ILEC DS-1 Price on Competition in the Block including Cable Indicators
Phase II Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.044	-0.043	-0.043	-0.044
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
Customer is a Telecommunications Provider	-0.087	-0.087	-0.087	-0.087
	(0.016)*	(0.016)*	(0.016)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.098	0.098	0.098	0.098
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.069	-0.069	-0.069	-0.069
	(0.012)*	(0.012)*	(0.012)*	(0.012)*
Log of Establishments per Square Mile in the Zip Code	0.019	0.019	0.019	0.019
	(0.023)	(0.023)	(0.023)	(0.023)
Log of Employment per Square Mile in the Zip Code	-0.013	-0.013	-0.013	-0.013
	(0.018)	(0.018)	(0.018)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.064	0.064	0.064	0.064
	(0.034)	(0.034)	(0.034)	(0.034)
DOCSIS 3.0 Available in the Census Block		-0.026		
		(0.016)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.006	
			(0.014)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.005
				(0.016)
Constant	5.029	5.052	5.034	5.032
	(0.143)*	(0.143)*	(0.142)*	(0.142)*
Adjusted R-Squared	0.38	0.38	0.38	0.38
F Statistic	47.78	42.15	41.94	41.93
Observations	548,020	548,020	548,020	548,020

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.2a: Regression of Log of ILEC DS-1 Price on Competition and Fiber in the Block including Cable Indicators
Price Cap Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.025	-0.024	-0.024	-0.025
	(0.005)*	(0.005)*	(0.005)*	(0.005)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.005	0.007	0.006	0.005
	(0.005)	(0.006)	(0.006)	(0.006)
Customer is a Telecommunications Provider	-0.195	-0.195	-0.195	-0.195
	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Customer is a Mobile Telecommunications Provider	0.119	0.119	0.119	0.119
	(0.007)*	(0.007)*	(0.007)*	(0.007)*
Customer is a Cable Operator	-0.061	-0.061	-0.061	-0.061
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
Log of Establishments per Square Mile in the Zip Code	0.019	0.019	0.019	0.019
	(0.021)	(0.021)	(0.021)	(0.021)
Log of Employment per Square Mile in the Zip Code	-0.023	-0.023	-0.023	-0.023
	(0.014)	(0.014)	(0.014)	(0.014)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.029	0.029	0.029	0.029
	(0.031)	(0.031)	(0.031)	(0.031)
DOCSIS 3.0 Available in the Census Block		-0.021		
		(0.009)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.004	
			(0.007)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.000
				(0.007)
Constant	5.262	5.280	5.266	5.262
	(0.145)*	(0.145)*	(0.145)*	(0.145)*
Adjusted R-Squared	0.33	0.33	0.33	0.33
F Statistic	145.80	129.62	129.81	130.11
Observations	1,227,540	1,227,540	1,227,540	1,227,540

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.2b: Regression of Log of ILEC DS-1 Price on Competition and Fiber in the Block including Cable Indicators
Phase I Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.012	-0.011	-0.012	-0.012
	(0.007)	(0.007)	(0.007)	(0.007)
An Indep. CLEC Has a Fiber Network in the Census Block	0.003	0.005	0.004	0.003
	(0.006)	(0.006)	(0.006)	(0.006)
Customer is a Telecommunications Provider	-0.259	-0.259	-0.259	-0.259
	(0.014)*	(0.014)*	(0.014)*	(0.014)*
Customer is a Mobile Telecommunications Provider	0.138	0.138	0.138	0.138
	(0.009)*	(0.009)*	(0.009)*	(0.009)*
Customer is a Cable Operator	-0.053	-0.053	-0.053	-0.053
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Log of Establishments per Square Mile in the Zip Code	0.017	0.017	0.017	0.017
	(0.030)	(0.030)	(0.030)	(0.030)
Log of Employment per Square Mile in the Zip Code	-0.029	-0.029	-0.029	-0.029
	(0.019)	(0.019)	(0.019)	(0.019)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.017	0.016	0.016	0.017
	(0.043)	(0.043)	(0.043)	(0.043)
DOCSIS 3.0 Available in the Census Block		-0.017		
		(0.011)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.005	
			(0.008)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.002
				(0.008)
Constant	5.374	5.389	5.378	5.373
	(0.219)*	(0.218)*	(0.219)*	(0.219)*
Adjusted R-Squared	0.29	0.29	0.29	0.29
F Statistic	124.50	113.07	113.92	115.22
Observations	679,520	679,520	679,520	679,520

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.2c: Regression of Log of ILEC DS-1 Price on Competition and Fiber in the Block including Cable Indicators
Phase II Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Census Block	-0.045	-0.044	-0.045	-0.045
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.009	0.011	0.010	0.010
	(0.010)	(0.011)	(0.011)	(0.011)
Customer is a Telecommunications Provider	-0.087	-0.087	-0.087	-0.087
	(0.016)*	(0.016)*	(0.016)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.098	0.098	0.098	0.098
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.069	-0.069	-0.069	-0.069
	(0.012)*	(0.012)*	(0.012)*	(0.012)*
Log of Establishments per Square Mile in the Zip Code	0.019	0.019	0.019	0.019
	(0.023)	(0.023)	(0.023)	(0.023)
Log of Employment per Square Mile in the Zip Code	-0.013	-0.013	-0.013	-0.013
	(0.018)	(0.018)	(0.018)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.064	0.064	0.064	0.064
	(0.034)	(0.034)	(0.034)	(0.034)
DOCSIS 3.0 Available in the Census Block		-0.027		
		(0.016)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.006	
			(0.014)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.005
				(0.016)
Constant	5.021	5.043	5.026	5.025
	(0.143)*	(0.143)*	(0.142)*	(0.142)*
Adjusted R-Squared	0.38	0.38	0.38	0.38
F Statistic	42.07	37.61	37.46	37.44
Observations	548,020	548,020	548,020	548,020

