2016 NCTA INTX
Academic Workshop
May 16th & 17th

Workshop Participants

Yochai Benkler, Professor of Law, Harvard University
Babette E. Boliek, Associate Professor, Pepperdine University School of Law
Adam Candeub, Professor, Michigan State University College of Law
David Clark, Professor, Massachusetts Institute of Technology
Stacey Dogan, Professor, Boston University School of Law
Carolyn Gideon, Assistant Professor of International Communication and Technology Policy and Director of Hitachi Center for Technology and International Affairs, The Fletcher School, Tufts University
Ray Gifford, Senior Fellow, Silicon Flatirons, University of Colorado
Shane Greenstein, Professor, Harvard Business School
Christiaan Hogendorn, Associate Professor of Economics, Wesleyan University
John B. Horrigan, Senior Researcher, Pew Research Center
Gus Hurwitz, Assistant Professor, University of Nebraska College of Law
Roslyn Layton, PhD Fellow, Aalborg University
William Lehr, Research Scientist/CSAIL, Massachusetts Institute of Technology
Daniel Lyons, Associate Professor, Boston College Law School
John Mayo, Professor of Economics, Business and Public Policy, Georgetown University
Gabor Molnar, Senior Fellow, Silicon Flatirons, University of Colorado
David Reed, Senior Fellow, Silicon Flatirons, University of Colorado
Taylor Reynolds, Technology Policy Director, MIT Computer Science and Artificial Intelligence Lab
William Rogerson, Charles E. and Emma H. Morrison Professor of Market Economics, Northwestern University
Marc Rysman, Professor of Economics, Boston University
Andy Sellars, Director, BU/MIT Technology & Cyberlaw Clinic
Olivier Sylvain, Associate Professor, Fordham Law School
Nicol Turner-Lee, Vice President and Chief Research & Policy Officer, Multicultural Media, Telecom and Internet Council (MMTC)
Scott Wallsten, Vice President for Research and Senior Fellow, Tech Policy Institute
Phil Weiser, Executive Director, Silicon Flatirons; Dean,University of Colorado Law School
Kevin Werbach, Associate Professor of Legal Studies and Business Ethics, The Wharton School, University of Pennsylvania
Christopher S. Yoo, John H. Chestnut Professor of Law, Communication, and Computer & Information Science, University of Pennsylvania
Ali Yurukoglu, Associate Professor, Stanford Graduate School of Business

Industry Guests

James Assey, Executive Vice President, NCTA
Rudy Brioché, VP, Global Public Policy & Policy Counsel, Comcast Cable
Elizabeth Chernow, Comcast Cable
Rick Cimerman, VP External & State Affairs, NCTA
Noopur Davis, SVP Security and Privacy, Comcast Technology and Product
Marva Johnson, Corp. VP, Government & Industry Affairs, Bright House Networks
Roy Lathrop, Senior Director of State Government Affairs, NCTA
Jason Livingood, Vice President - Internet Services, Comcast Cable
Diana Oo, Senior Director of Global Public Policy, Comcast Cable
Galen Pospisil, NCTA
Madura Wijewardena, Executive Director, Comcast Cable

Workshop Locations

Monday, May 16, 2016
Samberg Conference Center - MIT
6th Floor, Dining Room 5 & 6
MIT Chang Building (E52)
50 Memorial Drive
Cambridge, MA 02139

Tuesday, May 17, 2016
Boston Convention and Expo Center
415 Summer Street
Boston, MA 02210
Directions & Parking Information

Hotel

Hyatt Regency Cambridge
575 Memorial Drive
Cambridge, MA 02139
Phone: 617-492-1234

Helpful Contacts

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Monday, May 16, 2016
Samberg Conference Center - MIT
6th Floor, Dining Room 5 & 6
MIT Chang Building (E52)
50 Memorial Drive
Cambridge, MA 02139

A Center for Law, Technology, and Entrepreneurship at the University of Colorado
Silicon Flatirons

CSAIL
MIT COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE LABORATORY

Breakfast 8:30 - 9:00am
Room 5

Welcome 9:00 - 9:15am
William Lehr and Phil Weiser

Emerging Issues 9:15 - 10:15am
Moderator: Gabor Molnar
Presenters:
- Shane Greenstein, *The Empirical Economics of Online Attention*
- Marc Rysman, *Empirics of Business Data Services*

Discussant: Stacey Dogan

Break 10:15 - 10:30am
Room 6

Distributional Consequences and Impacts of Broadband Policy 10:30 - 12:00pm
Moderator: Scott Wallsten
Presenters:
- John B. Horrigan, *Smartphones and Home Broadband Subscriptions: Substitutes, Complements, or Something Else?*
- Olivier Sylvain, *Network Equality*
- Nicol Turner-Lee, *Zero Ratings and the Public Interest (paper forthcoming)*
- Daniel Lyons, *Lifeline Needs Revolutionary, Not Evolutionary, Change*

Discussant: Yochai Benkler

Lunch 12:00 - 1:15pm
Room 6

Privacy and Security 1:15 - 2:30pm
Moderator: Kevin Werbach
Presenters:
- Adam Candeub, *Common Carriage Privacy Redux*
- Gus Hurwitz, *Cyberensuring Security*
- Carolyn Gideon and Christiaan Hogendorn, *Broadband Industry Structure and Cybercrime: An Empirical Analysis*

Discussant: Taylor Reynolds

Break 2:30 - 2:45pm
Room 6

Competition Policy 2:45 - 3:45pm
Moderator: Ray Gifford
Presenters:
- John Mayo, *The Evolution of 'Competition': Lessons for 21st Century Telecommunications Policy*
- Christopher S. Yoo, *Empirical Analysis of the Broadband Coverage in Europe: Infrastructure Sharing vs. Facilities - Based Competition* (Abstract)

Discussant: Babette E. Boliek

The Evolving MVPD Universe 3:45 - 4:45pm
Moderator: William Lehr
Presenters:
- David Reed, *Trends in Cable Network Economics: Implications for Public Policy*
- Ali Yurukoglu, *Size Effects and Bargaining Power in the Multichannel Television Industry*

Discussant: William Rogerson

Happy Hour Reception 5:00 - 6:00pm
Room 6

Dinner and Roundtable Discussion on Cybersecurity, Trust, and the Evolving Internet 6:00 - 8:00pm
Room 5
Moderator: Phil Weiser
Presenters:
- David Clark
- Noopur Davis
- Jason Livingood

NCTA INTX The Internet & Television Expo

Tuesday, May 17, 2016
Boston Convention and Exhibition Center
415 Summer Street
Boston, MA 02210

MIT Shuttle to NCTA INTX The Internet & Television Expo **8:00am**
Gather in hotel lobby, depart Hyatt Regency Cambridge to Boston Convention Center

Local professors should plan to meet the group at luggage check. Please plan to arrive to the General Session Room no later than 9:00AM, we anticipate this TED Session to be packed.

Disruption: A TED Session Presented by INTX **9:30 - 10:30am**
General Session Stage, Hall C

Hosts: Bryn Freedman, Editorial Director & Curator, TED Institute
Kelly Stoetzel, Content Director, TED
Speakers: Negin Farsad, Social Justice Comedian & Filmmaker, TED
Adam Foss, Juvenile Justice Reformer, TED
Jesse Genet, Entrepreneur, TED
David Sengeh, Biomechatronics Engineer, TED

The Communicators: The FCC Commissioners on Competition, Convergence and Consumers **11:00 - 12:00pm**
Super Session Stage, General Session West

Hosts: Lydia Beyoud, Telecommunications Reporter, Bloomberg BNA
Peter Slen, Senior Executive Producer, C-SPAN
Speakers: Mignon Clyburn, Commissioner, Federal Communications Commission
Michael O'Rielly, Commissioner, Federal Communications Commission
Ajit Pai, Commissioner, Federal Communications Commission
Jessica Rosenworcel, Commissioner, Federal Communications Commission

Lunch **12:15 - 1:00pm**
The GROVE - located lower left of the LAWN – there will be signage and staff directing

INTX Marketplace Highlights/Tour **1:00 - 2:30pm**
Exhibit Floor

Optional Free Time: **2:30 - 5:30pm**
To explore Exhibit Floor or attend Tuesday's Educational Sessions

Optional Event: NCTA Chairman's Reception **6:00 - 7:30pm**
Ballroom, Level 3 - City Overlook

Full Schedule for Tuesday's Sessions

The Empirical Economics of Online Attention

Andre Boik, Shane Greenstein, and Jeffrey Prince*

April 2016

Preliminary. Not for quotation without Permission.

Abstract

We model and measure how households allocate online attention, and assess if and how online attention changed between 2008 and 2013, a time of large increases in online offerings, e.g., video and access points. We calculate our measures using click-stream data for thousands of U.S. households. We find that general measures of breadth and depth of online attention are remarkably stable over this period, while shares of domain categories markedly change – with video and social media expanding, and chat and news contracting. We illustrate how this finding is difficult to reconcile with standard models of optimal time allocation, and suggest alternatives that may be more suitable. The fact that increasingly valuable offerings change where households go online, but not their general (i.e., breadth/depth) online attention patterns, has important implications for competition and welfare.

* University of California, Davis, Department of Economics; Harvard Business School, Department of Technology and Operations Management; and Indiana University, Department of Business Economics and Public Policy, Kelley School of Business. We thank Kelley School of Business and the Harvard Business School for funding. We thank seminar audiences at Georgetown, Harvard and Northwestern, and conference participants at the American Economic Association Annual Meetings and the International Industrial Organization Conference for comments and suggestions. Philip Marx for excellent research assistance. We are responsible for all errors.

1. Introduction

"…in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." (Simon, 1971).

First articulated about information systems, Herb Simon brought attention to a broad economic principle that applies to any situation with abundant information. The principle remains relevant today, even more so for the supply of information by the commercial Internet. Scarce users' attention must be allocated across the Internet's vast supply of web sites. It is not an exaggeration to say that firms compete for user attention.

At first glance competition among Internet sites has much in common with other competitive settings. Users make choices about where to allocate their time, and there is only a finite amount of such time to allocate. In some cases (e.g., electronic commerce), the firms try to convert that attention into sales. In other cases (e.g., most media), firms try to convert that attention into advertising sales. Firms compete for users by investing in web page quality and other aspects of their business related to the services displayed on the pages. Over time, new firms enter with new offerings, and users can respond by making new choices, potentially substituting one source of supply for another.

First impressions mislead. This situation lacks one of the standard hallmarks of competitive situations. Relative prices largely do not determine user choice among options, nor do prices determine competitive outcomes. Most households pay for monthly service, then allocate among endless options without further expenditure. Unless a household faces a binding cap on usage, no price shapes any other marginal decision. Present evidence suggests only a small fraction of users face such constraints across the majority of their surfing (Nevo, Turner, Williams, 2015). In fact, as we will show below, only one of the top twenty domains (Netflix) is a subscription service, i.e., where the price of a web site plays an explicit role in decision making.

How should economic analysis characterize the links between user allocation of attention and online competition in the absence of prices? An empirically grounded theory of competition would have to characterize market demand. That depends on three interrelated aspects of users: how users allocate the amount and division of attention across multiple sources of information; how users adjust the allocation to a change in supply; and how this change in the allocation shapes the competition for their attention. From those three building blocks, it should be possible to characterize: household heterogeneity in allocation of attention *at any point in time*, how households substitute between sources of supply *over time*, and, by extension, how aggregate demand changes in the face of increasing supply of options. Finally, such results could inform a theory about how the allocation of online attention shapes competitive behavior, such as entry of new sites or building of new features to attract attention.

The goal of this paper is to make such a characterization of demand, based on empirically grounded observation. We examine a specific context, the adjustment of attention at US households to the enormous changes in supply of online options between the years 2008 and 2013. We choose these starting and ending periods because over 70% of US households were on broadband connections by 2008, and in the intervening years US households experienced a massive expansion in online video offerings, social media, and points of contact (e.g., tablets, smartphones), among other changes. These years allow us to examine household reaction to large changes in supply of content.

Specifically, we examine a dataset of more than 30 thousand primary home computers at US households in 2008 and 2013. These data come from ComScore, a firm that tracks households over an entire year, recording all of the web domains visited, as well as some key demographics. Our unit of observation is choices made by households over the course of a week. We calculate the weekly market for online attention (total time), its concentration (in terms of time) for domains (our measure of breadth, or "focus"), and the weekly fraction of domain visits that lasted at least 10 minutes (our measure of depth, or "dwelling"). In addition, we measure shares of attention for different domain categories (e.g., social media). Using these measures of online attention, we examine how they vary over the time period, as supply changes.

Our findings suggest that aggregate demand has very specific properties. First, we find strong evidence that income plays an important role in determining the allocation of time to the Internet. This finding reconfirms an earlier estimate of a relationship (Goldfarb and Prince, 2008), but does so on more extensive detail and later years. We find that higher income households spend less total time online per week. Our results suggest that a household making $25-35K a year spends 92 *more* minutes a week online than a household making $100K or more a year in income, and differences vary monotonically over intermediate income levels. Relatedly, we also find that the level of time on the home device only mildly responds to the menu of available web sites and other devices – it slightly declines between 2008 and 2013 – despite large increases in online activity via smartphones and tablets over this time. At the same time, the monotonic negative relationship between income and total time remains *stable*, exhibiting the same slope of sensitivity to income. The change is generally similar across income groups, and is consistent with a simple hypothesis about the changing allocation of time across devices. That is, any new value stemming from additional total time online (across all devices) appears to be largely coming from time on new, alternative devices.

Despite the evidence of some economic determinants of total online time, we see evidence that its allocation is sensitive to different factors. Breadth and depth are not well-predicted by income, but there are roles for major demographics, such as family education, household size, age of head of household, and presence of children. More remarkable, both depth and breadth do not meaningfully change in spite of massive changes in supply. We also examine how breadth and depth changed with the massive changes in supply (i.e., video proliferation and Internet points of contact) between 2008 and 2013. Our expectation was that depth would increase, and more tentatively, that breadth would increase as well. . Our findings do little to confirm what we expected. Rather, focus and dwelling has remained remarkably *stable* over the five years. While there is a statistical difference in the joint distribution of focus and dwelling, it is just that – statistical, and driven by our large sample. The size of the difference is remarkably small, with little implied economic consequence. Also remarkable is that these measures are so stable despite households changing the web sites they visit a great deal. Between 2008 and 2013 online categories, such as social media, and possibly video, become a substitute for both chat and news, and this substitution is readily apparent in our dataset. In summary, new offerings *did* alter where households went online, but only mildly altered how much total time they spent on their machines, and *did not* meaningfully alter their general breadth and depth, as if the determinants of total time and particularly which sites to visit are distinct from the determinants of breadth and depth.

These findings have important implications for competition to reallocate online attention. Our results imply that reallocation does not take the form of changes in concentration of domain visits or proportion of long/intense visits. Instead, reallocation of online attention came almost entirely in the form of changes in how that concentration/intensity portfolio is filled. Because the demographics of household heterogeneity did not dramatically change between 2008 and 2013, aggregate demand only mildly changed, as total time online change. Altogether, as we illustrate in our theoretical development, these findings suggest that at any point in time there are a fixed set of "slots" of attention to allocate, and very limited substitution by households between different "slots" of different lengths. Stated starkly, firm entry and exit compete for given slots of time from users.

Our results merit attention for numerous reasons. First of all, the commercial Internet is a big market, and it has experienced increases in online offerings throughout its short existence. Starting from modest beginnings in the mid-1990s, this sector of the US economy today supports tens of billions of advertising revenue, and trillions in transaction revenue in online sales. Yet, despite the shared features with other competitive US markets, user choice among many web sites remains largely uninformed by prices, and analysis has not built on this simple fact. This leaves a gap in analysis about how commercial firms compete for user attention.

As of this writing, economists generally have not focused on priceless online competition except for a few theoretical pieces on competition for attention (Athey, Calvano and Gans, 2013).There has been almost no formal statistical work on the competition for attention except in the context of conflicts for very specific applications, such as, for example, conflicts between news aggregators and news sites (Chiou and Tucker, 2015, Athey and Mobius, 2012), and conflict between different search instruments (Baye et al. 2016). No work has characterized the entire allocation of a household – the "what, where and how" behind the core economics of competition for online attention, nor built a model of aggregate demand from such data. We address this gap.

Our study also relates to the extensive literature on the economic allocation of time. We ask whether user patterns of behavior are consistent with the predictions of a basic theoretical model of the allocation of time. In this study we present a standard economic model of time allocation, which follows the prior literature (Hauser et al. 1993, Ratchford et al. 2003, Savage and Waldman 2009) and finds much of its roots in Becker (1965). Using this model, we highlight theoretical ambiguities as to predicted changes in online attention with increased online offerings. We then create novel measures of online attention allocation designed to capture the total time allocated to online offerings, and the breadth and depth of a household's online attention. We use these to characterize three basic types of online attention measurements – How much? How is it allocated? and Where is it allocated?

These findings and this outlook build on prior work on the value of household time online, and contrasts with it. Several studies provide evidence demonstrating the demand for, and market value of, speed in broadband access, which users spread over a vast array of content (Rosston, Savage, and Waldman, 2010, Hitt and Tambe, 2007). Prior work also has characterized the value of online attention in terms of its consumer surplus or the opportunity cost of work time (Goolsbee and Klenow, 2006, Brynjolfsson and Oh, 2012). In addition, prior work has considered how users trade-off between online and offline leisure time, recognizing the user pays an opportunity cost of online time by withdrawing from other leisure activity (Webster, 2014, Wallsten, 2015). In contrast, we focus on the value generated by users' allocation of attention to the suppliers of online web sites, and focus on competition for that attention. That focus leads to a very different analysis of the core economics.

We also contrast with the marketing literature on online advertising. As the Internet ecosystem increases the availability of online offerings, consumers can adjust their online attention to gain value in several ways. Specifically, consumers can: 1) Increase the total amount of attention they allocate to the Internet, 2) Re-allocate their ad-viewing attention to better targeted ads, and/or 3) Re-allocate their attention to more and/or higher value domains. Much of the prior work pertaining to online advertising has focused on #2, namely, the principals of targeting ads. This is largely driven by firms tapping into "big data" and extensive information about users' private lives. The marketing literature on targeting tends not to focus on why behavior changes by consumers as supply changes. In contrast, our analysis centers on the reaction of households to changes in supply, which focuses on the determinants of #1 and #3, which are generally under the control of the consumer, and as of this writing, have been less studied and are less understood. This leads to a very different conceptualization about competition for attention.

Though we depart from some of the existing economics literature, our findings are not much of a departure from field work conducted by anthropologists and researchers on user-machine design. That line of research has documented the periodic – or "bursty" – use of many online sources, consistent with our findings about the breadth of session times (Lindley, Meek, Sellen, Harper, 2012, Kawsaw and Brush, 2013). It also documents the "plasticity" of online attention, as an activity that arises from the midst of household activities as a "filler" activity (Rattenbury, Nafus and Anderson, 2008, Adar, Teevan, Dumais, 2009), which provides an explanation for the consistency of breadth and depth patterns within a household in spite of large changes in the available options. We make these links in the discussion of the findings. Hence, we also view our work as a bridge between economic analysis and conversations taking place within other domains of social science.

2. Dynamics of the Internet Ecosystem: 2008-2013

The era we examine is one characterized by rapid technical advance and widespread adoption of new devices. Continuing patterns seen since the commercialization of the Internet in the 1990s (Greenstein, 2015), new technical invention enabled the opportunity for new types of online activity and new devices. For example, the cost of building an engaging web site declined each year as software tools improved, the effectiveness of advertising improved, and the cost of microprocessors declined. In addition, the cost of sending larger amounts of data to a user declined each year as broadband network capacity increases.

The start of our time period is near the end of the first diffusion of broadband networks. By 2007 close to 62 million US households had adopted broadband access for their household Internet needs, while by 2013 the numbers were 73 million. The earlier year also marked a very early point in the deployment of smart phones, streaming services, and social media. The first generation of the iPhone was released in June of 2007, and it is widely credited with catalyzing entry of Android-based phones the following year, and by 2013 more than half of US households had a smartphone. Tablets and related devices did not begin to diffuse until 2010, catalyzed, once again, by the release of an Apple product – in this case, the iPad in April, 2010.

Also relevant to our setting are the big changes in online software. Streaming services had begun to grow at this time, with YouTube entering in February, 2005, and purchased by Google in October of 2006. Netflix and Hulu both began offering streaming services in 2008. Social media was also quite young. For example, Twitter entered in March, 2006, while Facebook starts in February, 2004, and starts allowing widespread use in September, 2006. By 2013 social media had become a mainstream online application, and, as our data will show, was widely used. In summary, the supply of options for users changed dramatically over the time period we examine.

3. A Model of Online Attention

In this section we present a standard model of attention allocation applied to households' online attention allocation decisions. Subsequently, we use the model to examine the predicted effects of two shocks and evaluate the assumptions needed for the model to rationalize our empirical findings.