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.3a: Regression of Log of ILEC DS-1 Price on Competition in the Building, Block, and Tract including Cable Indicators
Price Cap Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Building	-0.046	-0.046	-0.046	-0.046
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.028	-0.026	-0.027	-0.028
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.036	-0.036	-0.036	-0.036
	(0.009)*	(0.009)*	(0.009)*	(0.009)*
Customer is a Telecommunications Provider	-0.195	-0.195	-0.195	-0.195
	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Customer is a Mobile Telecommunications Provider	0.118	0.118	0.118	0.118
	(0.007)*	(0.007)*	(0.007)*	(0.007)*
Customer is a Cable Operator	-0.061	-0.061	-0.061	-0.061
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
Log of Establishments per Square Mile in the Zip Code	0.021	0.021	0.021	0.021
	(0.021)	(0.021)	(0.021)	(0.021)
Log of Employment per Square Mile in the Zip Code	-0.024	-0.024	-0.024	-0.024
	(0.014)	(0.014)	(0.014)	(0.014)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.034	0.034	0.034	0.034
	(0.031)	(0.031)	(0.031)	(0.031)
DOCSIS 3.0 Available in the Census Block		-0.019		
		(0.009)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.004	
			(0.007)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.001
				(0.007)
Constant	5.284	5.302	5.287	5.283
	(0.150)*	(0.150)*	(0.150)*	(0.150)*
Adjusted R-Squared	0.33	0.33	0.33	0.33
F Statistic	138.26	124.43	124.44	124.44
Observations	1,227,540	1,227,540	1,227,540	1,227,540

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.3b: Regression of Log of ILEC DS-1 Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase I Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Building	-0.036	-0.036	-0.036	-0.036
	(0.009)*	(0.009)*	(0.009)*	(0.009)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.024	-0.023	-0.024	-0.024
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.035	-0.035	-0.035	-0.035
	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Customer is a Telecommunications Provider	-0.260	-0.260	-0.260	-0.260
	(0.014)*	(0.014)*	(0.014)*	(0.014)*
Customer is a Mobile Telecommunications Provider	0.138	0.138	0.138	0.138
	(0.009)*	(0.009)*	(0.009)*	(0.009)*
Customer is a Cable Operator	-0.054	-0.054	-0.054	-0.054
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Log of Establishments per Square Mile in the Zip Code	0.020	0.020	0.020	0.019
	(0.030)	(0.030)	(0.030)	(0.030)
Log of Employment per Square Mile in the Zip Code	-0.030	-0.030	-0.030	-0.030
	(0.019)	(0.019)	(0.019)	(0.019)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.022	0.022	0.022	0.022
	(0.044)	(0.044)	(0.044)	(0.044)
DOCSIS 3.0 Available in the Census Block		-0.013		
		(0.010)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.004	
			(0.008)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.003
				(0.008)
Constant	5.392	5.405	5.395	5.389
	(0.227)*	(0.227)*	(0.227)*	(0.228)*
Adjusted R-Squared	0.29	0.29	0.29	0.29
F Statistic	122.73	110.78	110.92	111.85
Observations	679,520	679,520	679,520	679,520

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 1.3c: Regression of Log of ILEC DS-1 Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase II Areas

	DS-1	DS-1	DS-1	DS-1
A Facilities-based Competitor is in the Building	-0.064	-0.064	-0.064	-0.064
	(0.013)*	(0.013)*	(0.013)*	(0.013)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.032	-0.031	-0.032	-0.032
	(0.011)*	(0.011)*	(0.011)*	(0.012)*
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.038	-0.037	-0.038	-0.038
	(0.015)*	(0.015)*	(0.015)*	(0.015)*
Customer is a Telecommunications Provider	-0.087	-0.087	-0.087	-0.087
	(0.016)*	(0.016)*	(0.016)*	(0.016)*
Customer is a Mobile Telecommunications Provider	0.098	0.098	0.098	0.098
	(0.010)*	(0.010)*	(0.010)*	(0.010)*
Customer is a Cable Operator	-0.069	-0.069	-0.069	-0.069
	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Log of Establishments per Square Mile in the Zip Code	0.020	0.020	0.020	0.020
	(0.023)	(0.023)	(0.023)	(0.023)
Log of Employment per Square Mile in the Zip Code	-0.014	-0.013	-0.014	-0.014
	(0.018)	(0.018)	(0.018)	(0.018)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.068	0.067	0.068	0.068
	(0.034)*	(0.034)*	(0.034)*	(0.034)*
DOCSIS 3.0 Available in the Census Block		-0.028		
		(0.016)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.007	
			(0.014)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.006
				(0.016)
Constant	5.051	5.075	5.057	5.055
	(0.142)*	(0.141)*	(0.140)*	(0.140)*
Adjusted R-Squared	0.38	0.38	0.38	0.38
F Statistic	39.12	35.82	35.57	35.55
Observations	548,020	548,020	548,020	548,020

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.1a: Regression of Log of ILEC DS-3 Price on Competition in the Block including Cable Indicators
Price Cap Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.101	-0.088	-0.096	-0.104
	(0.044)*	(0.045)*	(0.045)*	(0.045)*
Customer is a Telecommunications Provider	-0.002	-0.002	-0.002	-0.001
	(0.044)	(0.044)	(0.044)	(0.044)
Customer is a Mobile Telecommunications Provider	0.229	0.229	0.229	0.229
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Customer is a Cable Operator	-0.083	-0.082	-0.083	-0.083
	(0.047)	(0.047)	(0.047)	(0.047)
Log of Establishments per Square Mile in the Zip Code	0.095	0.092	0.096	0.094
	(0.096)	(0.097)	(0.096)	(0.095)
Log of Employment per Square Mile in the Zip Code	0.049	0.048	0.046	0.050
	(0.081)	(0.082)	(0.081)	(0.080)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.282	0.279	0.280	0.282
	(0.136)*	(0.137)*	(0.136)*	(0.135)*
DOCSIS 3.0 Available in the Census Block		-0.195		
		(0.128)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.086	
			(0.115)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.040
				(0.062)
Constant	4.449	4.646	4.534	4.420
	(0.637)*	(0.652)*	(0.649)*	(0.639)*
Adjusted R-Squared	0.26	0.26	0.26	0.26
F Statistic	7.21	6.39	6.31	6.32
Observations	110,905	110,905	110,905	110,905

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.1b: Regression of Log of ILEC DS-3 Price on Competition in the Block including Cable Indicators
Phase I Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.028	0.012	-0.008	-0.026
	(0.063)	(0.065)	(0.064)	(0.063)
Customer is a Telecommunications Provider	-0.034	-0.037	-0.039	-0.034
	(0.064)	(0.064)	(0.064)	(0.064)
Customer is a Mobile Telecommunications Provider	0.248	0.247	0.248	0.248
	(0.058)*	(0.059)*	(0.058)*	(0.058)*
Customer is a Cable Operator	-0.116	-0.113	-0.115	-0.117
	(0.077)	(0.076)	(0.077)	(0.077)
Log of Establishments per Square Mile in the Zip Code	0.127	0.133	0.137	0.129
	(0.161)	(0.169)	(0.166)	(0.162)
Log of Employment per Square Mile in the Zip Code	0.003	-0.017	-0.015	0.000
	(0.147)	(0.157)	(0.153)	(0.148)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.557	0.577	0.578	0.560
	(0.196)*	(0.201)*	(0.198)*	(0.196)*
DOCSIS 3.0 Available in the Census Block		-0.422		
		(0.181)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.270	
			(0.186)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.027
				(0.089)
Constant	3.384	3.779	3.583	3.396
	(0.808)*	(0.842)*	(0.828)*	(0.813)*
Adjusted R-Squared	0.24	0.25	0.25	0.24
F Statistic	5.85	5.55	5.24	5.20
Observations	58,790	58,790	58,790	58,790

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.1c: Regression of Log of ILEC DS-3 Price on Competition in the Block including Cable Indicators
Phase II Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.209	-0.216	-0.215	-0.216
	(0.056)*	(0.057)*	(0.057)*	(0.057)*
Customer is a Telecommunications Provider	0.086	0.086	0.086	0.086
	(0.059)	(0.059)	(0.059)	(0.059)
Customer is a Mobile Telecommunications Provider	0.223	0.221	0.222	0.222
	(0.100)*	(0.100)*	(0.100)*	(0.100)*
Customer is a Cable Operator	-0.036	-0.035	-0.035	-0.035
	(0.045)	(0.045)	(0.045)	(0.045)
Log of Establishments per Square Mile in the Zip Code	-0.108	-0.102	-0.104	-0.104
	(0.090)	(0.088)	(0.089)	(0.090)
Log of Employment per Square Mile in the Zip Code	0.156	0.150	0.153	0.154
	(0.078)*	(0.077)	(0.078)*	(0.078)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	-0.069	-0.056	-0.050	-0.053
	(0.171)	(0.168)	(0.170)	(0.170)
DOCSIS 3.0 Available in the Census Block		0.164		
		(0.092)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			0.130	
			(0.080)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.110
				(0.082)
Constant	6.171	5.987	5.993	6.031
	(0.592)*	(0.580)*	(0.589)*	(0.590)*
Adjusted R-Squared	0.27	0.27	0.27	0.27
F Statistic	3.88	3.89	3.81	3.66
Observations	52,115	52,115	52,115	52,115

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.2a: Regression of Log of ILEC DS-3 Price on Competition and Fiber in the Block including Cable Indicators
Price Cap Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.095	-0.084	-0.091	-0.097
	(0.045)*	(0.046)	(0.046)*	(0.046)*
An Indep. CLEC Has a Fiber Network in the Census Block	-0.080	-0.057	-0.069	-0.086
	(0.054)	(0.056)	(0.055)	(0.054)
Customer is a Telecommunications Provider	-0.002	-0.002	-0.002	-0.001
	(0.044)	(0.044)	(0.044)	(0.044)
Customer is a Mobile Telecommunications Provider	0.229	0.229	0.229	0.229
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Customer is a Cable Operator	-0.083	-0.082	-0.083	-0.083
	(0.047)	(0.047)	(0.047)	(0.047)
Log of Establishments per Square Mile in the Zip Code	0.095	0.092	0.096	0.093
	(0.096)	(0.097)	(0.096)	(0.095)
Log of Employment per Square Mile in the Zip Code	0.048	0.047	0.046	0.050
	(0.081)	(0.082)	(0.081)	(0.080)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.283	0.280	0.281	0.283
	(0.135)*	(0.137)*	(0.136)*	(0.135)*
DOCSIS 3.0 Available in the Census Block		-0.192		
		(0.128)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.083	
			(0.116)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.043
				(0.063)
Constant	4.521	4.695	4.594	4.494
	(0.631)*	(0.645)*	(0.641)*	(0.633)*
Adjusted R-Squared	0.26	0.26	0.26	0.26
F Statistic	6.66	5.99	5.92	5.93
Observations	110,905	110,905	110,905	110,905