3.1. The Standard Model with Setup Costs

We propose a standard model of online attention following the basic structure of the seminal work by Becker (1965) on the allocation of time, and which has been adapted by others in various ways to examine household demand for broadband (e.g. Savage and Waldman 2009). Critical to our model is that visits to online domains do not carry a price; rather, the cost of a domain visit is the opportunity cost of that attention which could be allocated elsewhere. Further, we suppose that there is a setup cost to visiting each domain. The setup cost can be interpreted as either a necessary minimum time cost to absorb the information at a domain, a cognitive cost of switching domains, a time cost of waiting for a new domain to load, or so on. The point is that the existence of any such cost will generate continuous visits to domains that end only when the time slot has expired or the marginal utility from additional time spent at the domain falls below the marginal utility of visiting some other domain net of the switching cost.

In this setting, household i chooses the amount of time to spend at each Internet domain (t_{ij}) on its "home device" to maximize its standard continuous, differentiable utility function net of setup costs:

$$(1)\ max_{t_{i1},\dots,t_{iJ}} U\left(t_{i1},\dots,t_{iJ},T_i-\left(t_{i1}+\cdots+t_{iJ}\right);\vec{W}\right) - \sum_j^J 1(t_{ij}>0)F$$

$$\text{s.t. } t_{i1}\geq 0,\dots,t_{iJ}\geq 0, T_i\geq\left(t_{i1}+\cdots+t_{iJ}\right)$$

where F is the setup cost of visiting a domain. In equation (1), $\vec{W}$ represents all relevant features (i.e., content, subscription fee – if any, etc.) for the available web domains. Further, T_i represents all time available to household *i* in a week, and the final argument of *U(.)* is the equivalent of a composite good; in this case, it represents all other activities for which household *i* could be using its time (e.g., sleep, work, exercise, and time on other devices). Hence, this formulation implicitly assumes household *i* fully exhausts all of its available time.

For the moment no structure is placed on the utility function, so we define $t_{ij}^* = argmax\ (1)$ as the attention allocation function that solves this problem. A natural way of characterizing this function is in terms of total time, and the breadth and depth of the allocation of time online. We start with total time on the device over a "representative" period. For illustrative purposes, think of this as a week of time.[1] The model produces the following identity for time online for household i (TO_i) when there are J domains:

$$(2)\ TO_i = \sum_j t_{ij}^*$$

Next, we consider measures for breadth and depth of online time allocation. That is, how is attention allocated *across* domains, and how intensely is it allocated *within* a domain? Our measure of breadth stems from the classic literature in industrial organization. Specifically, we measure breadth using a Herfindahl-Herschman index for time spent at domains visited by household i, denoted C_i. We define C_i as:

[1] In the data section below we have experimented considerably with alternative units of analysis, such as a day, week, month and year. Consistent with many available measures of the Internet and, more broadly, leisure time (e.g., Wallsten, 2015), we have found considerable variability in household online use day to day, and hour to hour. However, in preliminary work, not shown here, we have found considerable stability in weekly patterns of online behavior, and that the same households differ from one another in much the same way week after week. Hence, in this study, we focus exclusively on characterizing one "representative" week for a household.

$$C_i = \sum_{j}^{J} \frac{t_{ij}^{*2}}{(t_{i1}^{*} + \cdots + t_{iN}^{*})}$$

Defined this way, our measure of breadth captures the level of concentration (in terms of time at domains) household i exhibits in its domain visits. This measure works equally well in the cross-section and over time. At any point in time it measures heterogeneity across households: a high value for C_i indicates a breadth of visits that is highly concentrated at a small number of domains, whereas a low value for C_i indicates a breadth of visits that is unconcentrated, i.e., spread out across relatively many domains. It also can measure changes over time: C_i gets larger as a household substitutes a larger fraction of its time into fewer web domains.

Our measure of depth takes inspiration from an early constraint on YouTube, specifically the cap on video length of 10 minutes, which lasted until mid-2010. We measure depth as the fraction of domain visits by household i that lasted at least 10 minutes, denoted L_i. If the setup cost is strictly positive, the standard model suggests households spend all of their time at each domain continuously. Hence, the depth of households' visits can be summarized by the fraction that exceed a given threshold of time, $\bar{t}$:

$$L_i = \frac{\sum_j^J 1(t_{ij} > \bar{t})}{\sum_j^J 1(t_{ij} > 0)}$$

To calculate L_i in practice, we must decompose the optimal time spent at each domain during the given time period (e.g., a week). To see this, suppose $t_{i1}^{*} = 30$. Hence, time spent at domain #1 during the observed week was 30 minutes. However, this measurement does not distinguish between the 30 minutes being comprised of 6 separate visits lasting 5 minutes each and one visit lasting 30 minutes. Our measure of depth would account for such a difference.

In order to construct L_i, we first define $\overrightarrow{S_{\iota J}}$ as the vector of session lengths at domain j for household i. Hence, the length of $\overrightarrow{S_{\iota J}}$ is the number of separate visits made by household i to domain j.

Next, let t^*_{ijk} be the optimal time spent by household i at domain j during session k; therefore, t^*_{ijk} is simply the k[th] entry in $\overrightarrow{S_{ij}}$, and $\sum_k t^*_{ijk} = t^*_{ij}$. Given these additional definitions, we define L_i as:

$$(3)\ \ L_i = \frac{\sum_j \sum_k 1(t^*_{ijk}>10)}{\sum_j \sum_k 1(t^*_{ijk}>0)}$$

As defined, L_i is the proportion of total domain visits that lasted more than ten minutes for household i. Again, this measure works equally well in the cross-section and over time. At any point in time it measures heterogeneity across households in the fraction of time spent in longer sessions, with higher L indicating a higher fraction. It also measures changes over time at a household, with an increase in L indicating that a household has substituted a large fraction of its time into longer sessions.

An illustration can help build intuition for how these characterize cross sectional heterogeneity in online attention. We consider our first metric (C_i) to be a measure of focus – households with a high value for C_i focus their attention on a relatively small number of domains, and vice versa for households with a low values for C_i. We consider our second metric (L_i) to be a measure of a households propensity to dwell at the domains it visits – households with a high value for L_i tend to dwell at domains while households with a low value for L_i behave more like a tourist, visiting for a brief stint. Building on this intuition, we envision the very simple, 2x2, classification of households using these two metrics in Table 1 as a conceptual benchmark of heterogeneity across households.

Table 1: Simplified Household Types for Allocation of Online Attention

	High C	**Low C**
High L	Focused Dweller	Unfocused Dweller
Low L	Focused Tourist	Unfocused Tourist

Now that we have detailed our measures of online attention in terms of “how much?” and “how is it allocated?,” we consider one last measure: “where is it allocated?” For this measure, we calculate shares of total time online on the home device for different domain categories (we list the specific categories for our analysis below). Thus, we define TS_c as the share of total time across all households spent at domains in category c. Formally, we have:

$$(1)\ TS_c = \frac{\sum_i \sum_{j \in c} t_{ij}^*}{\sum_i TO_i}$$

Again, this measure works equally well for characterizing heterogeneity at a point in time, and changes in a household over time. That said, we think this measure suggests one approach to measuring changes in the extent of competition. We expect new entry to lead to turnover when users direct their attention to new categories of web sites. One measure of competition is the fraction of total attention that moves to these new categories.

Section 3.2. Effects of Two Model Shocks

Over the time period of our data, two important shocks occurred. First, a wave of new domains entered the worldwide web, and many of these new domains offered large amounts of video content. For example, Netflix and Hulu both began offering streaming online video during the earliest year of our data, and YouTube began allowing videos longer than ten minutes within the span of our data. While there certainly were domain exits during the time we analyze, the net change in domains was certainly positive, with a notable increase in online video available. This influx of domains manifests as an increase in J to J^* and a change in the full list of domains – and their characteristics – comprising the J^* total domains.

The second shock to our model was due to the release of a new batch of connected devices – in particular, tablets and smartphones. Given our model is for the home device, this shock essentially altered the composition of the composite good within the model.

An increase in the number of domains from J to J^* and the introduction of alternative devices affects the household utility maximizing problem as follows.

$$(2)\ max_{t_{i1},\ldots,t_{iJ^*},t_{i1}^{dev},\ldots,t_{iJ^*}^{dev}} U\left(t_{i1},\ldots,t_{iJ^*},t_{i1}^{dev},\ldots,t_{iJ^*}^{dev},T_i-\left(t_{i1}+\cdots+t_{iJ^*}^{dev}\right);\vec{W}\right) - \sum_j^J 1(t_{ij}>0)F$$

$$\text{s.t. } t_{i1}\geq 0,\ldots,t_{iJ^*}^{dev}\geq 0, T_i\geq (t_{i1}+\ldots+t_{iJ^*}^{dev})$$

The household faces more domain choices and the option to consume them on an alternative device. We assume setup costs affect the alternative device as they do for the home device, which implies the solution closely mirrors that without additional domains or an additional device. We ask how these two changes impact three key outcomes within our model: total time, breadth, and depth. That is, in terms of time online, we ask how these changes impact how much, and how it is allocated.

Without more information about the utility function and size of setup costs, the model could predict either an increase or decrease in the household's total time online and its breadth and depth of browsing on the home device. Here we place some structure on the household's maximization problem to generate simple predictions about the response of households' attention allocation decisions to the two shocks.

If the utility function is symmetric among domains, quasilinear in an unchanging offline outside option, and the setup costs are small, then an increase in the number of domains weakly increases the total amount of time online, and decreases the concentration of time spent across domains on the home device.[2] The standard model with small setup costs does not make a prediction about the depth of browsing because without setup costs – a given amount of time spent at a domain can be split in any way and still yield the same total utility. The introduction of an alternative device is predicted to weakly decrease the total amount of time spent on the home device, and to have no effect on the breadth of browsing on the home device. With small setup costs, the model again does not make a prediction about the depth of browsing.

When setup costs are large, then the household may have already been constrained to visit fewer than *J* domains before the shock and will continue to visit the same number of domains after the shock, so that the concentration of time across domains is unchanged. If the household was not constrained before

[2] The details of the microeconomics behind this prediction and those that follow can be found in the Appendix.

the shock, then concentration of time across domains will fall. Additionally, the marginal effect of the introduction of an alternative device is to weakly increase concentration: any domain visits substituted towards the alternative device increase the time share of the domains viewed on the home device.

Table 2: Summary of Standard Model's Predictions in Response to Two Shocks

	Small setup costs	Large setup costs ($F >> 0$)
Shock 1: New Domains	$\Delta TO_i \geq 0$ $\Delta C_i < 0$ ΔL_i (No prediction)	$\Delta TO_i \geq 0$ $\Delta C_i \leq 0$ $\Delta L_i = 0$
Shock 2: New Device	$\Delta TO_i \leq 0$ $\Delta C_i = 0$ ΔL_i (No prediction)	$\Delta TO_i \leq 0$ $\Delta C_i \geq 0$ $\Delta L_i = 0$

Table 2 summarizes the effect of the two shocks on the household's time online (TO_i), breadth of browsing (C_i), and depth of browsing (L_i) under the standard model with small and large positive setup costs. The standard model predicts an ambiguous effect on TO_i whether setup costs are small or large, while the model predicts a decrease in C_i if setup costs are small and an ambiguous change in C_i if setup costs are large. The predicted effect on L_i is 0 if setup costs are large, and there is no prediction for small setup costs. However, it is worth noting that the standard model with setup costs and symmetric utility suggests the level of L_i is either 0 or 1: all sessions are the same length in equilibrium, so they all are either above or below any specified threshold. Since we do not explicitly model different categories of domains, our model is silent with respect to how households will reallocate attention across different types of domain categories in response to the two model shocks. This limitation also constrains our ability to generate a predicted response to the growth in video and social media sites in a formal sense, although informally, the high time demands of such sites suggests a predicted increase in L_i.

In the following sections, we take our measures of households' depth and breadth of online browsing to the data to examine how these measures changed over our sample period and to evaluate the standard model's predictions. We will not be providing standard economic measures of substitution because there are no prices with which to measure cross-price elasticities and related values. Instead, we use our measures of "how much," "how is it allocated," and "where is it allocated" with regard to online attention on the home device – as defined in equations 5 through 8. By doing so, we can observe if households altered their behavior with respect to these outcomes over the timespan of our data, and if so, how.

3.3. Hypothesis development

Hypotheses need to distinguish between distinct determinants originating at the supply-side and demand-side in the attention economy. We postulate that supply determines the menu of available choices, and a different set of factors, such as household characteristics, determines the final allocation.

What determines the shock to the menu of choices available to users? Since these inventions become available to all market participants, such technical advance induces three responses of relevance to competition for attention: (1) Existing web sites improve their offerings in a bid for user attention; (2) entrepreneurial firms conceive of new services to offer online in a bid for user attention; and (3) new devices enter to attract user attention. Collectively, these determine the "supply" of web sites bidding for the attention of users in time t, which we summarize as S_t.

As for demand, we further postulate every household i in time t has a set of demographic characteristics – education and income – that allocate their attention among the available menu of options. We call these variables X_i. Together with supply, an allocation for a household can be characterized as three relationships:

Total time: $TO_{it} = \mathrm{TO}(S_t, X_{it})$

Concentration (breadth): $C_{it} = \mathrm{C}(S_t, X_{it})$

Length (depth): $L_{it} = \mathrm{L}(S_t, X_{it})$

What are the properties of this allocation? Goldfarb and Prince (2008) have shown that households with high income are more likely to adopt, but they do not use the Internet as intensively. They hypothesize that this is due to the outside option value of their leisure time. In this setting, if X_{it} is income, the Goldfarb-Prince effect would appear as:

H1. $TO_x(S_t, X_{it}) < 0$.

We seek to learn whether this income effect holds in our measures of the attention economy, and on a very different data set than previously used. A further question is whether time online on the home device has changed over time. That is, has the improvement in devices attracted user attention away from the improving web sites on PCs, or vice versa? The null hypothesis specifies no change in total time:

H2. $TO(S_t, X_{it}) - TO(S_{t-1}, X_{it-1}) = 0$.

The alternative could be either higher or lower. If we reject H2, then an interesting question focuses on whether the income effect has changed over time. That is, despite changes in the *level* of total time online, has the *rate* of the relationship between income and time online remained the same? Again, the null is no change:

H3. $TO_x(S_t, X_{it}) - TO_x(S_{t-1}, X_{it-1}) = 0$.

We can also ask whether greater online time leads to greater breadth and depth? If so, then – once again, assuming X is income – we would expect larger X to lead to lower total time, and less breadth and less depth. Initially we seek to test the null hypothesis in a one tail test, where the null is:

H4. $C_x(S_t, X_{it}) = 0$ and $L_x(S_t, X_{it}) = 0$, and the alternative is:

H4A. $C_x(S_t, X_{it}) > 0$ and $L_x(S_t, X_{it}) < 0$.

Once again, and parallel to the discussion for H2 and H3, if we reject H4 for H4A, then the next question concerns changes to the determinants of breadth and depth.

We also can test the reaction of households to growth in supply conditions. As has been widely reported, social networking applications and streaming have become more available over time. We expect users to substitute some of their time to these new applications. Did this substitution change the measured breadth and depth? We expect new sources of supply to increase depth and breadth, and so we set up a test to reject the null, where the null is for no change, expressed as:

H5. $C(S_t, X_{it}) - C(S_{t-1}, X_{it-1}) = 0$, and $L(S_t, X_{it}) - L(S_{t-1}, X_{it-1}) = 0$.

Similar to the above discussion about H2 and H3, after testing H5, we can further test whether breadth and depth are sensitive to demographics.

We stress that the longer the time period between t and t-1 the more likely rejecting the null hypothesis becomes. That is because the null defines household stability in the allocation of breadth and depth in spite of changes in options available to households, and presumably the growth in options becomes much larger with the passage of longer time. Substitution can arise from a vast array of endless possibilities, either splitting up a large moment of time into many smaller units of time or it can arise from taking many small units and putting them together into one long unit. After fives years of dramatic changes in supply we would not expect similar patterns to arise.

4. Data

We obtained household machine-level browsing data from Comscore for the years 2008 and 2013. We observe one machine for each household for the entire year, either all of 2008 or all of 2013. Here, the machine should be interpreted as the household's home computer. The information collected includes the domains visited on the machine, how much time was spent at each domain, and the number of pages visited within the domain. We also observe several corresponding household demographic measures including income, education, age, household size, and the presence of children. For simplicity we consider only the first four weeks of a month and do not consider partial fifth weeks. Importantly, we delete households that have fewer than 6 months of at least 5 hours of monthly browsing. We also delete the very few households with more than the 10,080 maximum number of minutes online per week, the result of a defective tracking device. For 2008, we are left with 40,590 out of 57,708 households and for 2013 we are left with 32,750 out of 46,926 households. In both years this amounts to over one million machine-week observations.

Summary statistics of our demographic measures are presented in Table 3. These demographics include household income thresholds, educational attainment of the head of the household, household size, the age of the head of the household, and an indicator for the presence of children. Comscore's sampling of households is known to be targeted more towards higher income households, but those income levels are comparable across the 2008 and 2013 data. Unfortunately the education identifiers are mostly missing in 2008, and only available for roughly half of all households in 2013. While there do not appear to be any major differences in the sample composition across years, the 2013 heads of households are younger. In addition, Comscore provides no information on the speed of the broadband connection except to indicate that virtually of them are not dial-up.

[Table 1 about here]

Summary statistics of our key variables representing browsing types such as the concentration of time across domains and the fraction of sessions that exceed 10 minutes are presented in Table 4. On average a household spends roughly 15 hours online per week in 2008 and 14 hours online in 2013. Perhaps surprisingly, our measures of browsing behavior are virtually identical across years, with 75% of sessions lasting over 10 minutes and households' allocation of time across domains being quite concentrated with an HHI of approximately 2,900. We discuss these similarities in greater detail in the next two sections.

[Table 2 about here]

5. Empirical Analysis

We take our utility framework and measures to characterize online attention to the 2008 and 2013 data. Households optimally allocate time across online domains and offline activities. This allocation maps to our data in terms of a total amount of time online, and a joint distribution of how that time is distributed across: number of sessions, unique domain visits, and time per session. As discussed in Section 2, to capture heterogeneity in online time allocation across households conditional on their time online, we generate intuitive measures of fundamental browsing behavior conditional on an amount of time online: focus (a measure of time concentration over domains) and propensity to dwell (a measure of time spent at a given domain).

In this section, we present three types of results that shed light on three corresponding basic questions pertaining to online attention: How much? How? and Where? In the first subsection, we present findings concerning total time online (how much). In the second subsection, we present findings concerning our measures of fundamental browsing behavior (how). In the third subsection, we present findings on the shares of attention garnered by different online content categories (where). For each of these sets of findings, we make comparisons across 2008 and 2013, and discuss key insights from these comparisons in Section 6.

5.1 Total Time Online

Our data do allow us to conduct measurements and analyses that are informative about households' total time online and how it has changed over the tumultuous period between 2008 and 2013. Since our data are at the home device level, we are limited in our ability to draw conclusions about the total time spent online by a household (across all devices). We only observe time spent on the PC.

First, our summary statistics show that the average household spends approximately 2 hours per day on the Internet. Our theory predicted that time on the PC could go up or down over time. We see, in fact, that total time online on the primary home device declined by approximately 5% between 2008 and 2013, which rejects the null on H2. If we assume total time online across all devices increased during this time (see Allen 2015, which supports this assumption), this suggests at least a minimal amount of substitution of online attention across devices. Nonetheless, the decline we observe is rather small, suggesting that much of the increased online attention on tablets and smartphones is in addition to, and not in place of, online attention on the home PC.

Our data also allow us to examine how total time online on the home device relates to demographics, and whether and how this relationship may have changed between 2008 and 2013. The existing literature studying Internet technology has found that adoption of most internet technology frontiers is predicted by more income and more education, and (up to a point) younger ages and larger families. However, the Internet seems to be different because it generally consumes leisure time and not money. Most standard models of adoption predict that the extent of *use* of Internet technology is increasing in the same factors that predict adoption.

We present the results of a simple regression of time online per week on demographics, and show the results in Table 3. In these data we see a Goldfarb-Prince effect in any given year, and the evidence is much stronger due to our access to a much large set of data over more households, and over multiple years.

We confirm H1, namely, total time online declines with income. Hence, we find that the determinants of total time online for the home device, particularly income, are consistent with those previously identified in the literature. In Figure 1, we show how this relationship compares across our two years of 2008 and 2013. Although we get a statistical rejection of H3, it is clear that there is no qualitative change in the relationship between time online and income over this period. For 2008, looking at the income endpoints, those with incomes greater than $100,000 spend 835 minutes of time online per week while those with incomes less than $15,000 spend 979 minutes of time online.

Other demographic determinants of time online are generally weak and inconsistent over the two years. We see a positive relationship between more education and total time in 2013, but the relationship is not monotonic in 2008. Large households also spend more time online, but the relationship is only strong in 2008. In 2013 only the presence of children captures this effect. Total time is also declining in the age of head of household in 2008, but no such monotonicity arises in 2013.