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.2b: Regression of Log of ILEC DS-3 Price on Competition and Fiber in the Block including Cable Indicators
Phase I Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.017	0.017	-0.001	-0.016
	(0.064)	(0.065)	(0.065)	(0.065)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.159	-0.090	-0.114	-0.156
	(0.082)	(0.087)	(0.085)	(0.082)
Customer is a Telecommunications Provider	-0.034	-0.037	-0.039	-0.034
	(0.064)	(0.064)	(0.064)	(0.064)
Customer is a Mobile Telecommunications Provider	0.249	0.247	0.248	0.249
	(0.058)*	(0.059)*	(0.059)*	(0.058)*
Customer is a Cable Operator	-0.116	-0.113	-0.115	-0.116
	(0.077)	(0.076)	(0.077)	(0.077)
Log of Establishments per Square Mile in the Zip Code	0.125	0.132	0.136	0.127
	(0.161)	(0.169)	(0.166)	(0.162)
Log of Employment per Square Mile in the Zip Code	0.002	-0.018	-0.015	0.000
	(0.147)	(0.157)	(0.153)	(0.148)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.562	0.580	0.582	0.564
	(0.196)*	(0.201)*	(0.198)*	(0.195)*
DOCSIS 3.0 Available in the Census Block		-0.417		
		(0.182)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.265	
			(0.187)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.020
				(0.089)
Constant	3.520	3.851	3.677	3.526
	(0.801)*	(0.831)*	(0.817)*	(0.804)*
Adjusted R-Squared	0.24	0.25	0.25	0.24
F Statistic	5.48	5.22	4.97	4.92
Observations	58,790	58,790	58,790	58,790

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.2c: Regression of Log of ILEC DS-3 Price on Competition and Fiber in the Block including Cable Indicators
Phase II Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Census Block	-0.210	-0.215	-0.214	-0.215
	(0.058)*	(0.058)*	(0.058)*	(0.058)*
An Indep. CLEC Has a Fiber Network in the Census Block	0.006	-0.007	-0.005	-0.004
	(0.070)	(0.071)	(0.071)	(0.071)
Customer is a Telecommunications Provider	0.086	0.086	0.086	0.086
	(0.059)	(0.059)	(0.059)	(0.059)
Customer is a Mobile Telecommunications Provider	0.223	0.221	0.222	0.222
	(0.100)*	(0.100)*	(0.100)*	(0.100)*
Customer is a Cable Operator	-0.036	-0.035	-0.035	-0.035
	(0.045)	(0.045)	(0.045)	(0.045)
Log of Establishments per Square Mile in the Zip Code	-0.108	-0.102	-0.104	-0.104
	(0.090)	(0.088)	(0.090)	(0.090)
Log of Employment per Square Mile in the Zip Code	0.156	0.150	0.153	0.154
	(0.078)*	(0.077)	(0.078)*	(0.078)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	-0.069	-0.056	-0.050	-0.053
	(0.171)	(0.168)	(0.170)	(0.170)
DOCSIS 3.0 Available in the Census Block		0.165		
		(0.093)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			0.130	
			(0.080)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.110
				(0.083)
Constant	6.165	5.993	5.998	6.034
	(0.594)*	(0.581)*	(0.590)*	(0.591)*
Adjusted R-Squared	0.27	0.27	0.27	0.27
F Statistic	3.43	3.48	3.42	3.29
Observations	52,115	52,115	52,115	52,115

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.3a: Regression of Log of ILEC DS-3 Price on Competition in the Building, Block, and Tract including Cable Indicators
Price Cap Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Building	-0.081	-0.080	-0.082	-0.081
	(0.052)	(0.052)	(0.052)	(0.052)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.105	-0.087	-0.098	-0.108
	(0.068)	(0.059)	(0.061)	(0.068)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.203	-0.204	-0.204	-0.202
	(0.087)*	(0.086)*	(0.087)*	(0.087)*
Customer is a Telecommunications Provider	-0.003	-0.003	-0.004	-0.003
	(0.045)	(0.044)	(0.044)	(0.045)
Customer is a Mobile Telecommunications Provider	0.227	0.228	0.228	0.227
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Customer is a Cable Operator	-0.081	-0.081	-0.081	-0.081
	(0.047)	(0.047)	(0.047)	(0.047)
Log of Establishments per Square Mile in the Zip Code	0.107	0.104	0.108	0.106
	(0.096)	(0.097)	(0.096)	(0.095)
Log of Employment per Square Mile in the Zip Code	0.045	0.045	0.043	0.047
	(0.082)	(0.083)	(0.082)	(0.081)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.302	0.295	0.299	0.302
	(0.138)*	(0.139)*	(0.138)*	(0.138)*
DOCSIS 3.0 Available in the Census Block		-0.185		
		(0.116)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.079	
			(0.106)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.041
				(0.062)
Constant	4.535	4.738	4.619	4.503
	(0.665)*	(0.673)*	(0.671)*	(0.667)*
Adjusted R-Squared	0.26	0.26	0.26	0.26
F Statistic	4.98	4.52	4.56	4.50
Observations	110,905	110,905	110,905	110,905