[Table 3 about here]

[Figure 1 about here]

Our findings and data relate the Goldfarb-Prince effect to its underlying determinants. We see that the relationship between total time and income remains largely stable across timeHence, the Goldfarb-Prince effect appears to be a stable relationship for total time at the household level.

5.2. Online Attention Allocation Patterns

In this subsection, we present analyses of focus and dwelling. Figure 2 presents the unconditional joint density of our measures of focus and propensity to dwell for 2008 and 2013. Here, we see a very well-behaved joint distribution that strongly resembles a joint normal. However, it is the comparison of the graphs over time that generates a particularly striking finding – the distribution of these measures of online attention allocation is essentially unchanged during this five year time period! The summary statistics in Section 3 showed that the means of each measure were very similar, but Figure 2 clearly indicates that the similarity goes well beyond just the means – the entire distributions are nearly identical.

Despite this, we can reject the null hypothesis that they are statistically indistinguishable, likely because our combined sample size is over three million. Tables 4a and 4b present statistical tests of the means of our measures of Focus and Propensity to Dwell across years and a Kolmogorov-Smirnov test for the equality of distribution functions across years, respectively. While not statistically identical, these differences are economically insignificant. The mean of household Focus is only 3.5% greater in 2013 and household Propensity to Dwell greater by only 1%.

[Figure 2 about here]

We are concerned that the measures of online attention allocation may be strongly driven by a household's total time online on the home device. For example, we may worry that households spending the most time online would be more likely to dwell and perhaps be less likely to be focused. In short, we are concerned that a household's location within the distribution presented in Figure 1 arises merely from income's influence on total time. To address this concern, we break total time online on the home device into quartiles, and recreate our joint distribution for each quartile. The results are in Figure 3. Here we see that, while not identical, the joint distribution of our measures of a household's browsing behavior is strikingly consistent across the quartiles. Further, we see that within quartile, this joint distribution is again highly stable between 2008 and 2013.

[Figure 3 about here]

As shown in our summary statistics in Section 3, there are some differences in the demographic profiles between our sample in 2008 and 2013. It could be that online attention allocation patterns, conditional on demographics, did change over this time period, but the changes are offset by the demographic changes in our samples. To address this possibility, we assess if and how our measures of online attention relate to our demographics, namely: income, age, education, household size, and presence of children.

Table 5 presents a set of seemingly-unrelated-regressions (SURs) for our measures of focus and propensity to dwell. We do not observe monotonic estimates with respect to income. Indeed, both depth and breadth are virtually independent of income levels after controlling for total time online. The demographics that meaningfully correlate with focus are lower levels of education, older heads of households, and household size. In contrast, households' propensity to dwell is largely independent of demographics. In particular, more educated households, larger households, and younger households visit a larger variety of sites in both 2008 and 2013.

[Table 5 about here]

Broadly speaking, the percentage of variation in our household classifications explained by demographics is less than 20% (for dwellers) and less than 3% (for whether the household is focused). Households that are larger, have more education and income are less likely to be classified as dwellers, but the economic significance of these effects is modest. Households with older heads of household and more education are less likely to be classified as focused, but the economic significance of these effects is also modest.

These are quite striking findings about the role of demographics in breadth and depth in light of our earlier results about total time. Income of households helps shape total time online far more than its composition. From the previous subsection, it appears that little has changed with regard to *how* households allocate their online attention, at least on their primary home device.

5.3. Online Attention Category Shares

As noted above, the period spanning 2008 to 2013 saw large changes in the supply of website domains, particularly with regard to online video. Consequently, we may see notable changes in *where* households allocate their time, despite remaining stable in *how* they allocate their time.

We classified the Top 1000 domains from both 2008 to 2013 by categories established by Webby and measured the share of attention garnered by each category for both years. We present these shares in Figure 4. Here we see that, in 2008, Chat is by far the largest category, attracting over 25% of households' attention; however, this category saw a dramatic shift by 2013, dropping to less than 2% in 2013. Attention allocated to News domains also sees a decrease, from roughly 10% down to 5%. We observe the largest increases of attention being allocated towards Social Media and Video, to 26% and 16%, respectively. Interestingly, three-quarters of the drop in share for Chat and News is reflected in the increased shares of Social Media and Video.

[Figure 4 about here]

Table 6 contains the top 20 domains of 2008 and 2013. A quick glance at these rankings and the change between 2008 and 2013 further confirms what we see in Figure 4. Particularly noteworthy is the mass exodus of chat and the rise in video.

[Table 6 about here]

5.4. Evaluating the Predictions of the Standard Model: is a behavioral component missing?

Between 2008 and 2013 we see a remarkable lack of change in both the breadth and depth of households' browsing habits. These results are difficult to rationalize in the context of the standard model with negligible setup costs. Such a model predicts an increase in the breadth of household browsing when supply increases, and makes no prediction about the depth of household browsing. The results are more easily rationalized by the standard model with setup costs: the supply of new domains increases breadth on the home device while alternative devices decreases breadth on the home device, resulting in an ambiguous net effect. With respect to the depth of household browsing, the standard model without setup costs is agnostic about depth while the standard model with positive setup costs predicts no change in the depth of household browsing.

From 2008 to 2013, we observe no change in the depth of household browsing. Again, the standard model with setup costs rationalizes the data better than the model without setup costs. However, the standard model with setup costs predicts all sessions be of the same length so that all sessions either fall above or below a given threshold. We do not see similar length. We see a mix of sessions of different lengths, *where the proportion has not changed across years*.

This mix of sessions of different lengths could be explained by an asymmetric utility function that captures how a household values each domain differently. However, we believe that our empirical findings point towards a static theory of household browsing behavior. In part, this is because the demand side did not react to a massive change in the environment of supply. For example, the vast change in the menu of supply from 2008 to 2013 did not change the breadth or depth of households' browsing.

To summarize, there is a discrete nature to households' domain choices and a bound on the number of domains that can be visited. The continuous utility function of the standard model without setup costs ignores these features and is at odds with our empirical results. We do not observe households splitting of time into more numerous and shorter domain visits, as predicted by the standard model without setup costs. The standard model augmented with a positive setup costs performs better: it predicts that even with increasing supply, there will be a finite number of domains visited.

The standard model augmented with setup costs does fall short, however, due to the lack of a clear prediction: it offers no guidance as to whether households' breadth of browsing will increase or decrease. The unchanging breadth *and* depth to households' browsing patterns invites an alternative theory of household browsing behavior, one that can explain this constancy.

What would such a theory contain? It might be behavioral or one where a household receives exogenous "slots" of time which are allocated to brief leisure activities such as watching television, reading, or browsing online. If, for example, online behavior is largely driven by a constant and exogenous nature of offline activities, then that would explain the remarkable stability of household browsing behavior over time despite vast changes in the amount and type of supply over the same period.

Field work conducted by anthropologists and researchers on user-machine design have observed behavior consistent with the exogenous offline activities determining the time spent in online activities. Such researchers have documented the periodic – or "bursty" – use of many online sources (Lindley, Meek, Sellen, Harper, 2012, Kawsaw and Brush, 2013). It also documents the "plasticity" of online attention, as an activity that arises within the midst of household activities as a "filler" activity (Rattenbury, Nafus and Anderson, 2008, Adar, Teevan, Dumais, 2009). This type of field work provides an explanation for the consistency of breadth and depth patterns within a household in spite of large changes in the available options. It explains it as a result of unchanging household habits, which shape availability of time, and shape the availability of slots of time. These theories would hypothesize that the slots do not change much, because they cannot change much, even as supply of online web sites does change.

6. Implications for online competition

What are the implications for online competition? To begin, we summarize our findings in Section 5 and discuss their main implications, focusing on no changes between 2008 and 2013 – a time of substantial change in the Internet ecosystem. We summarize our findings in Table 8, and state the results as follows. First, total time online at the primary home device has only modestly declined, and the decline is generally consistent across income groups. Second, the way in which households allocate their online attention, as measured by the concentration of domains visited (focus) and time spent in "long" sessions (dwelling), has remained remarkably stable. In addition, neither of these measures is well-predicted by total time online or major demographics. Lastly, the period between 2008 and 2013 saw major changes in online category shares, with social media and video experiencing significant increases while chat and news experienced significant declines.

Our findings also suggest that new points of contact – in the form of additional computers, tablets and smartphones – are substituting time away from the primary home device, but only modestly. Consequently, as total time across all devices strongly increased during this time (e.g., Allen 2015), it appears this increase manifested as time online at additional devices largely coming on top of a relatively stable home device. Hence, any new value stemming from additional time online appears to be largely coming from time on new, alternative devices.

Altogether, this adds up to a surprising characterization of the supply of attention by households and the demand for online activities. User allocation of a given amount of time online varies with supply conditions and not income, while the amount of time spent online varies with income and not the menu of supply.

We find the stability of online attention patterns over this time period to be especially striking, given the explosion of online video content and the growth of secondary devices during this time. In this context, we highlight three key takeaways. First, this finding shows that any changes in value households achieved resulting from these developments did *not* arise from a change in the *way* households allocated their online attention. Therefore, even if many households shifted their attention to more domains with video offerings, which tend to demand more dwelling, it appears these shifts are at the expense of attention at other domains at which the household was already dwelling. Second, this result suggests that households' online attention via secondary devices has not been such that it alters the basic pattern of online attention for the primary home device. This implies that households are not systematically distributing their attention across devices in a way that, e.g., shifts "touristy" or focused sessions to secondary devices. Lastly, this result implies that, despite a large influx of new domains and content offerings, households are not increasing the spread of their attention in response, at least at the device level.

This last set of findings suggest that households likely achieved additional value between 2008 and 2013 by reallocating their attention across domains with only mild changes in the total time being allocated. That is, households changed where they allocated their time online in terms of the types of domains they visited. The changes in category shares are consistent with social media, and possibly video, becoming a substitute for both chat and news. It is important to note, however, that these figures correspond to attention allocation through the household's home computer. The time period of 2008 to 2013 also saw a dramatic increase in the use of handheld devices capable of browsing the Internet; some of the changes in attention allocation presented in Figure 4 may also represent substitution to handheld devices. The category of chat, for example, has moved away from instant messenger software on the home computer towards text messaging software on devices.

This adds up to a striking model of competition for attention. As expected, there were large changes in the supply of web sites for households to choose, and many households responded to that expanded choice. Presumably existing web sites also improved, as they fought to keep the attention of existing users from households. However, the competition for users was constrained by virtually unmoveable feature of demand – the length of slots households were willing to sustain at a given site, and the ultimate desire of households to experience a wide variety of content. Competition for household attention *did* alter the total time on the home PC, shifting some of it to other devices, but competition for households *did not* lengthen or shorten the actual time online, nor did it change the effective consumption of variety.

7. Conclusions

To be written…

8. Appendix

This appendix provides more details behind the predictions of the standard model under small or large setup costs summarized in Table 2. We assume utility is symmetric among domains, has decreasing marginal utility across domains, and is linear in the normalized and constant outside option of offline activities so that $U\left(t_{i1}, \dots, t_{iJ*}, T_i - \left(t_{i1} + \cdots + t_{iJ*}\right); \overrightarrow{W}\right)$ can be written $U\left(t_{i1}, \dots, t_{iJ*}; \overrightarrow{W}\right) + T_i - \left(t_{i1} + \cdots + t_{iJ*}\right)$ and symmetry giving $U\left(t_{ik}, \dots, t_{i-k}; \overrightarrow{W}\right) = U\left(t_{i-k}, \dots, t_{ik}; \overrightarrow{W}\right)$ and $U_k\left(t_{ik}, \dots, t_{i-k}; \overrightarrow{W}\right) = U_k\left(t_{i-k}, \dots, t_{ik}; \overrightarrow{W}\right) \; \forall \; i, t_{ik}, t_{i-k}$.

8.1 Total time online, TO_i

When setup costs are small ($F = 0$), the household visits all available domains and allocates equal amounts of time to all of them. When the number of domains increases from J to J*, the total amount of time online TO_i increases by a factor of $\frac{J*}{J}$, and when an alternative device becomes available, TO_i is unchanged because it represents time on the home device. The standard model with small setup costs predicts total time online on the home device weakly increases in response to the two shocks when setup costs are small.

When setup costs are large ($F > 0$), the household may be constrained to visit a subset of domains even before the number of domains increases from J to J*. When new domains arrive, households will either allocate the same amount of time to online activities or increase their time spent online. When an alternative device becomes available, a household that was previously constrained to visit a subset of domains may substitute some of those visits towards the alternative device, decreasing time online on the home device. If the household was not previously constrained, then additional time spent on the alternative device does not affect time on the home device. Therefore the effect of the two shocks on total time online in the presence of large setup costs is ambiguous.

8.2 Breadth of browsing, C_i

When setup costs are small ($F = 0$), the household visits all available domains and allocates equal amounts of time to all of them. When domains increase from J to J*, the household visits as much as twice as many domains and spends no more time per domain as the household did before. The household's breadth of browsing weakly declines. When an alternative device becomes available, the household continues to visit all domains on the home device in equal amounts so that the breadth of browsing does not change. The standard model predicts the concentration of time across domains will fall in response to the two shocks when setup costs are small.

When setup costs are large ($F > 0$), the household may be constrained to visit a subset of domains even before the number of domains increases from J to J*. When new domains arrive, households will either visit the same number of domains and spend equal amounts of time per domain or will increase the number of domains visited and spend equal amounts of time per domain; concentration of time across domains weakly declines. The alternative device either causes no change in the allocation of time on the home device or results in the household substituting domain visits to the alternative device, in which case concentration of time across domains on the home device weakly increases. The net effect of the two shocks on the household's breadth of browsing is ambiguous when setup costs are large.

8.3 Depth of browsing, L_i

When setup costs are small ($F = 0$), the household can visit the same domain any number of different times to reach the same amount of total time spent at that domain: for instance, a single session of 10 minutes or ten sessions of 1 minute each. The standard model with small setup costs does not make a prediction about the depth of browsing.

When setup costs are large ($F > 0$), time spent across all visited domains is identical and expended in a single, continuous session so as to incur the setup cost only once. The household may be constrained to visit a subset of domains even before the number of domains increases from J to J*. When new domains arrive, households will either visit the same number of domains and spend equal amounts of time per domain as before or will increase the number of domains visited and spend equal amounts of time per domain as before; in either case, the depth of browsing remains unchanged. The alternative device either causes no change in the allocation of time on the home device or results in the household substituting domain visits to the alternative device, but leaving the depth of browsing of the remaining visits on the home device unchanged. The two shocks are not predicted to have any effect on the depth of browsing when setup costs are large.

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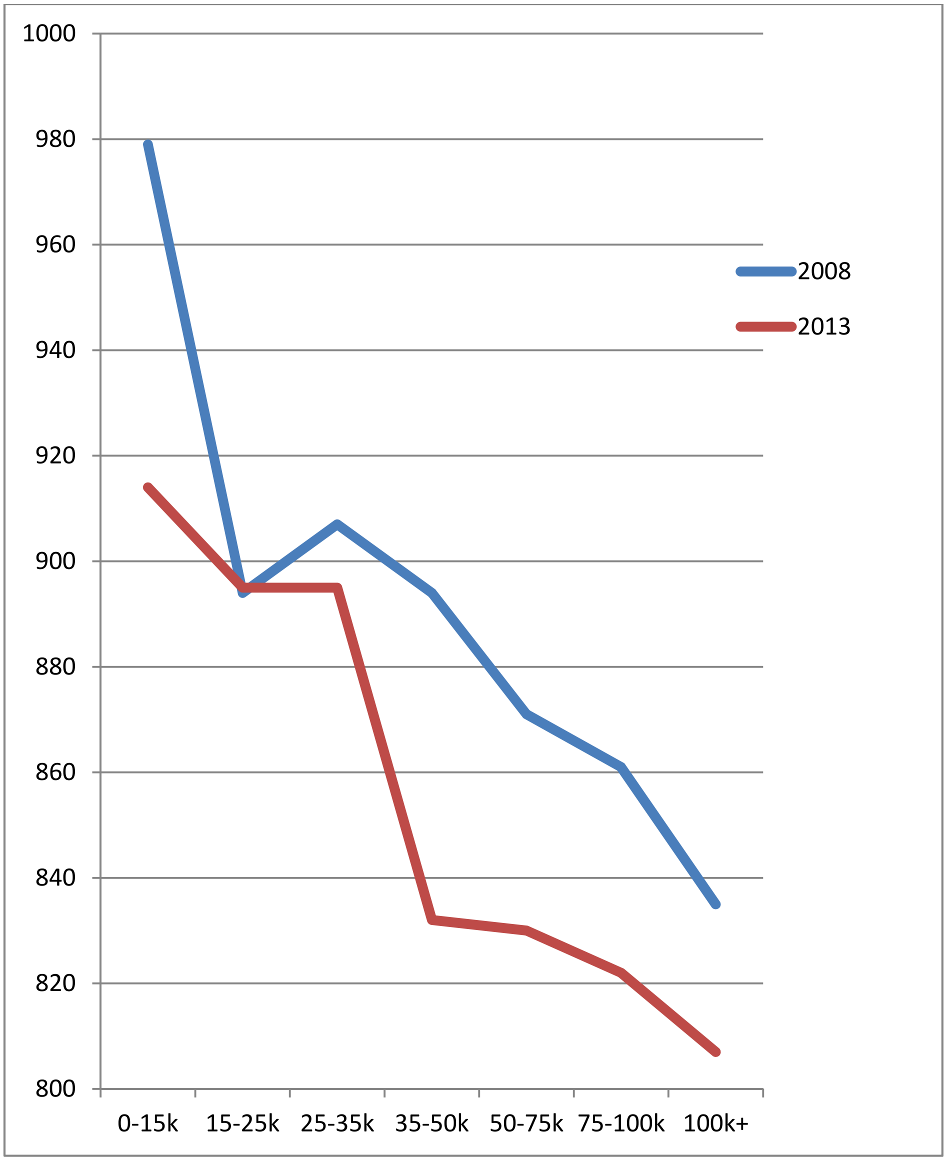
Figures

Figure 1

Total Time Online by Income (2008, 2013)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980
960
940
920
900
880
860
840
820
800
0-15k
15-25k
25-35k
35-50k
50-75k
75-100k
100k+
2008
2013

Figure 2

Unconditional Distribution of Online Attention (2008 vs. 2013)

2008	2013

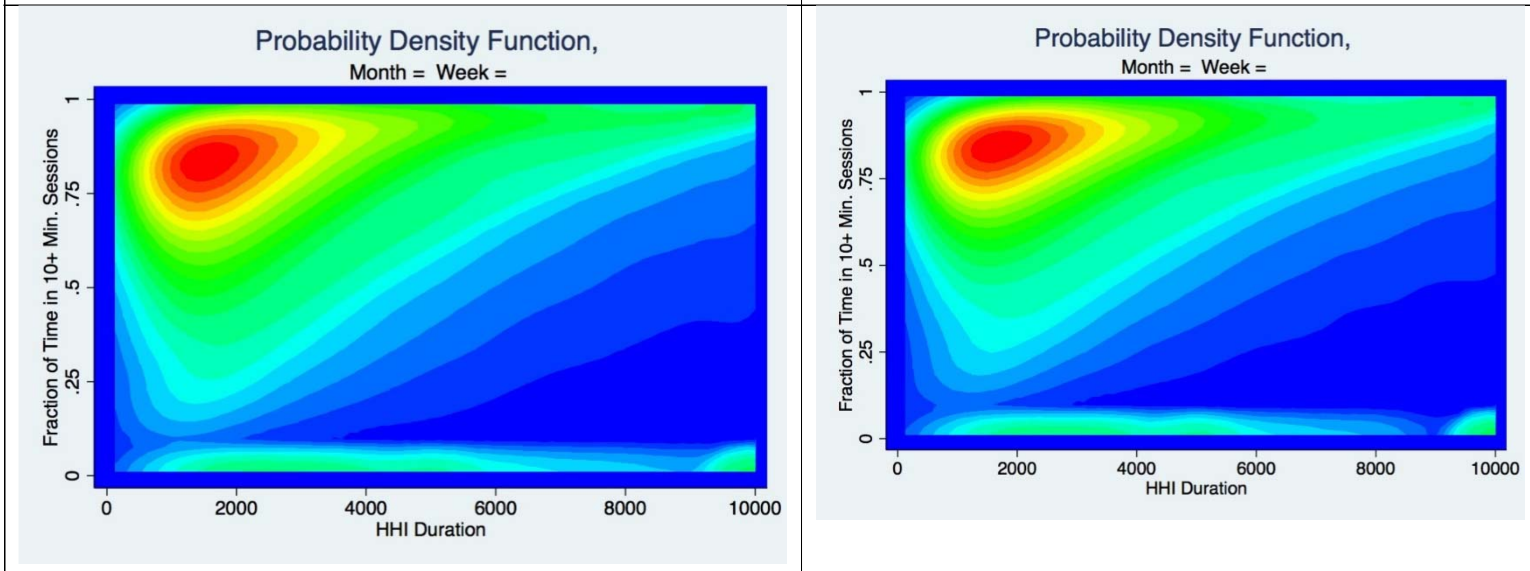

Figure 3

<u>Distribution of Online Attention for Households by Quartiles of Total Minutes Online</u>

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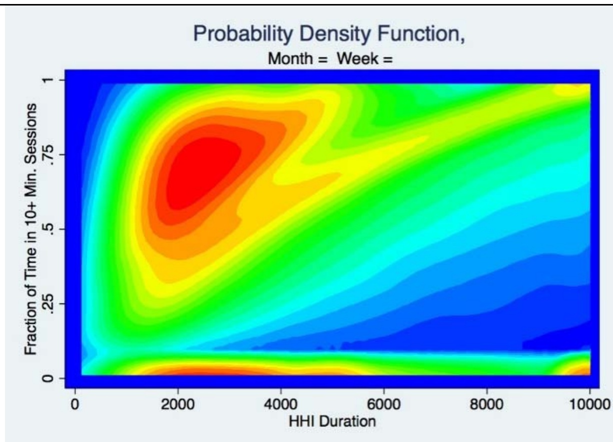
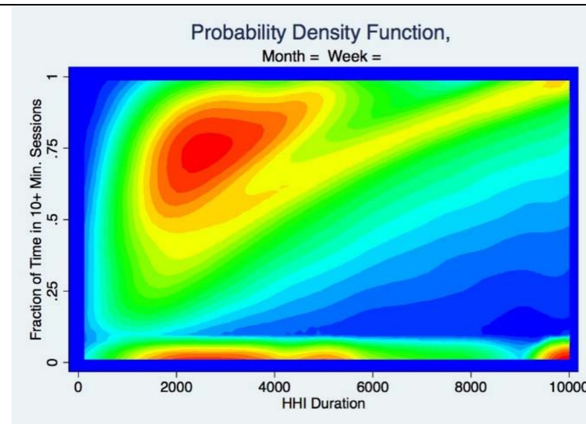
<tr><td>1st Quartile of Total Time Online</td><td>
</td><td>
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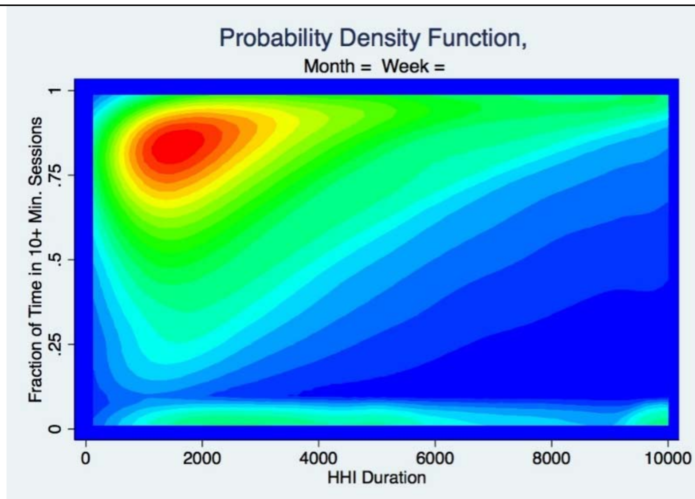
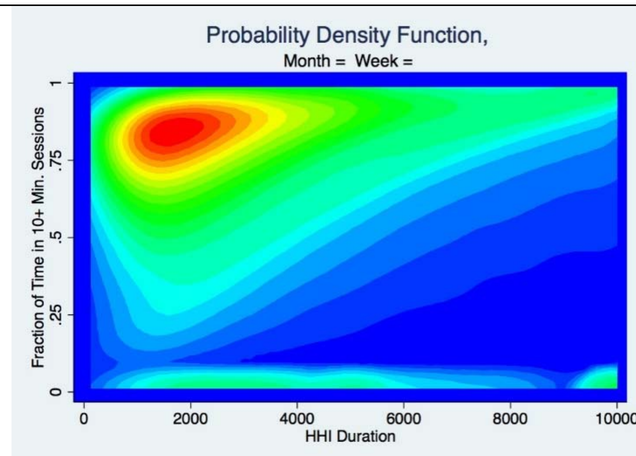
<tr><td>2nd Quartile of Total Time Online</td><td>
</td><td>
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Quartile
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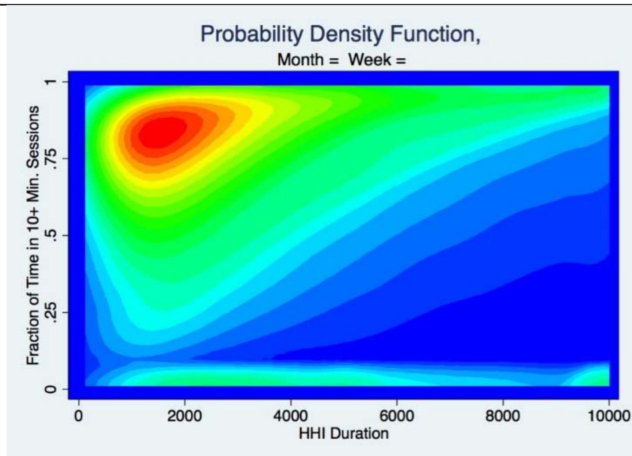
<td>
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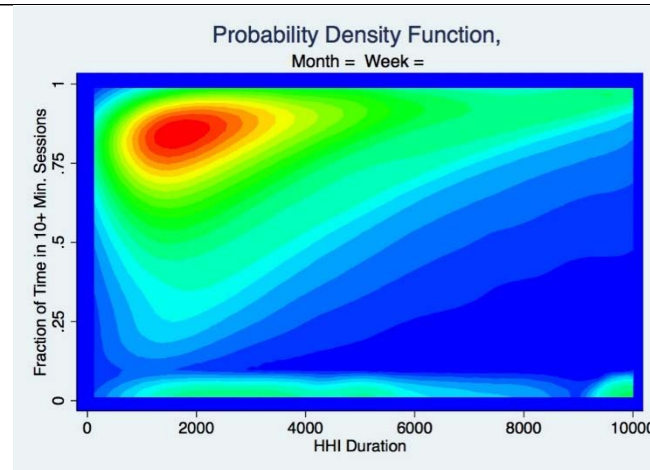
<td>
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<tr>
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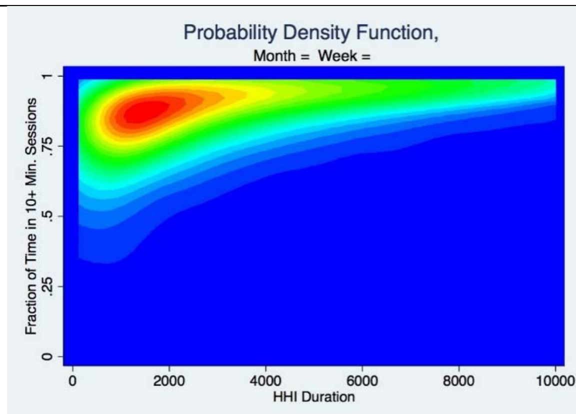
Quartile
of Total
Time
Online</td>
<td>
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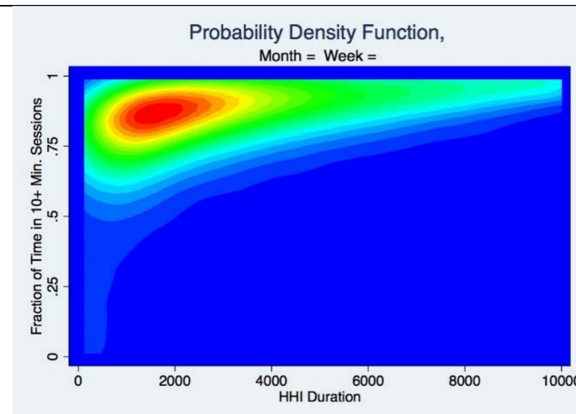
<td>
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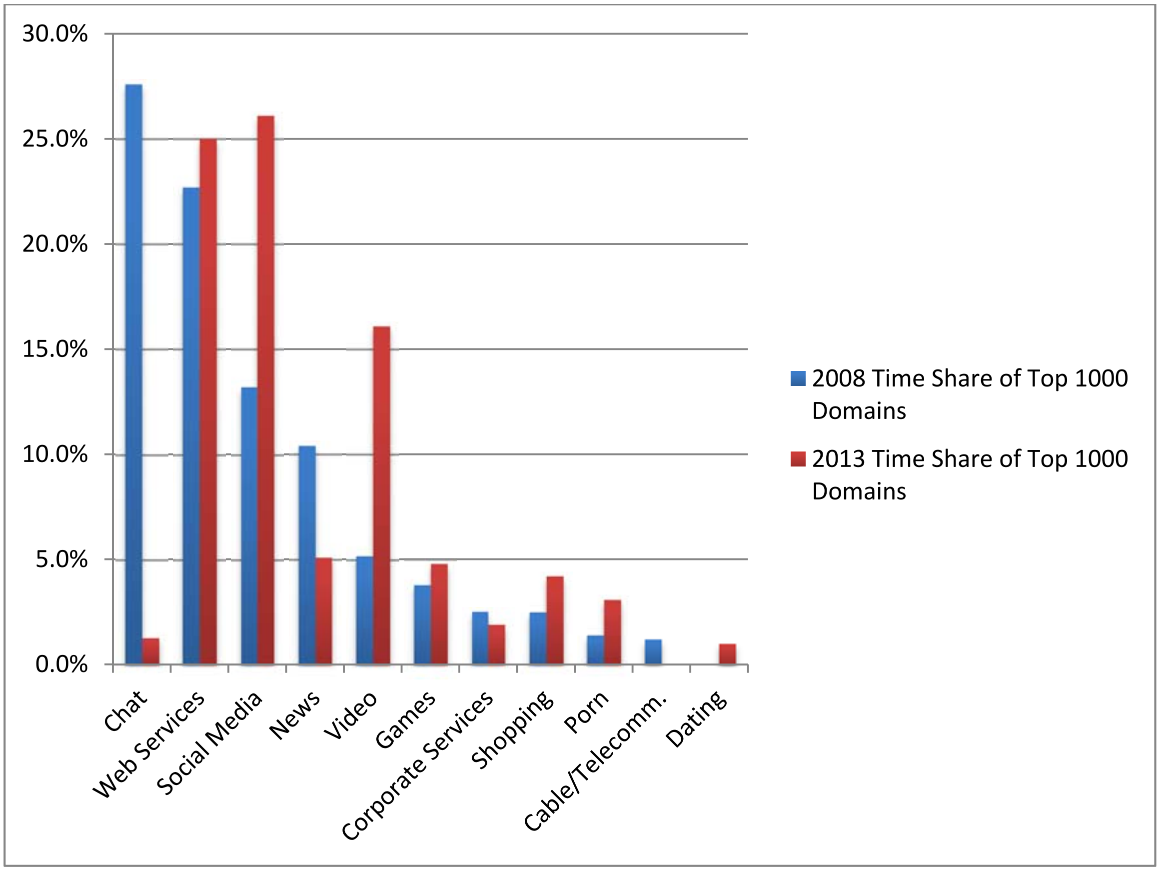
</table>

Figure 4

Changes in Attention Allocation across the Top 1000 Domains by Category (2008 - 2013)



Tables

Table 1

Household Summary Statistics

Variable	2008 N = 40,590		2013 N =32,750	
	Mean	Std. Dev.	Mean	Std. Dev.
Income < $15k	0.14	0.34	0.12	0.33
Income $15k-$25k	0.08	0.27	0.10	0.30
Income $25k-$35k	0.09	0.29	0.11	0.31
Income $35-$50k	0.11	0.31	0.15	0.35
Income $50-$75k	0.23	0.42	0.21	0.40
Income $75-$100k	0.16	0.36	0.13	0.34
Income $100k+	0.20	0.40	0.19	0.39
Age of Head of Household 18-20	0.00	0.07	0.05	0.21

Age of Head of Household 21-24	0.02	0.14	0.07	0.26
Age of Head of Household 25-29	0.05	0.22	0.08	0.27
Age of Head of Household 30-34	0.07	0.26	0.10	0.30
Age of Head of Household 35-39	0.11	0.31	0.08	0.28
Age of Head of Household 40-44	0.15	0.35	0.10	0.31
Age of Head of Household 45-49	0.17	0.38	0.12	0.33
Age of Head of Household 50-54	0.15	0.35	0.12	0.33
Age of Head of Household 55-59	0.10	0.30	0.09	0.29

Age of Head of Household 60-64	0.07	0.25	0.07	0.25
Age of Head of Household 65+	0.10	0.30	0.12	0.32
HH size = 1	0.07	0.25	0.12	0.32
HH size = 2	0.34	0.47	0.25	0.43
HH size = 3	0.25	0.43	0.21	0.40
HH size = 4	0.18	0.39	0.19	0.39
HH size = 5	0.11	0.31	0.16	0.37
HH size = 6+	0.05	0.22	0.07	0.27
Education < High School	0.00	0.01	0	0
Education High School	0.00	0.06	0.03	0.17
Education Some College	0.00	0.06	0.19	0.40
Education Associate Degree	0.00	0.02	0.16	0.37
Education Bachelor's Degree	0.00	0.06	0.11	0.32

Education Graduate Degree	0.00	0.04	0.01	0.08
Education Unknown	.99	0.11	0.49	.50
Children Dummy	.68	.47		

Table 2

Summary Statistics of Browsing Behavior

	Year = 2008 *N =1,721,820*			
Variable	**Mean**	**S.D.**	**Min**	**Max**
Minutes online per week	884	1281	1	10080
Unique domains visited per week	41	44	1	3936
Focus (HHI of time across domains)	2868	2026	33	10000
Propensity to Dwell (Fraction of sessions > 10 minutes)	0.75	0.23	0	1
	Year = 2013 *N = 1,360,683*			
Minutes online per week	849	1091	1	10078
Unique domains visited per week	41	47	1	7525
Focus (HHI of time across domains)	2968	2061	1.51	10000
Propensity to Dwell (Fraction of sessions > 10 minutes)	.76	.22	0	1

Table 3

Linear Regression - Time per week on demographics

	2008	2013
Covariate	**Minutes per Week**	**Minutes per Week**
Income $15k-$25k	-80.25*** (-3.83)	-18.85 (-0.95)
Income $25-$35k	-73.01*** (-3.57)	-18.67 (-0.96)
Income $35k-$50k	-91.39*** (-4.73)	-79.30*** (-4.49)
Income $50k-$75k	-117.7*** (-7.16)	-84.90*** (-5.08)
Income $75k-$100k	-131.3*** (-7.46)	-94.81*** (-5.25)
Income $100k+	-165.5*** (-9.90)	-124.1*** (-7.14)
Education High School	262.3 (1.84)	-

Education Some College	288.6* (1.97)	17.69 (0.64)
Education Associate Degree	188.7 (1.12)	12.84 (0.46)
Education Bachelor's Degree	348.1* (2.34)	79.60** (2.72)
Education Graduate Degree	248.3 (1.63)	131.3 (1.91)
HH Size = 2	-7.566 (-0.38)	-35.22* (-2.03)
HH Size = 3	10.38 (0.44)	-35.28 (-1.86)
HH Size = 4	27.27 (1.14)	-9.752 (-0.48)
HH Size = 5	74.72** (2.86)	1.002 (0.05)

HH Size = 6	113.6*** (3.69)	-21.04 (-0.87)
Age of Head of Household 21-24	-387.1*** (-4.20)	9.291 (0.34)
Age of Head of Household 25-29	-434.1*** (-4.88)	-15.89 (-0.62)
Age of Head of Household 30-34	-477.5*** (-5.42)	-36.37 (-1.47)
Age of Head of Household 35-39	-402.4*** (-4.58)	-21.14 (-0.84)
Age of Head of Household 40-44	-360.7*** (-4.11)	-17.66 (-0.71)
Age of Head of Household 45-49	-381.5*** (-4.36)	41.42 (1.69)
Age of Head of Household 50-54	-408.1*** (-4.66)	52.50* (2.12)
Age of Head of Household 55-59	-501.6*** (-5.71)	13.65 (0.54)

Age of Head of Household 60-64	-531.0*** (-6.01)	10.62 (0.40)
Age of Head of Household 65+	-550.6*** (-6.28)	14.60 (0.59)
Children	3.388 (0.25)	132.3*** (10.46)
Constant	958.6*** (6.12)	799.9*** (21.53)
R-Squared	0.01	0.01
N	1,710,147	1,359,331

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4a

Test of equality of means across years

	Dependent variable	Dependent variable
	Focus (HHI of time across domains)	**Propensity to Dwell (Fraction of Sessions > 10 minutes)**
2013	139*** (12.27)	0.01*** (12.67)
Demographic Controls	Y	Y
Control for Time Online	Y	Y
N	3,069,478	3,069,478

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4b

Two-Sample Kolmogorov-Smirnov Test for Equality of Distribution Functions

	Variable	Variable
	Focus (HHI of time across domains)	**Propensity to Dwell (Fraction of Sessions > 10 minutes)**
p-value	0.00	0.00
N	3,069,478	3,069,478

Table 5

SUR – Fraction of Sessions > 10 Minutes and Time HHI Across Domains

	2008	2008	2013	2013
Covariate	**HHI**	**Fraction > 10**	**HHI**	**Fraction > 10**
Income $15k-$25k	9.556 (1.37)	-0.00276*** (-3.84)	22.29** (2.98)	0.00189* (2.45)
Income $25-$35k	6.577 (0.99)	-0.00787*** (-11.54)	0.721 (0.10)	-0.0000278 (-0.04)
Income $35k-$50k	-8.455 (-1.32)	-0.00975*** (-14.78)	10.70 (1.57)	-0.00295*** (-4.20)
Income $50k-$75k	-29.68*** (-5.52)	-0.0108*** (-19.44)	16.06* (2.51)	-0.00270*** (-4.10)
Income $75k-$100k	-1.538 (-0.26)	-0.0142*** (-23.77)	-27.86*** (-3.94)	-0.00128 (-1.76)
Income $100k+	-42.53*** (-7.61)	-0.0161*** (-28.05)	-14.25* (-2.12)	-0.00461*** (-6.68)
Education High	624.2*** (4.30)	0.0922*** (6.17)	-	-

School				
Education Some College	530.3*** (3.65)	0.0749*** (5.01)	-11.73 (-1.08)	-0.0114*** (-10.18)
Education Associate Degree	402.9* (2.49)	0.101*** (6.05)	-64.78*** (-5.85)	-0.0135*** (-11.85)
Education Bachelor's Degree	299.2* (2.05)	0.0892*** (5.95)	-99.05*** (-8.60)	-0.0114*** (-9.63)
Education Graduate Degree	308.6* (2.10)	0.0960*** (6.33)	-125.7*** (-5.32)	-0.0163*** (-6.70)
HH Size = 2	-44.25*** (-6.54)	-0.000408 (-0.59)	-20.15** (-2.84)	-0.000213 (-0.29)
HH Size = 3	-57.55*** (-7.21)	-0.000247 (-0.30)	-18.03* (-2.34)	-0.000567 (-0.71)

HH Size = 4	-70.93*** (-8.68)	0.000446 (0.53)	-17.64* (-2.19)	0.00111 (1.34)
HH Size = 5	-102.7*** (-11.75)	0.00264** (2.94)	-35.72*** (-4.31)	-0.000443 (-0.52)
HH Size = 6	-235.4*** (-22.92)	0.00455*** (4.31)	-49.57*** (-5.16)	-0.00157 (-1.59)
Age of Head of Household 21-24	86.58** (3.25)	-0.00704* (-2.57)	-19.72 (-1.85)	-0.00398*** (-3.62)
Age of Head of Household 25-29	50.39* (2.00)	-0.00624* (-2.41)	-32.97** (-3.15)	-0.00800*** (-7.44)
Age of Head of Household 30-34	100.4*** (4.03)	-0.00273 (-1.06)	-0.159 (-0.02)	-0.000806 (-0.78)
Age of Head of Household 35-39	105.4*** (4.27)	0.00228 (0.90)	-7.925 (-0.77)	-0.00270* (-2.54)

Age of Head of Household 40-44	184.7*** (7.51)	0.00384 (1.52)	51.09*** (5.12)	-0.00437*** (-4.26)
Age of Head of Household 45-49	231.6*** (9.43)	0.00232 (0.92)	-0.367 (-0.04)	-0.00440*** (-4.38)
Age of Head of Household 50-54	232.9*** (9.47)	-0.00205 (-0.81)	-47.54*** (-4.87)	-0.00625*** (-6.22)
Age of Head of Household 55-59	199.0*** (8.04)	-0.00883*** (-3.47)	20.14* (1.98)	-0.00644*** (-6.16)
Age of Head of Household 60-64	304.2*** (12.18)	-0.00640* (-2.49)	16.32 (1.52)	-0.00531*** (-4.81)
Age of Head of Household 65+	360.0*** (14.56)	-0.00707** (-2.78)	53.28*** (5.41)	-0.00740*** (-7.30)

Children	-58.62*** (-12.78)	-0.000783 (-1.66)	-142.4*** (-27.01)	-0.000568 (-1.05)
Minutes per Week	-0.000443 (-0.37)	0.0000662*** (531.17)	-0.290*** (-181.12)	0.0000724*** (438.72)
Constant	2652.0*** (18.26)	0.617*** (41.25)	3346.2*** (228.47)	0.713*** (473.26)
N	1,710,147	1,710,147	1,359,331	1,359,331
R-Squared	0.00	0.14	0.03	0.13

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note that across years the education dummies are relative to no high school in 2008 and relative to high school in 2013. Std errors not clustered.