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.3b: Regression of Log of ILEC DS-3 Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase I Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Building	-0.045	-0.029	-0.040	-0.045
	(0.081)	(0.081)	(0.081)	(0.081)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.127	-0.072	-0.100	-0.126
	(0.100)	(0.076)	(0.081)	(0.100)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.273	-0.266	-0.267	-0.273
	(0.125)*	(0.120)*	(0.122)*	(0.125)*
Customer is a Telecommunications Provider	-0.040	-0.041	-0.044	-0.040
	(0.064)	(0.064)	(0.064)	(0.064)
Customer is a Mobile Telecommunications Provider	0.246	0.245	0.246	0.246
	(0.059)*	(0.059)*	(0.059)*	(0.059)*
Customer is a Cable Operator	-0.114	-0.112	-0.114	-0.114
	(0.077)	(0.076)	(0.076)	(0.077)
Log of Establishments per Square Mile in the Zip Code	0.151	0.152	0.158	0.153
	(0.161)	(0.169)	(0.166)	(0.162)
Log of Employment per Square Mile in the Zip Code	0.004	-0.015	-0.012	0.002
	(0.149)	(0.158)	(0.154)	(0.150)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.569	0.579	0.585	0.571
	(0.200)*	(0.204)*	(0.202)*	(0.200)*
DOCSIS 3.0 Available in the Census Block		-0.398		
		(0.162)*		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.248	
			(0.167)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.015
				(0.088)
Constant	3.516	3.928	3.713	3.523
	(0.859)*	(0.877)*	(0.867)*	(0.862)*
Adjusted R-Squared	0.25	0.25	0.25	0.25
F Statistic	4.73	4.56	4.29	4.28
Observations	58,790	58,790	58,790	58,790

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 2.3c: Regression of Log of ILEC DS-3 Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase II Areas

	DS-3	DS-3	DS-3	DS-3
A Facilities-based Competitor is in the Building	-0.150	-0.146	-0.146	-0.148
	(0.059)*	(0.059)*	(0.059)*	(0.059)*
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.098	-0.105	-0.106	-0.105
	(0.079)	(0.079)	(0.080)	(0.080)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.174	-0.169	-0.168	-0.170
	(0.117)	(0.117)	(0.117)	(0.117)
Customer is a Telecommunications Provider	0.088	0.088	0.088	0.088
	(0.059)	(0.059)	(0.059)	(0.059)
Customer is a Mobile Telecommunications Provider	0.224	0.223	0.223	0.224
	(0.100)*	(0.100)*	(0.100)*	(0.100)*
Customer is a Cable Operator	-0.033	-0.033	-0.033	-0.033
	(0.046)	(0.046)	(0.046)	(0.046)
Log of Establishments per Square Mile in the Zip Code	-0.107	-0.102	-0.103	-0.104
	(0.090)	(0.089)	(0.090)	(0.090)
Log of Employment per Square Mile in the Zip Code	0.146	0.141	0.144	0.144
	(0.078)	(0.078)	(0.078)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	-0.041	-0.029	-0.022	-0.026
	(0.175)	(0.173)	(0.175)	(0.175)
DOCSIS 3.0 Available in the Census Block		0.142		
		(0.092)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			0.115	
			(0.081)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				0.093
				(0.083)
Constant	6.251	6.081	6.081	6.123
	(0.633)*	(0.624)*	(0.633)*	(0.634)*
Adjusted R-Squared	0.27	0.27	0.27	0.27
F Statistic	2.20	2.27	2.19	2.09
Observations	52,115	52,115	52,115	52,115

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.1a: Regression of Log of ILEC High Bandwidth Price on Competition in the Block including Cable Indicators
Price Cap Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	0.015	0.020	0.020	0.020
	(0.027)	(0.027)	(0.027)	(0.027)
Customer is a Telecommunications Provider	0.159	0.159	0.159	0.159
	(0.054)*	(0.054)*	(0.054)*	(0.054)*
Customer is a Mobile Telecommunications Provider	-0.181	-0.181	-0.181	-0.181
	(0.116)	(0.116)	(0.116)	(0.116)
Customer is a Cable Operator	-0.237	-0.236	-0.235	-0.235
	(0.209)	(0.209)	(0.209)	(0.209)
Log of Establishments per Square Mile in the Zip Code	-0.213	-0.214	-0.211	-0.209
	(0.086)*	(0.087)*	(0.087)*	(0.087)*
Log of Employment per Square Mile in the Zip Code	0.152	0.153	0.151	0.150
	(0.078)	(0.078)*	(0.078)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.044	0.041	0.045	0.045
	(0.116)	(0.116)	(0.116)	(0.115)
Natural Log of Mbps	0.279	0.279	0.279	0.279
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Packet-based Connection	-0.090	-0.089	-0.089	-0.090
	(0.071)	(0.071)	(0.071)	(0.071)
DOCSIS 3.0 Available in the Census Block		-0.078		
		(0.049)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.067	
			(0.031)*	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.064
				(0.031)*
Constant	5.418	5.489	5.456	5.441
	(0.539)*	(0.546)*	(0.544)*	(0.542)*
Adjusted R-Squared	0.43	0.43	0.43	0.43
F Statistic	16.18	15.20	15.84	15.81
Observations	69,960	69,960	69,960	69,960