Table 6

The Top 20 Domains of 2008 and 2013 (by Total Time Allocated)

2008 Top 20 Domains	Category	2013 Top 20 Domains	Category
myspace.com	Social Media	facebook.com	Social Media

yahoo.com	News	youtube.com	Video
yahoomessenger.exe	Chat	google.com	Web Services
aim6.exe	Chat	yahoo.com	News
google.com	Web Services	tumblr.com	Personal Blog
msnmsgr.exe	Chat	msn.com	News
youtube.com	Video	aol.com	News
msn.com	News	craigslist.org	Shopping
aol.com	News	bing.com	Web Services
aim.exe	Chat	ebay.com	Shopping
facebook.com	Social Media	amazon.com	Shopping
live.com	News	twitter.com	Social Media
msn.com-prop	Chat	yahoomessenger.exe	Chat
myspaceim.exe	Chat	go.com	Sports
ebay.com	Shopping	wikipedia.org	Web Services
waol.exe	Chat	live.com	News
starware.com	Corporate Services	skype.exe	Chat
pogo.com	Games	reddit.com	Social Media
craigslist.org	Shopping	outlook.com	Web Services
go.com	Sports	netflix.com	Video

Table 7

Linear Regression - Unique domains visited per week

	2008	2013
Covariate	**Unique domains visited per week**	**Unique domains visited per week**
Time per week	0.0181^{***} (89.75)	0.0252^{***} (91.81)
Income \$15k-\$25k	0.748 (1.31)	-0.969 (-1.57)
Income \$25-\$35k	0.906 (1.56)	-0.183 (-0.28)
Income \$35k-\$50k	1.092^{*} (2.06)	-0.895 (-1.63)
Income \$50k-\$75k	1.661^{***} (3.75)	-0.840 (-1.58)
Income \$75k-\$100k	1.199^{*} (2.54)	-1.086 (-1.87)
Income \$100k+	1.977^{***} (4.37)	-0.204 (-0.36)
Education High School	-6.908 (-0.81)	-

Education Some College	-13.02 (-1.65)	0.590 (0.62)
Education Associate Degree	-9.897 (-1.22)	1.325 (1.40)
Education Bachelor’s Degree	-5.593 (-0.71)	2.968** (3.01)
Education Graduate Degree	-9.223 (-1.15)	7.603** (2.84)
HH Size = 2	-0.195 (-0.35)	-0.0245 (-0.04)
HH Size = 3	0.718 (1.07)	0.0539 (0.09)
HH Size = 4	0.299 (0.45)	-0.520 (-0.82)
HH Size = 5	1.000 (1.39)	0.273 (0.41)

HH Size = 6	3.780***□(4.25)	0.213□(0.28)
Age of Head of Household 21-24	-3.730□(-1.51)	1.093□(1.31)
Age of Head of Household 25-29	-4.907*□(-2.10)	2.007*□(2.52)
Age of Head of Household 30-34	-5.497*□(-2.39)	-0.155□(-0.21)
Age of Head of Household 35-39	-5.465*□(-2.38)	0.650□(0.83)
Age of Head of Household 40-44	-6.853**□(-3.01)	0.131□(0.17)
Age of Head of Household 45-49	-7.135**□(-3.13)	1.336□(1.71)
Age of Head of Household 50-54	-7.055**□(-3.09)	1.582*□(2.09)
Age of Head of Household 55-59	-7.829***□(-3.42)	0.968□(1.24)

Age of Head of Household 60-64	-9.177***□(-4.00)	1.706*□(2.05)
Age of Head of Household 65+	-8.979***□(-3.93)	0.596□(0.79)
Children	0.932*□(2.43)	2.384***□(6.01)
Constant	34.29***□(4.27)	16.38***□(12.74)
R-Squared	0.28	0.34
N	1,710,147	1,359,331

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8

Hypotheses and Findings

Hypothesis	Description	Finding	Source
H1. $TO_x(S_t, X_{it}) < 0$.	Total time declines with income	Confirmed.	Table 4 Figure 1
H2. $TO(S_t, X_{it}) - TO(S_{t-1}, X_{it-1}) = 0$.	Total time does not change over time with new supply.	Total time slightly declines.	Table 3
H3. $TO_x(S_t, X_{it}) – TO_x(S_{t-1}, X_{it-1}) = 0$.	The relationship between income and total time does not change with new supply.	Very little change in relationship.	Figure 1
H4. $C_x(S_t, X_{it}) = 0$ and $L_x(S_t, X_{it}) = 0$,	Breadth/depth does not vary/decline with income.	Breadth/depth do not vary with income.	Table 5
H5. $C(S_t, X_{it}) - C(S_{t-1}, X_{it-1}) = 0$, and $L(S_t, X_{it}) - L(S_{t-1}, X_{it-1}) = 0$.	Breadth/depth does not change with new supply.	Breadth/depth does not vary meaningfully with new supply.	Figure 2

APPENDIX B

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

EMPIRICS OF BUSINESS DATA SERVICES

WHITE PAPER

By Dr. Marc Rysman[1]
Boston University

April 2016

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

TABLE OF CONTENTS

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.[2] 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.[3] The FCC relaxed price-cap regulations in metropolitan statistical areas (MSAs) that met certain triggers for competitive presence.[4] However, indications that the triggers were not working as intended has led to a freeze on this process.[5]

This paper studies the supply of BDS, also called “special access.” An important goal of this project is to

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[2] 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.

[3] 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 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).

[4] *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.*

[5] *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).

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[6] 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"). 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.

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

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[6] 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

[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 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; 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.

provide a deeper understanding of the industry.

The paper studies what are arguably three different data sets covering revenue, locations and prices, yet 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).

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

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

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, and how parameters can be interpreted in light of the issues alluded to here.

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 report all BDS revenue, but not from

[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) 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.

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.

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 all locations with connections owned or leased as an IRU that are connected to a Metro Ethernet (MetroE)-capable headend. 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 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 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[11] 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 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 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.

[11] 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.

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 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 million in 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.[12] 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.[13]

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.[14]

[BEGIN HIGHLY CONFIDENTIAL]

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

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

[14] *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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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, this problem affects CPs more than ILECs, and so Tables 1 and 2 might overstate ILEC revenues relative to CP revenues. To investigate this, FCC 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.[15] As before, this table counts all earnings made over leased BDS and UNEs.

Company	2013	2014	2015
AT&T	$30,113	$29,523	$28,929
Verizon	$20,716	$19,839	$18,922
CenturyLink	$11,038	$10,999	$10,561
Level3	$3,011	$4,193	$4,989
Windstream	$1,666	$1,767	$1,863
Comcast	$3,241	$3,951	$4,742
Time Warner	$1,901	$2,312	$3,284
Frontier	$2,276	$2,183	$2,161
Charter	$812	$993	$1,127
Earthlink	$945	$911	$945
Cox*	$1,800		
Total (excl. Cox)	$75,719	$76,671	$77,523

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

[15] 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.

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 and has regulatory capacity restrictions, and in some instances may not be true for ILEC deployments (where only copper facilities may be available).[16] But in general, my approach should be reasonable.[17]

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.[18]

[16] 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).

[17] 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.

[18] *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,

(continued…)

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.[19] 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.

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.[20] 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.

Table 4 shows the distribution of about 1.217 million buildings (unique locations) in the data by provider type and technology.[21] CPs report locations where they serve or at least have a connection to the location

(Continued from previous page)
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.

[19] 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/).

[20] *See* Narrative Responses to Question II.A.8 in the Collection.

[21] 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
(continued…)

for approximately 522,000 buildings or 43% of buildings.[22] 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.[23] 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.

	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

(Continued from previous page)
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.

[22] 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.

[23] 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%).

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[24]

[BEGIN HIGHLY CONFIDENTIAL]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[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,[25] so we might be concerned that since these data are two years old, cable

[24] 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.

[25] *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

(continued…)

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.[26]

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.

	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

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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.

[26] 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.

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.[27]

	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.[28]

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

[27] 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.

[28] 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.

census blocks in the United States.[29]

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
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

[29] 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

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.[30] 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.

[30] 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.

	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).[31] 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 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

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

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.[32] 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.[33] 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 the price determining the presence of competition, or 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. 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

[32] 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.

[33] 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.

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.

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.

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.[34] 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.[35] 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

[34] 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.

[35] Dun & Bradstreet data are only available for census blocks located in MSAs.

by the standards of competition analysis.[36] 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.[37]

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.[38] 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 a building 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

[36] 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 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%.

[37] 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.

[38] 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.[39]

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 market power finds inconsistent and insignificant results on local competition for high bandwidth

[39] 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.

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.

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.

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 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.[40] If that correlation is high enough, then best efforts cable could be

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

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 or by cable, but it does not change the conclusion in this paper that there is evidence that local competition affects BDS prices.

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.

	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
	DS-1 Tract FE	DS-3 Tract FE	Hi Band Tract FE	DS-1 County FE	DS-3 County FE	Hi Band County FE
	(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

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.[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.

[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.

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

<u>The Carrier Has Phase 2 Pricing Flexibility in the Wire Center</u>

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

<u>Phase 1 x Facilities-based Competitor in Census Block</u>

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.

<u>Phase 2 x Facilities-based Competitor in Census Block</u>

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.

<u>Customer is a Telecommunications Provider</u>

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

<u>Customer is a Mobile Telecommunications Provider</u>

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

<u>Customer is a Cable Operator</u>

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

<u>Establishments in the Zip Code</u>

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.

<u>Annual Payroll ($1,000) in the Zip Code</u>

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

<u>Employment in the Zip Code</u>

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

<u>Number of Establishments in the Census Block (D&B)</u>

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

<u>Establishments (D&B) per Square Mile in the Census Block</u>

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

<u>Mbps</u>

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

<u>Packet-based Connection</u>

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 in the Census Block	3,596	14,190	0.01	591	603,238

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."[1]

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.[2] 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.[3] The FCC took this step based on "significant evidence that these rules . . . are not working as predicted, and widespread

[1] *Pricing Flexibility Suspension Order*, 27 FCC Rcd at 10563, para. 11.

[2] *See 2005 Special Access NPRM*, 20 FCC Rcd at 1994, para. 1.

[3] *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."[4] 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 . . . ."[5] 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."[6]

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."[7] 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)."[8] The FCC also intends to assess the reasonableness of terms and conditions offered by ILECs for business data service.[9] 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."[10]

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

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[4] *Id*.

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

[6] *Id*. at 10560, para. 6.

[7] *Id*. at 16346-47, paras. 68-69.

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

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

[10] *Data Collection Implementation Order*, 28 FCC Rcd at 13192, para. 5.

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.[11] 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.[12] 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."[13] 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.[14] 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.[15] 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.[16] The large majority of information collected, especially the locations and billing information, is from the year 2013.

[11] *Id*. at 16331, para. 30.

[12] *Id*. at 16331-33, paras. 31-35.

[13] *Id*. at 16333, paras. 36-37.

[14] *Id*. at 16333-34, para. 38.

[15] *Id*. at 16334, para. 39.

[16] *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.

Smartphones and Home Broadband Subscriptions: Substitutes, Complements, or Something Else?

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NOTE: The views expressed in this paper are those of the author and not those of the Pew Research Center.

Introduction

In the latter part of the last decade, many policymakers and other stakeholders thought the United States was in the midst of a broadband crisis. Some were concerned that truly high-speed networks (wireless or wireline) were not extensively deployed in the United States. Others worried about uptake. Notwithstanding fast adoption of home (almost entirely) wireline broadband service in America, broadband adoption in other countries was higher by some measures than the United States. An additional dimension of the uptake problem was the digital divide, that is, the notion that those without home broadband connectivity experience negative social or economic consequences due to lack of home internet access.

By the middle of the 21st century's second decade, innovation in wireless internet access had changed the nature of the tech adoption problem. Fast fourth generation wireless networks and the rapid adoption of smartphones have given Americans a new way to go online and presented people with choice that few imagined a decade ago. One can subscribe to a traditional wireline broadband service using cable, fiber, or DSL technology. Or one can subscribe to a wireless 4G service at access speeds comparable to those available from wireline a decade ago. And, of course, people can (and do) subscribe to both; some 59% do according to the latest Pew Research Center data.

Having more choice for getting online at broadband speeds has two consequences for policymakers. First, in competition policy, wireless internet access from telecommunications carriers might serve as a meaningful check on market power for the provision of home broadband service from wireline internet service providers (ISPs). Abiding concerns, such as those voiced by Federal Communications Commission Chairman Tom Wheeler, that not enough households have more than one wireline ISP offering next generation speeds underscores the stakes in competition policy. Second, the wireless option may address the digital divide if those without wireline home broadband service take advantage of wireless to get online.

Yet the consequences of choice in internet access depend on how people exercise it. In this paper, the goal is to dig into research that has examined patterns of online access since the advent of the smartphone revolution. It will also focus not just on access patterns, but usage as well. The paper's analysis will explore whether online usage varies depending on home wireline broadband access, smartphone-only access, or access to both kinds of access tools. Understanding possible differences in usage across access modes should be relevant to policymakers interested in both competition and equity.

I. What do analysts say about wireline-wireless substitution?

A mixture of anecdote and theoretical holding-forth tends to characterize some of the discussion of whether wireless is a substitute for wireline broadband access. The Free State Foundation offers one example, in declaring that, in the face of growing numbers of "smartphone only" individuals, the FCC should recognize that mobile broadband and fixed broadband are substitutes and that an already competitive broadband market is only more so. From a very different perspective, Harvard's Susan Crawford looks at the same numbers and draws the opposite conclusion, saying the market for high-end service is not competitive.

Another perspective sees substitution not being a universal pattern, but one relevant to certain demographic segments. Minorities – specifically African Americans and Hispanics – have lower rates of home broadband subscriptions and higher rates of smartphone only adoption, as do low-income households. Given this, smartphones are a substitute for wireline access mainly for these demographic groups.

A more dynamic view of the matter does not see 4G wireless as a substitute for wireline broadband today, but notes the real potential that 5G will have the capacity to be a substitute for wireline service. This view argues further that realizing the potential of 5G will require extensive investment in wireline infrastructure. As to industry, whose views may be shaped by advocacy positions on competition policy, wireless access is generally portrayed as a competitive threat to wireline service offerings.

A more nuanced perspective wisely suggests that the question of wireless/wireline substitutability must be "put to the consumer." In a discussion on that, Leslie Marx suggests that speed may not be the most important attribute consumers examine in the wireless-wireline choice. She notes a European Commission report that says that about 25% of those with access to next generation access networks are not interested in additional speed. From this, she infers that such consumers, seemingly indifferent to speed, may see 4G networks as viable alternatives to wireline networks.

The remainder of this paper aims to "put to the consumer" the issue of wireline versus wireless substitutability by examining data on patterns of adoption and usage of wireless and wireline access services. This will entail a review of research studies which have examined this question, as well as data and findings from the Pew Research Center.

II. Review of recent studies

Surveys of consumers are the hallmark of research that explores wireline versus wireless choices and different surveys have different objectives. In 2013, researchers with Connected Nation combined data from that organization's surveys across a number of different U.S. states in Smartphones as a Substitute – Why Some Smartphone Users Aren't Subscribing at Home. This research uses a multinomial regression model to pick apart the demographic factors that are associated with smartphone-only users. With the ability to control for a range of socio-economic and demographic characteristics, the analysis found that younger respondents, lower-income respondents, African Americans, rural residents, and households without children all were significantly more likely to be smartphone only. Notably, given the common understanding from cross-tabulations that Hispanics are more likely to be smartphone-only, the Connected Nation research finds that this is really a youth effect. That is, since Hispanics are on average much younger than the rest of the population and because young adults are more likely to be smartphone-only, Hispanics' high smartphone-only incidence is a result of their youthful profile.

Mossberger, et.al. (2012) focus on usage patterns for smartphone-only individuals compared to those with home broadband in Measuring Digital Citizenship: Mobile Access and Broadband. For an urban population – the Mossberger survey gathered data from 3,000 residents of Chicago – the analysis shows that, across a range of online activities, smartphone-only respondents generally show lower levels of incidence. For using the internet for community news, visiting a local government website, using the internet for work, and searching for the internet for health information, and more, smartphone-only users trailed home broadband subscribers by about 10 percentage points. The only exception to this pattern was using the internet to look for or apply for a job; there smartphone-only respondents were more likely than broadband subscribers to do that by a margin of 83% to 60%. The paper also found that smartphone-only respondents have lower levels of digital skills than those with broadband at home.

Beyond looking at demographics and behavior, another way to investigate the substitution issue is through attitudes. Would people give up their broadband connection for a smartphone? Do people prefer different modes of access for different kinds of online activities? In a 2014 survey for "Smartphones and Broadband: Tech users see them as complements and very few would give up their home broadband subscription in favor of their smartphone," Horrigan looks at internet users' responses to questions about preferences for connectivity. The paper found that:

- Very few broadband users would be willing to cancel their home broadband connection in favor of their smartphone for online access. Some 63% said they would be very unlikely to do this and another 29% said they would be somewhat unlikely to do this – or 92% overall unwilling to cancel broadband in favor of smartphone-only.

- A home broadband connection is the preferred means for information searches, shopping, and watching video, while the smartphone is the preferred means for communicating with family or friends. Specifically:
    - 89% agree very (63%) or somewhat (26%) strongly that their computer, using their home broadband connection, is their preferred means for looking for information about health care or for school work.
    - 83% agree very (56%) or somewhat (29%) strongly that they prefer to use their computer for shopping.
    - 78% agree very (43%) or somewhat (35%) strongly that the smartphone is their preferred way to get hold of a family or friend.
    - Just 29% agree very (11%) or somewhat (28%) strongly that the smartphone is the preferred device for watching online video.

Additionally, 55% of smartphone users report having a data cap and, among them, half (52%) report waiting until they are within range of Wi-Fi to do certain activities or that they avoid certain data-intensive activities such as video.

III. Studies from the Pew Research Center

In a series of studies, the Pew Research Center has investigated smartphone adoption patterns and how people experience the internet using a smartphone. In 2014, the Pew Research Center undertook an extensive examination of the smartphone adoption patterns. The "U.S. Smartphone Use in 2015" report finds that 19% of Americans are smartphone-dependent, which includes people who are either smartphone-only (10% of the adult population) or have some sort of access beyond just a smartphone but the access is limited to such an extent that they use their smartphones mainly for access (15% of all adults). Some 7% of Americans say both conditions apply to them. Like the Connected Nation report, Pew finds that the "smartphone dependent" are younger, lower-income, and more likely to be African American or Latinos.

The Pew analysis also contrasts the "smartphone dependent" with smartphone owners with multiple access paths. Clear differences emerge along economic lines.

- The "smartphone dependent" are more than twice as likely as other smartphone users to say they have had to cancel or suspend service due to financial constraints – by a 48% to 21% margin.
- The "smartphone dependent" also run up against data caps more often than other smartphone users (most of whom presumably have wireless networks from their home broadband network). Half (51%) of the "smartphone dependent" say this compared with 35% for other smartphone users.

Other Pew findings underscore difficulties that smartphone users have when trying to carry out certain tasks online. The 2015 report "Searching for Work in the Digital Era" looks at how people use digital resources in job search. Overall, 79% of Americans who have looked for work in the past two years have used digital tools to do so, with 34% saying it was the most important tool they used. Additionally, 28% of adults have used a smartphone as part of their search and half of those have filled out a job application using a smartphone. Yet, the 28% of Americans who use the smartphone for job search do encounter problems with using the smartphone for this purpose. Among this 28%:

- 47% said job search content did not properly display on their device
- 47% said they had trouble with content not optimized for a mobile device
- 38% reported having difficulty entering large amount of text on their smartphone
- 37% had problems submitting required files or documents to a job search site.

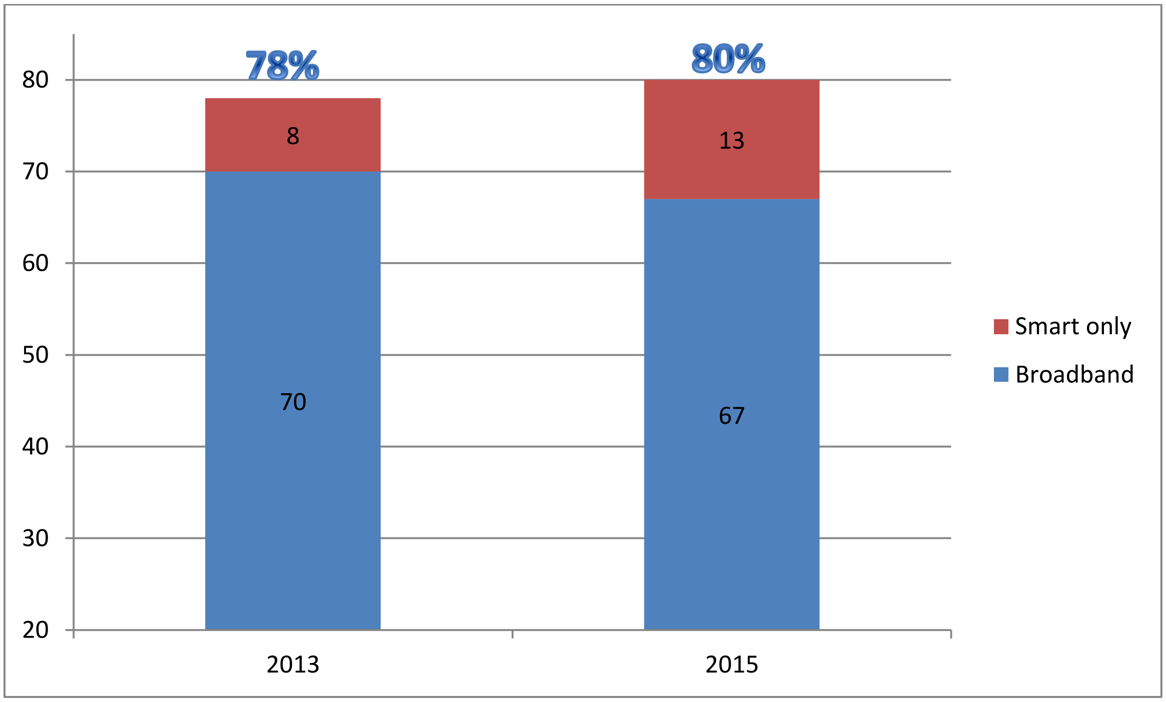
With some of the difficulties and constraints that smartphone-only individuals experience, it is no surprise that they sometimes have to engage in "workarounds" to find the access they need. Often this involves the local public library. For public library users, those with smartphones only are more likely to use a library's Wi-Fi, computers, or internet connections to get online – by a 34% to 26% margin in comparison to those with home broadband. Similarly, for those who engage in personal learning activities, the smartphone-only are more likely to do this at the library than those with broadband at home (by a 26% to 22% margin). They are also less likely than home broadband users to pursue this learning online (by a 47% to 59% margin).

Another perspective on the role of smartphones comes from looking at how people use technology to pursue lifelong learning. In "Lifelong Learning and Technology," Pew found that 74% of adults who engaged in personal learning activities in the prior year, such as attending book club meetings, conferences, conventions, or taking course. Among the 74% who did one of those learning activities (when asked what means they used when learning took place at home):

- 69% say they did this learning on a laptop or desktop computer;
- 11% say they used their smartphone, and;
- 9% cite a tablet computer.

Finally, Pew's "Home Broadband 2015" report analyzes the changing composition of online access, introduces the notion of "advanced internet access," and explores reasons why people do not have broadband – with particular focus on the role of smartphones. With respect to the changing composition of access, the report finds that over the 2013 to 2015 time frame, advanced internet access, that is, those *either* with a home broadband subscription *or* a smartphone, increased slightly from 78% to 80%. Within that, though, the share of those with broadband at home dropped from 70% to 67% while smartphone-only adoption increased from 8% to 13%.

Advanced internet access



Importantly, the drop in home broadband and the rise in smartphone-only adoption mirrored one another. African Americans, rural residents, and low and lower-middle income Americans showed above average declines in home broadband adoption and above-average increases in smartphones only as their online access means.

Several groups are shifting their home internet connectivity away from broadband and toward smartphones

% of each group who have …

	Broadband at home			Smartphone, but no broadband at home		
	2013	2015	CHANGE	2013	2015	CHANGE
All adults	70%	67%	-3%	8%	13%	+5%
African Americans	62	54	-8	10	19	+9
Rural residents	60	55	-5	9	15	+6
Household income < $20K	46	41	-5	13	21	+8
$20K–$50K	67	63	-4	10	16	+6
$50K–$75K	85	80	-5	5	10	+5
Parents	77	73	-4	10	17	+7
High school degree or less	50	47	-3	11	18	+7

Source: Pew Research Center surveys

PEW RESEARCH CENTER

The upshot at looking at adoption patterns in this way is that, even if the drop in the traditional metric of access (broadband subscriptions at home) may alarm some, smartphones steadies the ship, with the uptick in advanced internet access grows from 2013 to 2015.

But how does the utility of the smartphone fare for those without broadband? For some, the smartphone suits them fine. The Pew survey explored this by asking about reasons people do not have broadband in a two-step process. First, non-users were asked to identify from a list of reasons why they do not have service at home. Second, having had the chance to choose more than one reason, non-users were asked to state the most important reason they do not subscribe to broadband. Here are the results:

Non-broadband users cite a number of barriers to adoption

% in each group who cite the following as reasons for not having broadband at home

	All non-broadband users	Smart-phone only
The monthly cost of a home broadband subscription is too expensive	59%	58%
You have other options for internet access outside of your home	46	59
The cost of a computer is too expensive	45	41
Your smartphone lets you do everything online that you need to do	27	65
Some other reason I haven't already mentioned	25	20
Broadband service is not available where you live, or is not available at an acceptable speed	23	27

Cost is the most important barrier to adopting broadband

% of non-broadband users who cite these as the most important reasons for not having a broadband connection

	All non-broadband users	Smart-phone only
The monthly cost of a home broadband subscription is too expensive	33%	33%
Your smartphone lets you do everything online that you need to do	12	29
You have other options for internet access outside of your home	10	9
The cost of a computer is too expensive	10	5
Some other reason I haven't already mentioned/no reason given	25	14
Broadband service is not available where you live, or is not available at an acceptable speed	5	6

As the table shows, there is a segment of non-broadband users that see the smartphone as sufficient to their digital access needs. Among smartphone-using non-broadband adopters (that is 42% of all non-broadband users), close to two-thirds say the smartphone lets them do all they need to online, though a smaller share (under one-third) cite it as the most important reason they do not have service. That puts a lower limit of the number of non-broadband users who view the smartphone as a substitute for home high-speed service at one-third of all non-broadband users and an upper limit at two-thirds of all non-adopters. Splitting the difference, let's say half of all non-broadband users see the smartphone as a substitute for a home high-speed connection.

Doing the math (with 33% of Americans lacking a home broadband connection, with 42% of them having a smartphone, and roughly half of those viewing smartphones as a substitute for broadband) yields a finding that 7% of all American adults see their smartphone as a substitute for a home broadband connection. That amounts to roughly 1 in 10 smartphone users.

Another finding from the Pew report to introduce is how people viewed the importance of a home broadband subscription over the 2010 to 2015 time interval. In 2010, Pew asked people whether not having broadband at home was a major disadvantage or a minor disadvantage in areas such as finding a job, accessing government services, getting health information, and more. In 56% of Americans said lacking broadband at home was a major disadvantage across different topic areas, a figure that grew to 69% in 2015.

Importantly, those figures on the value people place on having broadband at home grew more steeply for non-broadband users. Less than half (48%) of non-adopters said lacking broadband at home was a major disadvantage in 2010, but nearly two-thirds (65%) said this in 2015. Among that 65% of non-adopters, the monthly cost of service was cited by 38% as the most important reason they lacked service – compared to 24% of remaining non-adopters who cited cost as the most important reason they do not have broadband.

In sum, the Pew data on broadband adoption in 2015 paint a picture where smartphones are clearly filling important access gaps for those without a home broadband subscription plan. For many of non-broadband users with a smartphone plan, the smartphone is adequate for their needs (and a majority says they have alternative internet access outside the home). Yet they clearly see the value of a home broadband connection and, if affordability were not a barrier, a good many would likely get high-speed service at home.

IV. Personal information processing

Although most digital divide discourse often centers on access gaps, access is not an end in itself. It is a means to living in an information society where people seek to (and often essentially are *required to*) carry out tasks online. There are obvious upsides to this – the ease of using the internet to communicate with friends or colleagues or the benefits of finding a bargain online. There are also potential downsides; people may experience information stresses, such as information overload or have difficulty finding the information they need.

To explore this, the Pew Research Center's April 2016 survey asked a nationally representative sample of adults about eight different types of information searches they might have done in the prior month. The question was framed to explore information needs on issues of consequence in their lives. The role of the internet in meeting those information needs was not the thrust of the questioning. Yet, as the table below shows, those with more tools with which to access digital resources had greater rates of information searches.

In the past month, have you searched for information about:			
	All	Broadband, smartphone, AND tablet computer	Smartphone only
Community news and information	66%	75%	54%
Health care or health insurance,	41	45	29
Schools or education	39	48	34
Traffic or commuting	34	46	24
Personal finances	32	44	19
Government services or benefits	28	30	26
Issues pertaining to your job	28	40	23
Local home repair	19	21	16
Average number of searches	2.87	3.50	2.26

Those with personal tech abundance – the 39% of adults that have a home broadband connection, a smartphone, and a tablet computer – do more information searches than the 13% of adults who are smartphone-only. Now, some of the difference may be attributable to demographics and differences in information needs. At the same time, multivariate analysis shows that the difference in information searching between the two groups is, to a significant extent, associated with online access tools.

When it comes to "information stresses," differences also emerge between those with lots of digital resources and those with only one.

Information stresses

	All	Broadband, smartphone AND tablet computer	Smartphone only
Feel stressed about the information I must keep track of	42%	37%	43%
It is sometimes difficult for me to find the information I need	36	24	49
Feel overloaded by information	20	14	21

Information overload is not much of a problem for people, but somewhat more of an issue for people with a smartphone only. There is a moderate amount of stress associated with keeping track of information flows for all adults and those with a smartphone feel this a bit more than those with lots of options for getting online.

The big difference emerges in looking at the ease of finding information. Smartphone-only adults are twice as likely to have difficulty in finding information as those with each of three tools for digital access. If you have personal tech abundance, it is typically not hard to find the information you need; if you only have a smartphone there is a 50-50 chance you have trouble from time to time.

V. Smartphones and Communications Policy

Smartphones fill a crucial access hole for some segments of the population, but the evidence assembled here suggests that they are not a robust substitute for a wireline broadband subscription. Few (about one in ten) smartphone-owning Americans indicate that the smartphone is a substitute for a home broadband connection. Not many broadband users would consider doing away with a broadband connection in favor of their smartphone. A strong majority (nearly two-thirds of non-adopters) say that lacking broadband at home is a major disadvantage and, for them, cost looms large as a reason they do not subscribe. For the remaining set of non-adopters, the monthly fee for access recedes as a reason; digital skills and not understanding the relevance of having service are key factors for this group.

The other key point is the user experience for those with smartphones as their lone personal tool for online access. Relative to smartphone users with multiple access pathways, the smartphone-only are more likely to experience service interruptions or to run into data cap constraints. They also do a narrower scope of online activities than those with broadband and encounter problems associated with a small screen. Smartphone-only users are generally less likely to engage in information searches that have consequences for their lives. Finally, the smartphone-only encounter significant difficulties in finding the information they need.

For those interested in the **digital divide**, the message is clear, with a dash of nuance:

- The smartphone is not a substitute for home wireline broadband for half of non-adopters.
- Smartphone users who see their wireless access as a reasonable substitute participate in a "workaround" ecosystem for carrying out online tasks. They cope with data caps and seek out access options outside the home. Since cost rivals the utility of the smartphone as a reason they do not have a broadband subscription, many smartphone-only users might purchase service with the right plan.

For **industry**, the findings on smartphone use are important in the context of the market for broadband service reaching saturation or possibly contracting. Two possible implications for industry are:

- More price discrimination
- More policy scrutiny

With declines in home broadband adoption most acute for low to lower-middle income households, ISPs may consider tailoring offerings to such households. This has already happened with programs such as Internet Essentials from Comcast and AT&T's $10 per month broadband offer for qualifying low-income households, although there is evidence that consumers are not always aware of these plans. Such price discrimination may garner more subscribers, but would also come with less revenue per user in a portion of the market expensive to serve because of higher churn rates.

Another consequence of flattening adoption pertains to investment in next generation networks. A market with home adoption stalled at 70% means a smaller user base from which to recoup the cost of upgrading or building expensive new high speed networks. If the result is lower investment levels and a lock-in of current market structure, policymakers might take note. Antitrust scrutiny is possible if policymakers worry that there are too few providers of very high speed service in too many locales. Regulatory remedies seem both out of fashion and politically infeasible, but topics such as rate regulation might nonetheless take on new prominence in policy discourse. Calls for municipal broadband – the notion that cities should build fiber networks – may also grow louder.

Innovation has not solved the digital divide for non-broadband homes. At best, it has offered some users a bridge to a workaround ecosystem that gives them access to online resources, with the attendant hassles of data caps and small screen constraints. If smartphones continue to contribute to flat home broadband adoption rates, policy debates about the digital divide may begin to intersect more prominently with competition policy.

Network Equality

Olivier Sylvain*

One of the clear goals of the federal Communications Act is to ensure that all Americans have reasonably comparable access to the Internet without respect to whom or where they are. Yet the main focus of policymakers and legal scholars of Internet policy today has been on promoting innovation, a concept that Congress barely invokes in the statute. The flagship regulatory intervention for this approach is "network neutrality," a rule that forbids Internet providers from blocking or interfering with users' connections. To the extent that net neutrality addresses the distributional goals of communications law, it posits that openness will foster innovation which, in turn, will draw user interest which, in turn, will induce investment in more and better infrastructure which, in turn, will benefit today's underserved. This is the trickle down theory of Internet innovation.

This Article critiques this approach. While it has its merits, the privileging of innovation in communications policy could exacerbate existing racial, ethnic, and class disparities because the quality of users' Internet connections refract through those persistent demographic variables. This Article calls for a return to the distributional equality principle at the heart of communications law and policy.

The Internet is essential to almost every aspect of our lives. Like electricity a century ago, it is a technology that determines how we work, campaign, exercise, learn, heal, and love. The benefits of a high-quality Internet connection are especially important—indeed more important—for racial minorities, poor people, and all others who must negotiate structural inequalities in other aspects of their lives in ways that advantaged people do not. Policymakers and scholars accordingly must affirmatively further equality in Internet access, or at least adopt a regulatory approach that seeks above all to ensure equality. The Internet is too indispensable to rely on innovation alone.

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INTRODUCTION

The Internet can be a great equalizer. It enables far-flung, underserved, and oppressed communities to share ideas, products, and services with anyone around the world. It creates connections for people who would otherwise be isolated. We have seen this happen everywhere, from Red Hook, Brooklyn in the wake of Hurricane Sandy to remote mountain villages in San Juan Yaee, Oaxaca to the homes of chronically ill elementary school students in Sumter, South Carolina to the postelection protesters in the streets of Tehran, Iran.[1] The Internet can be a gateway to a vast world otherwise beyond users' reach. In this way, it can be a great democratizing and leveling force.

But this is only half of the story. For the Internet to be a platform for communicative integration, all users must have reasonably comparable Internet access. Otherwise, the disadvantage that remote and underserved communities already experience will only worsen.

This has been true for most communications and general use technologies. Indeed, universal service was the objective for which Congress wrote the Communications Act over eight decades ago. The prevailing communications technologies were different then, of course. But the statute's objective was clear: lawmakers prioritized universal deployment in the broad terms.[2] This remains true. Congress has only clarified this central aim over time. Today, policymakers must ensure that the benefits of the newest communication technologies are "ma[d]e available, so far as possible, to all the people of the United States without discrimination on the basis of race, color, religion, national origin, or sex."[3] The statute, moreover, puts the level of broadband service that policymakers must make available to all users in relative terms; it requires that access and fees charged be "reasonably comparable" no matter whom or where users are.[4] These distributional principles must guide communications policymaking above all else.

Despite this clear command, communications policymakers and legal scholars in the United States today overwhelmingly focus on ensuring that the Internet is a platform for innovation.[5] And, in so doing, they might be complicit in perpetuating existing disparities in availability, adoption, and use across the country.

Low entry costs and decentralized transmission design, the prevailing ethos holds, foster disruptive "generativity."[6] Online companies

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1. *See* Robbie Brown, *A Swiveling Proxy That Will Even Wear a Tutu*, N.Y. TIMES (June 7, 2013), http://mobile.nytimes.com/2013/06/08/education/for-homebound-students-a-robot-proxy-in-the-classroom.html; Noam Cohen, *Red Hook's Cutting-Edge Wireless Network*, N.Y. TIMES (Aug. 22, 2014), http://www.nytimes.com/2014/08/24/nyregion/red-hooks-cutting-edge-wireless-network.html; Jared Keller, *Evaluating Iran's Twitter Revolution*, ATLANTIC (June 18, 2010, 8:00 AM), http://www.theatlantic.com/technology/archive/2010/06/evaluating-irans-twitter-revolution/58337/; *see also* Lizzie Wade, *Where Cellular Networks Don't Exist, People Are Building Their Own*, WIRED (Jan. 14, 2015, 6:30 AM), http://www.wired.com/2015/01/diy-cellular-phone-networks-mexico/.

2. *See* 47 U.S.C. § 151 (2015); *id.* § 1302(a).

3. 47 U.S.C. § 151 (2015).

4. *Id.* § 254(b)(3).

5. *See, e.g.*, BARBARA VAN SCHEWICK, INTERNET ARCHITECTURE AND INNOVATION (2010); Tim Wu & Christopher S. Yoo, *Keeping the Internet Neutral?: Tim Wu and Christopher Yoo Debate*, 59 FED. COMM. L.J. 575 (2007); *see also* Fred von Lohmann, *Fair Use as Innovation Policy*, 23 BERKELEY TECH. L.J. 829 (2008); Mark A. Lemley & R. Anthony Reese, *Reducing Digital Copyright Infringement Without Restricting Innovation*, 56 STAN. L. REV. 1345 (2004).

6. *See* JONATHAN ZITTRAIN, THE FUTURE OF THE INTERNET—AND HOW TO STOP IT 80–90 (2008).

like Amazon, Zipcar, Travelocity, and Uber were all once fledgling start-ups that, through the savvy and creativity of their developers, created new value for customers in the retail product distribution, car rental, travel agency, and taxi dispatch industries. To the extent there is anything of the Communication Act's commitment to equality in this disruption, policymakers and legal scholars assume that the spillover effects of innovation by talented and networked elites will eventually spread to everyone else.[7]

This trickle down theory has guided broadband policymaking for the last decade.[8] Even as policymakers and scholars disagree about how best to promote innovation on the Internet, the ascendant ethos has coalesced around "network neutrality," an approach that would allow users and innovators to engage the Internet freely and without permission from their broadband providers.[9] Broadband providers under a regime of network neutrality would be barred from blocking or discriminating between applications and content.[10] This was the approach the Federal Communications Commission ("FCC") took when it adopted its Open Internet Rules in February 2015.[11] The White House and the FCC have recited the trickle down mantra to justify the Rules as though it is an iron law: Internet innovation, they argue, will generate user interest which, in turn, will induce investment in Internet infrastructure which in turn, will benefit everyone.[12]

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7. *See* Brett M. Frischmann, Infrastructure: The Social Value of Shared Resources 336 (2012); *see also* Protecting and Promoting the Open Internet, GN Docket No. 14-28, Report and Order on Remand, Declaratory Ruling, and Order, 30 FCC Rcd. 5601, 5657 ¶ 128 (Feb. 26, 2015) ("We do not seek to disrupt the legitimate benefits that may accrue to edge providers that have invested in enhancing the delivery of their services to end users. On the contrary, such investments may contribute to the virtuous cycle by stimulating further competition and innovation among edge providers, to the ultimate benefit of consumers.").

8. *See* Appropriate Regulatory Treatment for Broadband Access to the Internet Over Cable Facilities, CS Docket No. 02-52, Declaratory Ruling and Notice of Proposed Rulemaking, 17 FCC Rcd. 4798 (2002). Broadband is a regulatory term of art that the FCC has used for over the past decade and a half to classify high-speed connections in the "last mile." *See id.* The term "broadband" is short hand for what Congress described in the Communications Act as "advanced telecommunications capability." 47 U.S.C. § 1302(d)(1) (2013). In January, the FCC updated the broadband standard to 25 Mbps for downloads and 3 Mbps for uploads. *See* Press Release, FCC, FCC Finds U.S. Broadband Deployment Not Keeping Pace 1 (Jan. 29, 2015) (on file with author).

9. Barbara van Schewick, *Network Neutrality and Quality of Service: What a Nondiscrimination Rule Should Look Like*, 67 Stan. L. Rev. 1 (2015); Tim Wu, *Network Neutrality, Broadband Discrimination*, 2 J. on Telecomm. & High Tech. L. 141 (2003) (coining the term).

10. van Schewick, *supra* note 9, at 4; Wu, *supra* note 9, at 141.