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.1b: Regression of Log of ILEC High Bandwidth Price on Competition in the Block including Cable Indicators
Phase I Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	0.003	0.013	0.010	0.010
	(0.037)	(0.036)	(0.037)	(0.037)
Customer is a Telecommunications Provider	0.005	0.004	0.005	0.005
	(0.056)	(0.056)	(0.056)	(0.056)
Customer is a Mobile Telecommunications Provider	-0.132	-0.132	-0.132	-0.132
	(0.148)	(0.148)	(0.148)	(0.148)
Customer is a Cable Operator	-0.117	-0.116	-0.116	-0.116
	(0.250)	(0.250)	(0.250)	(0.250)
Log of Establishments per Square Mile in the Zip Code	-0.297	-0.298	-0.294	-0.292
	(0.109)*	(0.110)*	(0.110)*	(0.110)*
Log of Employment per Square Mile in the Zip Code	0.221	0.221	0.219	0.219
	(0.097)*	(0.098)*	(0.098)*	(0.098)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.007	0.005	0.008	0.009
	(0.168)	(0.168)	(0.168)	(0.168)
Natural Log of Mbps	0.236	0.237	0.236	0.237
	(0.074)*	(0.074)*	(0.074)*	(0.074)*
Packet-based Connection	-0.020	-0.018	-0.018	-0.019
	(0.077)	(0.077)	(0.077)	(0.077)
DOCSIS 3.0 Available in the Census Block		-0.103		
		(0.060)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.065	
			(0.038)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.059
				(0.038)
Constant	5.647	5.750	5.686	5.666
	(0.734)*	(0.732)*	(0.735)*	(0.734)*
Adjusted R-Squared	0.41	0.41	0.41	0.41
F Statistic	11.53	11.20	11.20	11.05
Observations	48,499	48,499	48,499	48,499

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.1c: Regression of Log of ILEC High Bandwidth Price on Competition in the Block including Cable Indicators
Phase II Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	-0.002	-0.002	-0.001	-0.001
	(0.036)	(0.037)	(0.036)	(0.036)
Customer is a Telecommunications Provider	0.497	0.497	0.496	0.496
	(0.090)*	(0.090)*	(0.090)*	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.324	-0.324	-0.324	-0.324
	(0.058)*	(0.058)*	(0.058)*	(0.058)*
Customer is a Cable Operator	-0.679	-0.678	-0.678	-0.678
	(0.323)*	(0.323)*	(0.323)*	(0.323)*
Log of Establishments per Square Mile in the Zip Code	-0.039	-0.039	-0.038	-0.038
	(0.150)	(0.149)	(0.149)	(0.149)
Log of Employment per Square Mile in the Zip Code	0.032	0.032	0.032	0.032
	(0.138)	(0.137)	(0.138)	(0.138)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.113	0.113	0.114	0.113
	(0.165)	(0.166)	(0.166)	(0.166)
Natural Log of Mbps	0.397	0.397	0.397	0.397
	(0.021)*	(0.021)*	(0.021)*	(0.021)*
Packet-based Connection	-0.217	-0.218	-0.217	-0.217
	(0.164)	(0.164)	(0.164)	(0.164)
DOCSIS 3.0 Available in the Census Block		0.017		
		(0.076)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.027	
			(0.057)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.019
				(0.056)
Constant	4.680	4.667	4.695	4.689
	(0.585)*	(0.610)*	(0.604)*	(0.601)*
Adjusted R-Squared	0.48	0.48	0.48	0.48
F Statistic	79.20	71.30	72.84	73.16
Observations	21,461	21,461	21,461	21,461

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.2a: Regression of Log of ILEC High Bandwidth Price on Competition and Fiber in the Block including Cable Indicators
Price Cap Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	0.019	0.024	0.024	0.024
	(0.028)	(0.028)	(0.028)	(0.028)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.054	-0.050	-0.050	-0.050
	(0.037)	(0.037)	(0.037)	(0.037)
Customer is a Telecommunications Provider	0.160	0.159	0.159	0.160
	(0.054)*	(0.054)*	(0.054)*	(0.054)*
Customer is a Mobile Telecommunications Provider	-0.181	-0.181	-0.181	-0.180
	(0.116)	(0.116)	(0.116)	(0.116)
Customer is a Cable Operator	-0.236	-0.235	-0.234	-0.234
	(0.209)	(0.209)	(0.209)	(0.209)
Log of Establishments per Square Mile in the Zip Code	-0.213	-0.214	-0.211	-0.209
	(0.086)*	(0.087)*	(0.087)*	(0.087)*
Log of Employment per Square Mile in the Zip Code	0.152	0.153	0.151	0.151
	(0.078)	(0.078)*	(0.078)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.043	0.040	0.044	0.044
	(0.116)	(0.116)	(0.116)	(0.116)
Natural Log of Mbps	0.279	0.279	0.279	0.279
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Packet-based Connection	-0.090	-0.089	-0.089	-0.089
	(0.071)	(0.071)	(0.071)	(0.071)
DOCSIS 3.0 Available in the Census Block		-0.076		
		(0.049)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.066	
			(0.031)*	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.062
				(0.031)*
Constant	5.467	5.532	5.500	5.486
	(0.542)*	(0.548)*	(0.546)*	(0.545)*
Adjusted R-Squared	0.43	0.43	0.43	0.43
F Statistic	14.82	14.07	14.62	14.60
Observations	69,960	69,960	69,960	69,960