11. Protecting and Promoting the Open Internet, *supra* note 7.

12. This phenomenon has been described as "the virtuous cycle of network innovation and [infrastructure development]." *See* Exec. Office of the President, Community-Based Broadband Solutions: The Benefits of Competition and Choice for Community Development and Highspeed Internet Access 6 (2015). Net neutrality has its detractors, concerned that too heavy a regulatory touch would undermine innovation. Providers, on this view, have an incentive to create new value for subscribers in ways that a flat network neutrality rule would undermine. *See* Christopher S. Yoo,

Emphasizing innovation over everything else is costly. First, as a regulatory objective, Congress has determined that promoting innovation is simply not as important as assuring substantive distributional equality.[13] At best, innovation is a third-order priority that barely makes an appearance in the Communications Act.[14]

Second, universal deployment of broadband is vital because the Internet is today's premier general use technology.[15] Like electricity, the Internet suffuses every aspect of our daily lives. The Internet has become the platform through which people learn about and seek jobs, health care, housing, and education. It defines the way in which currency flows and investments are made. The Internet, moreover, has become an essential feature of the way in which people play, meet life partners, and share intimate thoughts. It plays an essential part of the way in which political and social movements organize and spread. And beyond making phones smart, the Internet today is also enabling our homes, appliances, cars, clothing, and general accessories to be even "smarter."[16]

In short, it is the premier communications platform through which public life today is shaped and is increasingly becoming the repository of our individual and collective identity.[17] To be excluded from all of its affordances is either an act of defiance, ignorance, or the consequence of material misfortune and disadvantage.

At best, the singular focus on innovation tenuously advances the imperative to make reasonably comparable communications services available to all Americans. Yet, the trickle down theory might even undermine the very economic and social benefits that policymakers and scholars purport will flow from network neutrality because its immediate beneficiaries are the very elites who already benefit from relatively superior service. Many Americans today have mediocre connections with only limited functionality.[18] Still others are relatively ignorant of or indifferent to the full range of the Internet's affordances and constitutive applications.[19] And a notable number of Americans are completely shut

Beyond Network Neutrality, 19 HARV. J.L. & TECH. 1, 34 (2005). But even opponents share a commitment to innovation over other policy goals.

13. *See infra* Part I.C.

14. *See infra* Part I.C.

15. *Cf.* ROBERT PLOTKIN, THE GENIE IN THE MACHINE: HOW COMPUTER-AUTOMATED INVENTING IS REVOLUTIONIZING LAW AND BUSINESS 30 (2009) (referring to computers as "general-purpose machines" or "universal machines").

16. *See generally* ZITTRAIN, *supra* note 6 (exploring the past, present, and future of the Internet).

17. *See* JARON LANIER, YOU ARE NOT A GADGET 25 (2010) (discussing the "Singularity" idea).

18. *See* Philip M. Napoli & Jonathan A. Obar, *The Emerging Mobile Internet Underclass: A Critique of Mobile Internet Access*, 30 INFO. SOC'Y J. 323, 326 (2014).

19. *See* Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act, GN Docket No. 11-121, Eighth Broadband Progress Report, 27 FCC Rcd. 10,342,

out, with no serviceable connections in their local residential area.[20] Recent studies show that the "digital divide" remains a stubborn problem, stimulating the familiar demographic fault lines of race, ethnicity, and income that play a significant role in determining whether a user has access to the Internet.[21]

Race, ethnicity, and income do not just influence whether users have access to the Internet. Those factors also affect how they use it, which, in turn, fundamentally shape the nature of the online world. For example, Blacks, Latinos, rural residents, and low income Americans are more likely to access the Internet through a smartphone or other mobile device than Whites.[22] And while this development has helped to close the availability and access gap, mobile devices have a narrower range of functionality. Today, conventional mobile devices do not have many of the capabilities as personal computers. Further, mobile devices are not as immersive because they do not have the same range of storage or processing capacity.[23] Thus, users who can now go online because of mobile technology still cannot do as much online as networked elites. Mobile connections are not a substitute for fixed wired service.[24]

These findings elaborate the pathbreaking findings that the National Telecommunications and Information Administration published in the 1990s on broadband availability and adoption rates.[25] That report is often credited with coining the phrase "digital divide" and sensitizing policymakers and journalists to the fact of disparity between the "information haves and have nots."[26]

Race, ethnicity, and income continue to define availability, adoption, and use patterns nearly two decades later. The trickle down theory purports to redress these disparities, but does so through indirection: it promises that infrastructure investment and deployment will be the

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10,403–11 ¶¶ 139–56 (2012) [hereinafter Eighth Broadband Progress Report]; *see also* U.S. CENSUS BUREAU, MEASURING AMERICA: COMPUTER AND INTERNET TRENDS IN AMERICA (2014).

20. Eighth Broadband Progress Report, *supra* note 19, at 10,369–70 ¶¶ 45–47.

21. *See* David Crow, *Digital Divide Exacerbates US Inequality*, FIN. TIMES (Oct. 28, 2014, 4:03 PM), http://www.ft.com/intl/cms/s/2/b75d095a-5d76-11e4-9753-00144feabdc0.html#axzz3IIlsgT5A.

22. *See* AARON SMITH, PEW RESEARCH CTR., SMARTPHONES AS AN INTERNET APPLIANCE (2011). Specifically, thirty-eight percent of Black/Latino smartphone users rely on their smartphones while only seventeen percent of non-Hispanic Whites do. *Id.* This distribution might reflect the role of median income, since users with incomes of less than $30,000 were more than twice as likely as those with incomes of $50,000 or more to do so. *See* KATHRYN ZICKUHR & AARON SMITH, PEW RESEARCH CTR., DIGITAL DIFFERENCES (2012).

23. *See* Napoli & Obar, *supra* note 18, at 324; Eli Noam, *Let Them Eat Cellphones: Why Mobile Wireless Is No Solution for Broadband*, 1 J. ON INFO. POL'Y 470, 480–81 (2011).

24. *Cf.* Susan P. Crawford, *First Amendment Common Sense*, 127 HARV. L. REV. 2343, 2355–56 (2014).

25. *See generally* NAT'L TELECOMM. & INFO. ADMIN., FALLING THROUGH THE NET: DEFINING THE DIGITAL DIVIDE (1999) (examining which American households have access to telephones, computers, and the Internet, and which do not).

26. *See id.* at Executive Summary.

fortuitous by-products of formal neutrality. But, unless policymakers address disparity head-on, neutrality could just as likely worsen existing inequalities in the short and long term because its first and most immediate beneficiaries are networked elites. That is, even when networks are "open," actually existing structural patterns of disparity and difference will remain and determine the ways through which users engage the Internet. If these are not reversed, the relative advantage in access that networked elites hold will reproduce itself over time until it eventually becomes entrenched.

Surprisingly, an unintended—and unrecognized—benefit of the FCC's network neutrality proceeding, as well as a series of other recent regulatory interventions, is an opening to reclaim the core distributional concerns of the Communications Act.[27] The FCC has declared that the Internet is a public general use technology—like electricity—and, accordingly, must be treated under law as a common carrier. Under this rule, service providers must ensure that all members of the public who try to access the Internet are treated equally.[28] While the FCC's vision of equal treatment is predicated on formal neutrality, the Open Internet Rules provide a legal foundation for a new commitment to substantive equality.

This Article uses this potential new commitment to argue for a return to the fundamental principle of equality over neutrality. Some legal scholars already have done pioneering work on bias, discrimination, and harassment in social networking and elsewhere online, and the law's potential role in stamping them out.[29] It is time to turn this project for law reform to broadband infrastructure and service.[30] In this vein, the

27. It took strong public pushback to get to this opening. The pivot toward the focus on disparity was chiefly inspired by the public's record-breaking resistance to the FCC and its Chairman's intentions to use the neutrality rules to encourage "economic growth, investment, innovation, free expression, and competition." *Oversight of the Federal Communications Commission: Hearing Before the Subcomm. on Comm. and Tech.* (2014) (statement of Tom Wheeler, Chairman, FCC). The gist of the public's reaction was not on the form or pace of innovation, but, rather, on the unadorned problem of inequality. *See, e.g.*, Steve Lohr, *F.C.C. Is Deluged with Comments on Net Neutrality Rules*, N.Y. TIMES (July 15, 2014), http://www.nytimes.com/2014/07/16/technology/a-deluge-of-comment-on-net-rules.html; Edward Wyatt, *F.C.C. Begins Investigation into Quality of Internet Download Speeds*, N.Y. TIMES (June 13, 2014), http://www.nytimes.com/2014/06/14/business/media/FCC-inquiry-into-ties-between-content-companies-and-service-providers.html?_r=2.

28. *See* Press Release, FCC, FCC Adopts Strong, Sustainable Rules to Protect the Open Internet (Feb. 26, 2015) (on file with author).

29. *See, e.g.*, Danielle Keats Citron, *Cyber Civil Rights*, 89 B.U. L. REV. 61 (2009); Jerry Kang, *Cyber-Race*, 113 HARV. L. REV. 1130 (2000).

30. In an article that I published five years ago, I addressed the FCC's failure to abide by important public-regarding procedural norms (embodied in administrative law doctrine, for example) in its implementation of broadband policy. *See* Olivier Sylvain, *Internet Governance and Democratic Legitimacy*, 62 FED. COMM. L.J. 205 (2010). There, I argued that the agency relied too uncritically on engineering norms in order to promulgate its rules. Now, however, that the agency's authority to regulate broadband has been scrutinized by federal courts and its current plan for regulating the

Article builds on research on the current "digital divide," but especially scholarship by Jerry Kang on the similitude and tension in the language of nondiscrimination in debates concerning network neutrality and civil rights.[31] The Article argues that broadband disparity continues to have consequences for how the poor and racial and ethnic minorities integrate into a host of contexts.

In doing so, however, this Article makes two novel contributions to existing scholarship. First, it attempts to excavate and revive communication law's core commitment to substantive distributional equality and identifies it as a principle that should guide policy in this area. Second, it urges a shift in regulatory and scholarly focus that better reflects distributional concerns. It does so by identifying interventions for the future.

The Article proceeds in four parts. Part I analyzes the trickle down theory of Internet innovation, arguing that innovation is not a core or even second-order priority of the Communications Act. Deployment and distributional equality, it shows, are the primary objectives of public law in this area. Part II describes the current state of broadband service generally and the distributional fault lines in availability, access, and use. These raw facts underscore how misplaced the singular focus on innovation has been. That the Internet is a general use technology strongly suggests that access and use disparities will exacerbate racial, ethnic, and income disparities elsewhere in public life. Part III describes the network neutrality, as well as "Open Internet" proceeding that led the FCC to promulgate the new rules. While the agency remains loyal to the trickle down theory of innovation, this Article shows, the agency acceded to the public's demand for equality in broadband policy.

In Part IV, the Article lays out the positive argument for network equality. First, it argues that the concept of substantive equality supplies a productive framework for the regulation of broadband service in ways that the prevailing focus on innovation and formal neutrality do not. It shows, moreover, that recent federal policy holds untapped potential to foster distributional equality of broadband resources, but the FCC has not done enough. Formal neutrality in access to bandwidth is meaningless without greater attention to inequality in the constitutive elements of the network itself. This final Part concludes by summarizing some of the limitations of the network equality framing.

I. The Trickle Down Theory of Internet Innovation

All communication technologies shape public life. The Internet is no different. Like industrial book publishing, postal roads, telegraphy, and

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provision of service has been subjected to public notice and comment, I turn to the substance of the agency's policies.

31. *See, e.g.*, Jerry Kang, *Race.Net Neutrality*, 6 J. on Telecomm. & High Tech. L. 1 (2007).

radio broadcasting in the past,[32] the Internet has facilitated new forms of expression and community.[33]

The transmission design on which the Internet has been based for almost four decades enables lay users to communicate almost anything with others anywhere around the world. Thus, today, a user can draw on the vast amounts of information coursing through the Internet to navigate the physical world with little more than a laptop or smart phone. A tourist can, for example, uncover transportation routes, discover the best local eateries, find a restroom, and avoid risky situations, all while video chatting with a friend miles away. But, of course, the Internet affords so much more. A paraplegic patient who lives outside of Dubuque can video chat with a kidney specialist in Chicago. A pop band in Cape Town can collaborate with likeminded musicians in Paris. Political activists can organize street protests in Cairo from anywhere around the world. The possibilities seem endless.

Today's raw physical political economy of Internet access—broadband—sits in stark contrast to all of this dynamic possibility because users in most local areas have the option of only one or two providers.[34] As gatekeepers in these areas, they have the incentive to extract fees from casual users and sophisticated edge providers like Netflix and Amazon. These fees cause little concern to those who can afford the premium service; they continue to transmit and download online services and applications as they wish. But those who cannot afford the better service can only scratch the surface of the Internet's rich affordances.

Until recently, in the United States, local access providers' pecuniary prerogatives generally determined lay users' service quality. They could offer tiered pricing schemes so that people who wanted or simply could afford better service could pay for it.[35] Access providers could also enter into specialized arrangements with major Internet companies and edge providers to quicken or otherwise privilege access to subscribers. Lay users generally have had little choice in the matter. One recent manifestation of this practice is "zero-rating," where mobile service providers do not count subscribers' connections to affiliated content or applications against data usage limits.[36] Mobile providers implement such plans to gain an obvious advantage over competitors.

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32. *See* James W. Carey, Communication as Culture: Essays on Media and Society 155–77 (1992); Richard John, Network Nation (2010); *see also* Sylvain, *supra* note 30, at 265–67.

33. *Cf.* Benedict Anderson, Imagined Communities (1983) (exploring role of capitalism and printing, rise of nation-states, and use of language in the creation and growth of communities).

34. Susan P. Crawford, Captive Audience: The Telecom Industry and Monopoly Power in the New Gilded Age 3, 120–22, 185–86 (2013).

35. van Schewick, *supra* note 9, at 127.

36. *Id.* at 30.

There are reasons to believe that zero-rating might actually help spawn Internet access in developing countries.[37]

This past February, the FCC substantially circumscribed the extent to which access providers could leverage their market position in this way. The agency promulgated new Open Internet Rules that forbid broadband providers from blocking or discriminating between different kinds of Internet applications and content. Its animating reason for the rules is to encourage innovation. The Commission employs the following syllogism to justify this approach: unimpeded innovation by application developers will generate more user interest which, in turn, will induce access providers to invest in infrastructure which, in turn, will benefit everyone, including the underserved. This is the trickle down theory of Internet innovation. The new rules do this by requiring broadband providers to be "neutral" in how they manage their users' connections.[38]

The FCC is not alone in its commitment to promoting innovation. The concept has been the animating concern for the President and other top-level federal policymakers, scholars, and stakeholders on all sides of the network neutrality debate for well over a decade.[39] The main disagreement has been over which regulatory arrangement creates the most value for consumers. But innovation is the driving concern for most. The following passage from a January 2015 report by the President's National Economic Council and Council of Economic Advisers captures the prevailing view:

> Over the longer term, broadband adoption also fuels a virtuous cycle of Internet innovation. This cycle begins when new applications of the Internet create demand for more bandwidth, resulting in a wave of network-level innovation and infrastructure investment. As more bandwidth becomes available, application-sector innovators find new ways to use that capacity, creating additional demand, leading to another round of network investment, and so on. While it is impossible to know what the next bandwidth-hungry killer application will be . . . both history and economic theory show that this virtuous cycle is a powerful driver of innovation and economic growth.[40]

37. *See* Diana Carew, *Zero-Rating: Kick-Starting Internet Ecosystems in Developing Countries*, PROGRESSIVE POL'Y INST. (Mar. 2015), http://www.progressivepolicy.org/wp-content/uploads/2015/03/2015.03-Carew_Zero-Rating_Kick-Starting-Internet-Ecosystems-in-Developing-Countries.pdf.

38. *See* discussion *infra* Part III.

39. *See, e.g.*, VAN SCHEWICK, *supra* note 5; Wu & Yoo, *supra* note 5; *Net Neutrality*, WHITE HOUSE, http://www.whitehouse.gov/net-neutrality#section-read-the-presidents-statement (Oct. 28, 2015); Tim Wu, *Why Have Telecommunications Law?: Anti-Discrimination Norms in Communications*, 5 J. ON TELECOMM. & HIGH TECH. L. 15, 26 (2006) [hereinafter Wu, *Why Have Telecommunications Law?*]; Tom Wheeler, Chairman, FCC, Remarks at Silicon Flatirons Center, Boulder, Colorado (Feb. 9, 2015) (transcript available at http://www.fcc.gov/document/chairman-wheeler-silicon-flatirons-center-boulder-colorado).

40. EXEC. OFFICE OF THE PRESIDENT, *supra* note 12.

Policymakers did not originate this framing. They owe it almost entirely to the most prominent information and Internet law scholars and thought leaders of the past decade.[41] The consensus view among advocates and opponents of intervention is that, whatever regulatory arrangement policymakers formulate, they should ensure that the Internet remains an engine for innovation.[42] Advocates generally argue that, in order for the Internet to continue to thrive, application developers must be able to "innovate without permission."[43] Opponents, on the other hand, assert that the price mechanism in the market is the best way to allocate costs and risks, and that service providers should be given the freedom to develop affiliations with content and application developers to create new value for subscribers.[44]

In any event, both sides of the debate presume that, whatever regulatory choice the agency makes, innovation fosters a wide range of incidental or spillover economic and social benefits that accrue to society as a result. This Part outlines the contours of the debate.

A. Network Neutrality as Innovation Policy

Neutrality advocates argue that service providers should not be able to ration the quality of users' broadband connections to further their own pecuniary interests. The staunchest advocates accordingly oppose any proposal that would allow providers to charge a premium to prioritize some Internet connections over others. They argue that most users and application start-ups would not be able to afford the specialized treatment, and that this asymmetry would work to the detriment of invention and innovation on the Internet generally. After all, these advocates point out, online giants like Google and Netflix were once start-ups, too, and only succeeded because they did not have to pay a premium to reach users.[45]

Many of these advocates accordingly argue for a flat-out ban on application and content discrimination. They argue that all Internet users, large or small, should be able to access the applications, content, services, and networked devices of their choice. Access providers, they argue, should not block or otherwise interfere with users' ability to share

41. *See, e.g.*, van Schewick, *supra* note 5; Wu & Yoo, *supra* note 5; *see also* von Lohmann, *supra* note 5; Lemley & Reese, *supra* note 5.

42. *See, e.g.*, Wu, *Why Have Telecommunications Law?*, *supra* note 39, at 26.

43. *See* van Schewick, *supra* note 9, at 24–27 n.76.

44. *See, e.g.*, Jonathan E. Nuechterlein, *Antitrust Oversight of an Antitrust Dispute: An Institutional Perspective on the Net Neutrality Debate*, 7 J. on Telecomm. & High Tech. L. 19, 24–26 (2009); Daniel F. Spulber & Christopher S. Yoo, *Mandating Access to Telecom and the Internet: The Hidden Side of Trinko*, 107 Colum. L. Rev. 1822, 1848–49 (2007); Yoo, *supra* note 12, at 34.

45. *See* Tim Wu, The Master Switch: The Rise and Fall of Information Empires 284 (2010) (discussing the rise of Google and the threat that it and other edge providers face from broadband providers).

ideas and content freely; developers should not have to worry about contracting with providers in order to reach users.[46] Instead, they argue, providers should be forbidden from discriminating against different applications or content. Providers should simply just use their best efforts to deliver data to their intended destination irrespective of application.[47] Such a rule, they assert, would ensure that the Internet continues to be the dynamic platform for innovation it has been for the past two to three decades.[48] Paid prioritization, on the other hand, would only encourage providers to supply high-quality service to those who are willing to pay. "Strong open Internet rules," they argue, "are necessary to preserve the virtual cycle of innovation and investment and ensure that the Internet remains a robust platform for consumer choice, economic growth and free speech."[49]

Neutrality advocates, moreover, point to providers' demonstrable interest in controlling user access to competitor services and applications. For example, Comcast, the most notorious of access providers among neutrality advocates, sought approval from federal regulators of its proposed merger with Time Warner, another dominant access provider.[50] The merger would have reached about a third of U.S. homes, far more than any of their competitors.[51] The companies expected that, by joining forces, they would meet increasing demand for better Internet-based services and create new value for their subscribers. Neutrality advocates feared that the new combination would exert unprecedented control over Internet connections.[52] After all, both companies have employed network management practices that leverage their strong market position at the expense of start-up edge providers.[53] They have also degraded connections to rival video and voice applications, ostensibly to protect

46. Letter from Michael Beckerman, President & CEO, The Internet Ass'n, to Marlene H. Dortch, Sec'y, FCC (Jan. 6, 2015) (on file with FCC); *see also* Susan P. Crawford, *Transporting Communications*, 89 B.U. L. REV. 871, 887 (2009); Wu, *supra* note 9, at 150.

47. *See* BRETT M. FRISCHMANN, INFRASTRUCTURE: THE SOCIAL VALUE OF SHARED RESOURCES 348–55 (2012); Susan P. Crawford, *The Internet and the Project of Communications Law*, 55 UCLA L. REV. 359, 403–04 (2007).