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.2b: Regression of Log of ILEC High Bandwidth Price on Competition and Fiber in the Block including Cable Indicators
Phase I Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	0.005	0.013	0.011	0.011
	(0.037)	(0.037)	(0.037)	(0.037)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.017	-0.008	-0.011	-0.012
	(0.058)	(0.059)	(0.059)	(0.059)
Customer is a Telecommunications Provider	0.005	0.005	0.005	0.005
	(0.056)	(0.056)	(0.056)	(0.056)
Customer is a Mobile Telecommunications Provider	-0.132	-0.132	-0.132	-0.132
	(0.148)	(0.148)	(0.148)	(0.148)
Customer is a Cable Operator	-0.117	-0.116	-0.115	-0.116
	(0.250)	(0.250)	(0.250)	(0.250)
Log of Establishments per Square Mile in the Zip Code	-0.296	-0.298	-0.294	-0.292
	(0.109)*	(0.110)*	(0.110)*	(0.110)*
Log of Employment per Square Mile in the Zip Code	0.221	0.221	0.219	0.219
	(0.097)*	(0.098)*	(0.098)*	(0.098)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.008	0.006	0.008	0.009
	(0.168)	(0.168)	(0.168)	(0.168)
Natural Log of Mbps	0.236	0.237	0.237	0.237
	(0.074)*	(0.074)*	(0.074)*	(0.074)*
Packet-based Connection	-0.020	-0.018	-0.018	-0.019
	(0.077)	(0.077)	(0.077)	(0.077)
DOCSIS 3.0 Available in the Census Block		-0.103		
		(0.061)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.065	
			(0.038)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.058
				(0.038)
Constant	5.660	5.756	5.695	5.676
	(0.736)*	(0.734)*	(0.737)*	(0.736)*
Adjusted R-Squared	0.41	0.41	0.41	0.41
F Statistic	10.38	10.18	10.18	10.05
Observations	48,499	48,499	48,499	48,499

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.2c: Regression of Log of ILEC High Bandwidth Price on Competition and Fiber in the Block including Cable Indicators
Phase II Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Census Block	0.007	0.007	0.008	0.008
	(0.037)	(0.037)	(0.037)	(0.037)
An Indep. CLEC Has a Fiber Network in the Census Block	-0.082	-0.083	-0.081	-0.082
	(0.044)	(0.044)	(0.044)	(0.044)
Customer is a Telecommunications Provider	0.498	0.498	0.497	0.497
	(0.090)*	(0.090)*	(0.090)*	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.324	-0.324	-0.324	-0.324
	(0.058)*	(0.058)*	(0.058)*	(0.058)*
Customer is a Cable Operator	-0.673	-0.673	-0.673	-0.673
	(0.324)*	(0.324)*	(0.324)*	(0.324)*
Log of Establishments per Square Mile in the Zip Code	-0.043	-0.043	-0.042	-0.042
	(0.151)	(0.151)	(0.151)	(0.151)
Log of Employment per Square Mile in the Zip Code	0.036	0.036	0.036	0.036
	(0.139)	(0.139)	(0.140)	(0.140)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.106	0.107	0.107	0.106
	(0.167)	(0.168)	(0.167)	(0.168)
Natural Log of Mbps	0.397	0.397	0.397	0.397
	(0.021)*	(0.021)*	(0.021)*	(0.021)*
Packet-based Connection	-0.216	-0.216	-0.216	-0.216
	(0.164)	(0.164)	(0.164)	(0.164)
DOCSIS 3.0 Available in the Census Block		0.020		
		(0.076)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.025	
			(0.057)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.016
				(0.056)
Constant	4.760	4.745	4.772	4.767
	(0.589)*	(0.611)*	(0.606)*	(0.603)*
Adjusted R-Squared	0.48	0.48	0.48	0.48
F Statistic	71.84	65.32	66.76	67.08
Observations	21,461	21,461	21,461	21,461

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.3a: Regression of Log of ILEC High Bandwidth Price on Competition in the Building, Block, and Tract including Cable Indicators
Price Cap Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Building	-0.004	-0.002	-0.004	-0.003
	(0.033)	(0.033)	(0.033)	(0.033)
At Least One Facilities-based Competitor is in the Block But Not the Building	0.015	0.020	0.020	0.019
	(0.028)	(0.028)	(0.028)	(0.028)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.060	-0.058	-0.062	-0.062
	(0.037)	(0.037)	(0.037)	(0.037)
Customer is a Telecommunications Provider	0.159	0.159	0.159	0.159
	(0.054)*	(0.054)*	(0.054)*	(0.054)*
Customer is a Mobile Telecommunications Provider	-0.181	-0.181	-0.181	-0.181
	(0.116)	(0.116)	(0.116)	(0.116)
Customer is a Cable Operator	-0.236	-0.235	-0.234	-0.235
	(0.209)	(0.209)	(0.209)	(0.209)
Log of Establishments per Square Mile in the Zip Code	-0.214	-0.215	-0.212	-0.210
	(0.086)*	(0.086)*	(0.086)*	(0.087)*
Log of Employment per Square Mile in the Zip Code	0.153	0.154	0.152	0.152
	(0.078)*	(0.078)*	(0.078)	(0.078)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.043	0.039	0.043	0.043
	(0.115)	(0.115)	(0.115)	(0.115)
Natural Log of Mbps	0.279	0.279	0.279	0.279
	(0.055)*	(0.055)*	(0.055)*	(0.055)*
Packet-based Connection	-0.090	-0.090	-0.090	-0.090
	(0.071)	(0.071)	(0.071)	(0.071)
DOCSIS 3.0 Available in the Census Block		-0.079		
		(0.049)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.069	
			(0.031)*	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.065
				(0.031)*
Constant	5.475	5.548	5.518	5.502
	(0.542)*	(0.549)*	(0.548)*	(0.546)*
Adjusted R-Squared	0.43	0.43	0.43	0.43
F Statistic	14.03	13.57	13.98	13.93
Observations	69,960	69,960	69,960	69,960

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.3b: Regression of Log of ILEC High Bandwidth Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase I Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Building	-0.002	0.004	0.000	0.000
	(0.044)	(0.044)	(0.044)	(0.044)
At Least One Facilities-based Competitor is in the Block But Not the Building	-0.013	-0.005	-0.007	-0.008
	(0.034)	(0.034)	(0.034)	(0.034)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.078	-0.074	-0.079	-0.079
	(0.053)	(0.053)	(0.053)	(0.053)
Customer is a Telecommunications Provider	0.005	0.005	0.005	0.005
	(0.056)	(0.056)	(0.056)	(0.056)
Customer is a Mobile Telecommunications Provider	-0.132	-0.132	-0.132	-0.132
	(0.148)	(0.148)	(0.148)	(0.148)
Customer is a Cable Operator	-0.117	-0.115	-0.115	-0.115
	(0.250)	(0.250)	(0.250)	(0.250)
Log of Establishments per Square Mile in the Zip Code	-0.296	-0.298	-0.294	-0.292
	(0.108)*	(0.109)*	(0.109)*	(0.109)*
Log of Employment per Square Mile in the Zip Code	0.221	0.222	0.220	0.220
	(0.097)*	(0.098)*	(0.098)*	(0.098)*
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.012	0.007	0.011	0.012
	(0.169)	(0.168)	(0.168)	(0.168)
Natural Log of Mbps	0.236	0.237	0.236	0.236
	(0.074)*	(0.074)*	(0.074)*	(0.074)*
Packet-based Connection	-0.020	-0.018	-0.019	-0.019
	(0.077)	(0.077)	(0.077)	(0.077)
DOCSIS 3.0 Available in the Census Block		-0.101		
		(0.061)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.064	
			(0.038)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.058
				(0.038)
Constant	5.702	5.804	5.744	5.725
	(0.742)*	(0.739)*	(0.743)*	(0.742)*
Adjusted R-Squared	0.41	0.41	0.41	0.41
F Statistic	9.78	9.67	9.63	9.55
Observations	48,499	48,499	48,499	48,499

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects

Table 3.3c: Regression of Log of ILEC High Bandwidth Price on Competition in the Building, Block, and Tract including Cable Indicators
Phase II Areas

	High Band	High Band	High Band	High Band
A Facilities-based Competitor is in the Building	-0.058	-0.058	-0.059	-0.059
	(0.043)	(0.043)	(0.043)	(0.043)
At Least One Facilities-based Competitor is in the Block But Not the Building	0.044	0.043	0.044	0.044
	(0.044)	(0.044)	(0.044)	(0.044)
At Least One Facilities-based Competitor is in the Tract But Not the Block	-0.039	-0.039	-0.040	-0.040
	(0.051)	(0.051)	(0.051)	(0.051)
Customer is a Telecommunications Provider	0.496	0.497	0.496	0.496
	(0.090)*	(0.090)*	(0.090)*	(0.090)*
Customer is a Mobile Telecommunications Provider	-0.325	-0.325	-0.325	-0.325
	(0.058)*	(0.058)*	(0.058)*	(0.058)*
Customer is a Cable Operator	-0.679	-0.679	-0.679	-0.679
	(0.324)*	(0.324)*	(0.324)*	(0.324)*
Log of Establishments per Square Mile in the Zip Code	-0.033	-0.033	-0.032	-0.032
	(0.148)	(0.148)	(0.148)	(0.148)
Log of Employment per Square Mile in the Zip Code	0.029	0.029	0.029	0.029
	(0.136)	(0.136)	(0.136)	(0.136)
Log of Average Annual Wage ($1,000) of Employees in the Zip Code	0.109	0.110	0.110	0.109
	(0.165)	(0.165)	(0.165)	(0.165)
Natural Log of Mbps	0.398	0.398	0.398	0.398
	(0.021)*	(0.021)*	(0.021)*	(0.021)*
Packet-based Connection	-0.219	-0.219	-0.219	-0.219
	(0.164)	(0.164)	(0.164)	(0.164)
DOCSIS 3.0 Available in the Census Block		0.012		
		(0.077)		
Metro Ethernet Cable Headend serves the Census Block (Expansive Definition)			-0.033	
			(0.058)	
Metro Ethernet Cable Headend serves the Census Block (Narrow Definition)				-0.025
				(0.057)
Constant	4.720	4.711	4.741	4.735
	(0.594)*	(0.621)*	(0.616)*	(0.614)*
Adjusted R-Squared	0.48	0.48	0.48	0.48
F Statistic	66.32	60.85	61.84	61.95
Observations	21,461	21,461	21,461	21,461

* $p<0.05$
Standard errors in parentheses allow for correlated error terms within a census block
Census Tract Fixed Effects