48. Wu, *Why Have Telecommunications Law?*, *supra* note 39, at 26; Wu, *supra* note 9, at 150. For advocates of this strong neutrality rule, access providers would only be excused from such obligations in the event of a targeted attack, virus, or other demonstrable threat to the operation of the local network.

49. *See, e.g.*, Letter from Michael Beckerman, *supra* note 46, at 1.

50. Cade Metz, *Why the Comcast-Time Warner Deal Is Far More Dangerous than You Think*, WIRED (Feb. 13, 2014, 4:25 PM), http://www.wired.com/2014/02/comcasts-45bn-time-warner-buy-change-everything/; Sanjay Sanghoee, *Why the Feds Should Block Comcast's Merger with Time Warner Cable*, FORTUNE (Apr. 22, 2014, 2:27 PM), http://fortune.com/2014/04/22/why-the-feds-should-block-comcasts-merger-with-time-warner-cable/.

51. Metz, *supra* note 50; Sanghoee, *supra* note 50.

52. Sanghoee, *supra* note 50.

53. Metz, *supra* note 50.

their own affiliated applications or services from the competition.[54] Partly in response to strong public resistance to the merger, the FCC signaled its wariness about the deal.[55] Seeing the writing on the wall, Comcast and Time Warner withdrew the plan.

Generally, neutrality advocates endorse a general rule against data discrimination, but would accommodate network management practices that assure "quality of service" for real-time or latency-sensitive audio or video applications—that is, accommodations for applications that require data to be sent in a particular way in order for the applications with which they are associated to function as they should.[56] Such an exception recognizes that being completely agnostic about the applications or bits of data that flow through the network would diminish the quality of some of the most popular video streaming applications. A rule of perfect neutrality that makes no exceptions for latency-sensitive applications, these advocates argue, would actually be biased in favor of applications like e-mail or even web browsers that are not as latency sensitive.

Opponents of network neutrality argue that access providers pose no real harm to the vast majority of Internet users. For them, the question should not be whether broadband providers' networks must be open but rather how policy can help providers create the most value for consumers. They argue that, instead, policymakers should take lessons from competition law.[57] The antitrust laws after all protect consumers and small companies from the predations of dominant incumbents.[58] Thus, regulators should focus instead on whether access providers actually have market power or engage in unfair trade practices.[59] If they

54. *See, e.g.*, Comcast Corp. v. FCC, 579 F.3d 1 (D.C. Cir. 2009); Madison River Communications, LLC, File No. EB-05-IH-0110, 20 FCC Rcd. 4295 (Enf't Bureau 2005) (order adopting consent decree); *see also* Press Release, *supra* note 28.

55. Devika Krishna Kumar, *Comcast Drops Time Warner Cable Bid After Antitrust Pressure*, REUTERS (Apr. 24, 2015, 6:25 PM), http://www.reuters.com/article/us-comcast-timewarnercable-idUSKBN0N E2D220150424.

56. *See* Wu, *supra* note 9, at 165. "Latency is a measure of the time it takes for a packet of data to travel from one point to another in a network and often is measured by round-trip in milliseconds." Eighth Broadband Progress Report, *supra* note 19, at 10,362 ¶ 23.

57. There has been hearty debate among scholars about how to administer network management regulations. *See, e.g.*, Philip J. Weiser, *The Future of Internet Regulation*, 43 U.C. DAVIS L. REV. 529, 569 (2009) (arguing a self-regulatory body subject to public agency oversight as best strategy for Internet regulation); Sylvain, *supra* note 30 (arguing for a participatory governance approach to Internet policymaking).

58. *See* John B. Kirkwood, *The Essence of Antitrust: Protecting Consumers and Small Suppliers from Anticompetitive Conduct*, 81 FORDHAM L. REV. 2425, 2433 (2013) (arguing that consumer welfare is the priority in antitrust law based on legislative history, case law, popular opinion, and ease of administration); *see also* Herbert Hovenkamp, *Implementing Antitrust's Welfare Goals*, 81 FORDHAM L. REV. 2471, 2474 (2013); John B. Kirkwood & Robert H. Lande, *The Fundamental Goal of Antitrust: Protecting Consumers, Not Increasing Efficiency*, 84 NOTRE DAME L. REV. 191, 211–36 (2008).

59. *See generally* CARL SHAPIRO & HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY (1998) (applying traditional economic theories to modern information-based technologies).

do not, advocates of this perspective argue, access providers should be able to affiliate or negotiate connection terms with edge providers like Netflix or Google on an individualized basis.[60] Regulators could assess the validity of such arrangements on a case-by-case basis. Such an approach, critics of the Open Internet Rules argue, would increase value for consumers and invite innovations that only special vertical and horizontal arrangements can create.[61] In any event, they note that price is an essential signal of consumers' willingness to pay. Tiered pay-for-priority schemes like these allow providers to earn a return on their investment while also allowing consumers to express their respective service preferences.

Other opponents express support for some network neutrality regulation of service providers, but strongly resist rendering broadband service "a utility" for fear that it would inhibit or delay investment and innovation in nascent applications and services. For example, these opponents hold, such approach could stall improvements in new mobile health products and services like remote monitoring of patients and mobile-connected pill bottles.[62] Thus, while this group's opposition to network neutrality is more narrowly tailored to defining the service as "a utility" (akin to electricity), it is nevertheless similarly grounded in support for innovation.

B. What the Innovation Fixation Misses

The debate among policymakers and scholars about how to allocate duties and costs in furtherance of innovation in the market for broadband service has framed federal policymakers' decisionmaking in the area for the past decade or so. But the preoccupation with innovation in information law and public policy has been in vogue for much longer, influencing technology company managers, scholars, and policymakers inside and outside of communications.[63]

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60. Verizon v. FCC, 740 F.3d 623, 659–61 (D.C. Cir. 2014) (Silberman, J., dissenting).

61. Framework for Broadband Internet Service, Open Internet Rulemaking, GN Docket Nos. 10-127, 14-28, Comments of Verizon and Verizon Wireless (July 15, 2014); *see also* Ev Ehrlich, *Net Neutrality Sounds Good, but It's Worse*, SFGate (July 24, 2014), http://www.sfgate.com/opinion/openforum/article/Net-neutrality-sounds-good-but-it-s-worse-5645596.php; Ariel Rabkin, *The Internet Isn't Plumbed Like the Water System*, Tech. Pol'y Daily (July 16, 2014), http://www.techpolicydaily.com/communications/internet-isnt-plumbed-like-water-system/.

62. *See* Letter from Joel White, Exec. Dir., Health IT Now Coal., Bradley Merrill Thompson, Gen. Counsel, M-Health Regulatory Coal., Robert B. McCray, President & CEO, Wireless-Life Scis. All., to Tom Wheeler, Chairman Fed. Commc'n Comm'n, et al. (Jan. 15, 2015) (on file with FCC).

63. I do not seek here to answer the important question of *how* innovation has prevailed on policymakers at the expense of other important regulatory priorities. It is enough here to observe, simply, that innovation is in vogue. *See generally* Clayton M. Christensen, The Innovator's Dilemma: When New Technologies Cause Great Films to Fail (1997) (addressing significance of corporate response to innovation in technology and change in market); *see also* Jill Lepore, *The*

Consider the influence of Moore's Law, a concept original to information and computer science.[64] In 1965, Gordon Moore, who was then the leading researcher for a major semiconductor developer in Silicon Valley, predicted that microchip processing capacity would increase by "roughly a factor of two per year."[65] That is, improvements in computing capacity would occur at a predictable exponential rate over time. That claim has not been perfectly realized because, in fact, advances in the area come in fits and starts.[66] Nevertheless, the gist of the claim has been influential.[67] Moore's prediction has proven persuasive enough that top researchers and technology company managers now count on it like a law of physics.[68] Manufacturers were integrating it into their industrial design practices within a decade of its announcement. The largest semiconductor makers today continue to rely on it to measure the pace of their manufacturing and marketing efforts, irrespective of whether in fact it accurately describes the pace of their native development processes.

As influential as it is, however, Moore's Law is also very limited in scope; it does not explain (or purport to explain) the manner in which processing capacity is distributed among lay consumers. In fact, while contemporary developers are the likeliest to benefit from each incremental improvement in computing capacity, most consumers do not bear witness to each of the advances. In this regard, Moore's Law does not offer an account of how different segments of the population actually receive or benefit from improvements in processing capacity. Moreover, the rate of improvement in computing capacity varies by device and most users do not have access to anything but mass produced devices. Communications and management scholars have recognized as much, having developed taxonomies of adoption that explain how new technologies disseminate through society over time—from beta release to popular adoption to obsolescence.[69]

These actual distributional factors are precisely what the preoccupation with innovation misses. This is not to say that policymakers

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Disruption Machine: What the Gospel of Innovation Gets Wrong, New Yorker (June 23, 2014), http://www.newyorker.com/reporting/2014/06/23/140623fa_fact_lepore?currentPage=all.

64. *See* Bob Schaller, The Origin, Nature, and Implications of "Moore's Law" (1996).

65. *Id.* at 7.

66. *See, e.g.*, John Markoff, *IBM Discloses Working Version of a Much Higher-Capacity Chip*, N.Y. Times (July 9, 2015), http://www.nytimes.com/2015/07/09/technology/ibm-announces-computer-chips-more-powerful-than-any-in-existence.html?_r=0.

67. To understand the force of the claim, note that the theory of natural selection in evolutionary biology does not purport to predict the rate at which prevalent observable human characteristics change.

68. Cornelis Disco, Getting New Technologies Together 206–07 (1998); *see also* Schaller, *supra* note 64.

69. *See generally* George M. Beal & Joe M. Bohlen, The Diffusion Process (1981) (discussing how farmers accept new tools and ideas).

and scholars have not addressed distributional concerns when they discuss innovation. They have. But their focus has been narrow. At least in the Open Internet Rules, the FCC has sought to allocate duties and entitlements that balance the interests of a very narrow range of networked elites, including, for example, start-up application developers, prominent edge providers, local access providers, and major television and film production studios. The average lay users are secondary. The underserved—the people for whom Congress arguably enacted the Communications Act—are overlooked.

C. Innovation Is a Third-Order Public Law Priority

In its new rules, the FCC generally seeks to facilitate innovation by requiring local access providers to treat data neutrally—that is, to refrain from discriminating or blocking Internet connections based on the data they contain or the edge providers and users from which they originate. But these rules do not concern themselves directly with the distributional question of whether or how lay users receive and use those connections. And to the extent that the rules do, they do so only through indirection. That is, policymakers assume that innovation (by the narrow band of developers mentioned above) will trickle down to lay users, irrespective of how its outputs get distributed among them.

But Congress made universal service deployment the primary concern of the Communications Act. The statute has many other, second-order objectives addressed to the telecommunications and information services industries, including infrastructure investment,[70] competition and interconnection,[71] privacy,[72] law enforcement,[73] and national security.[74] The amended statute, however, is unequivocal about its central purpose. Its first paragraph provides that the FCC is

> to make available, so far as possible, to all the people of the United States, without discrimination on the basis of race, color, religion, national origin, or sex, a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges.[75]

Congress added the absolutist language in this provision (in essence, "without discrimination on the basis of race, color, religion, national

70. *See* 47 U.S.C. § 1302 (2015); *see also id.* § 157.

71. *See* 47 U.S.C. §§ 201, 202 (2015); *id.* §§ 251, 252.

72. 18 U.S.C.A. §§ 2510–2522 (West 2015).

73. Communications Assistance for Law Enforcement Act, 47 U.S.C. § 1001–1021 (1994).

74. Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (USA PATRIOT) Act of 2001, Pub. L. No. 107-56, 115 Stat. 272 (2001).

75. 47 U.S.C. § 151 (1996). Before 1996, the provision simply provided that the FCC was responsible for "regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communication service." *Id.*

origin, or sex") in 1996 to ensure "nondiscrimination."[76] This concept was far different from the pro-competitive sense of "nondiscrimination" as it has appeared in the network neutrality debate. Where the latter is addressed to applications or services, in 1996, Congress sought to make plain that the FCC's central purpose is to protect users and people from discrimination irrespective of their station in life. Congress reiterated this point in Section 706 of the 1996 amendments.[77] In this way, the Act, including and especially the 1996 amendments, bespeaks Congress' unequivocal commitment to ensuring that communication technology is widely available to all users irrespective of who or where they are. And further that such service be "reasonably comparable."[78]

Congress has been consistent about this statutory objective across media platforms. For example, again, in the 1996 amendments, Congress announced a "national policy of diversity of media voices" in recognition that too few broadcast stations and producers were owned or operated by racial minorities or women.[79] The FCC subsequently relied on this 1996 amendment to propose a rule that would explicitly forbid discrimination on the basis of such characteristics. It sought to eliminate longstanding patterns of exclusion in order to diversify programming over the airwaves in a way that better reflected the variety of tastes of U.S. consumers.

Congress, on the other hand, has not made innovation even a secondary regulatory priority in the Communications Act. It invokes the concept in the statute only rarely.[80] In the few instances in which Congress does use some cognate of the term in the Act, it is just one of a variety of factors that the FCC must consider before making a specific regulatory decision. Congress, for example, invokes the term in connection with the FCC's authority to determine whether a telecommunications access provider has complied with rate requirements.[81] In this context, innovation is just one of a handful of factors that the agency must consider. The only other place in which Congress chose to use the word "innovate" or "innovative" in the Act is in reference to the general policy priorities of the Corporation for Public Broadcasting.[82] There,

76. H.R. Rep. No. 104-458, at 32 (1996) (Conf. Rep.).

77. *See* 47 U.S.C. § 1302(a) (1996) ("The Commission and each State commission with regulatory jurisdiction over telecommunications services shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans.").

78. *See* H.R. Rep. No. 104-458, at 18.

79. *See* 47 U.S.C. § 257(a), (c) (1996).

80. The word "innovation" appears just two times in the Communications Act, "innovative" appears just once, and "innovate" is absent entirely.

81. 47 U.S.C. § 226(h)(3) (2015) (discussing the breadth of service offerings, service quality, and price).

82. *See* 47 U.S.C. § 396(g)(1)(A) (2015).

innovation must be weighed against program "quality, diversity, creativity, [and] excellence."[83]

But the statute's relative indifference to innovation has evidently not been an impediment for those debating the substantive merits of network neutrality. Purely as a matter of constitutional and administrative law doctrine, however, the text of the statute must constrain the scope of the agency's authority to promulgate rules in the area. The FCC accordingly has hewed to some stated authority in the Act in order to announce the new rules, all while remaining loyal to its real interest in innovation. Specifically, the FCC has turned to provisions that encourage universal deployment of broadband.[84] Its argument proceeds as follows: openness and nondiscrimination encourage users and developers to create new applications and content; the more varied Internet applications are, the more likely that users will adopt broadband service; the more new users, the more likely that providers will invest in their networks and reach even more new users. For the agency and other proponents of the trickle down orthodoxy, universal deployment is innovation's happy by-product.

In fact, however, the FCC's real interest in innovation is orthogonal to the statute's core distributional concern. The rules, after all, will remain fully applicable well after everyone is well connected, precisely because universality is not their statutory objective.[85] This is not to say that a perfectly open national system of broadband might not encourage universal employment. Nor is this to say that the Open Internet Rules are illegitimate to the extent they promote innovation or encourage entrepreneurship and competition. The D.C. Circuit rightfully held that infrastructure investment is a reasonable objective of the rules under Title I of the Communications Act.[86] The point I make here is that, under the statute, innovation is at best a third-order priority under the Communications Act. As it relates to broadband in particular, Congress actually expressed near indifference about how the FCC should regulate broadband—whether through a system of openness or something else. Instead, the statute authorizes the agency to regulate *or simply refrain from regulating* broadband, as long as, whatever action the agency chooses "encourage[s]" broadband service "deployment on a reasonable and timely basis."[87]

83. 47 U.S.C. § 396(g)(2)(C) (2015).

84. Verizon v. FCC, 740 F.3d 623, 643–45 (D.C. Cir. 2014); *see also* Eighth Broadband Progress Report, *supra* note 19, at 10,385 ¶ 92; Preserving the Open Internet, Broadband Industry Practices, GN Docket No. 09-191, Report and Order, 25 FCC Rcd. 17,905, 17,905 ¶ 1 (2010).

85. The agency anticipates universal broadband adoption by 2022. *See* Eighth Broadband Progress Report, *supra* note 19, at 10,344–45 ¶ 3.

86. *Verizon*, 740 F.3d at 642.

87. The statute provides in pertinent part that in order to "encourage the deployment on a reasonable and timely basis" of broadband service, the FCC has the discretion to choose between

Universal deployment is not a matter that should be so easily contorted to advance other objectives. The Communications Act asserts that the FCC's core reason for being is to protect against distributional unfairness in the delivery of emergent communications services. To acknowledge as much would focus attention to whether broadband in the United States is available "to all Americans."

The answer to that inquiry is not a happy one. At least, it is complicated. As I show below in Part II, the Internet ecosystem today is defined by disparity and difference. There, I outline what the state of broadband service actually is in the United States, irrespective of how rapid the benefits of openness will flow to innovators and other networked elites.

II. The Reality of Network Disparity

Since the establishment of the United States Postal Service in the late eighteenth century, universal deployment of communications infrastructure has long been a core public law priority in the United States. But the statutory injunction in the Communications Act to assure universal deployment of communication technologies is especially pertinent at a time when networked communications have become essential to the operation of public life. This is why the FCC and other commentators have rightfully called the Internet the "general use" technology of our time.[88]

In fact, however, we are far short of universal deployment today. Current patterns in broadband delivery across the country suggest something more like "information redlining" in which providers fail to build and service racial and ethnic minorities or lower income and rural communities on the same terms as wealthier communities.[89]

This Part briefly chronicles the manner in which broadband service is unevenly distributed. Exhaustive research by the U.S. Census Bureau, the Pew Research Center, and others shows definitively that, first, disparities in broadband availability, adoption, and use have a substantial impact on the manner in which different users engage the Internet and, second, that these disparities track existing racial, ethnic, and class fault

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"price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment." 47 U.S.C. § 1302(a) (1996).

88. *Cf.* Plotkin, *supra* note 15, at 30 (referring to computers as "general-purpose machines" or "universal machines").

89. 140 Cong. Rec. 14844 (daily ed. June 28, 1994) (statement of Sen. Markey); *see also* John Eggerton, *MMTC Tells Government There Is Need for More than Speed*, Broadcasting & Cable (Jan. 15, 2015, 4:00 PM), http://www.broadcastingcable.com/news/washington/mmtc-tells-government-there-need-more-speed/137119.

lines.[90] If the Internet is the premier general use technology of our time, exclusion has substantial costs for the underserved and society at large. These findings are alarming because they run against the clear statutory objectives of communications law.

A. The Promise of an Open Internet

To understand the scope of what is at stake, it is worth noting how embedded the Internet is in public life today. It inhabits practically all aspects. Its most familiar applications—the World Wide Web and e-mail—enable people to communicate with landlords, political allies, doctors, and lovers. Other applications provide important information to consumers about products and services, including comparative price information about health care options, cars, and homes. They enable house hunters to find a place to live, homemakers to survey design ideas for their home, job seekers to communicate with prospective employers, and drivers to navigate backcountry roads.

The Internet today is also a vital component of our political culture. Partisans, activists, and casual users alike rely on social media and an array of Internet applications to mobilize people around issues and electoral campaigns. Some of these efforts seek to spread awareness about intractable sociopolitical and economic problems. Others are far more whimsical.[91]

Ordinary people are not the only beneficiaries of the Internet's affordances. The networked communication technologies of today have become a terrific source of data about consumers and their habits. This, in turn, has enabled "data brokers" and social networking administrators to analyze and predict user behavior and preference.[92] These advances have created new markets in search, reputation, and finance.[93] While many of these changes challenge conventions in national security, privacy, and consumer protection, firms continue to collect and share online data with third-party brokers quite freely. Online user data has become one of the driving currencies of the networked information

90. *See, e.g.*, U.S. Census Bureau, *supra* note 19; Aaron Smith, *Why Pew Internet Does Not Regularly Report Statistics for Asian-Americans and Their Technology Use*, Pew Research Ctr. (Mar. 29, 2013), http://www.pewinternet.org/2013/03/29/why-pew-internet-does-not-regularly-report-statistics-for-asian-americans-and-their-technology-use/.

91. Jason Wells, *Cancer Patient's Pre-Surgery Flash Mob Dance Goes Viral, Inspires*, L.A. Times (Nov. 8, 2013), http://articles.latimes.com/2013/nov/08/local/la-me-ln-cancer-patient-viral-video-flash-mob-dance-20131108.

92. Paul Ohm, *Broken Promises of Privacy: Responding to the Surprising Failure of Anonymization*, 57 UCLA L. Rev. 1701, 1760 (2010).

93. Frank Pasquale, The Black Box Society: The Secret Algorithms That Control Money and Information (2015).

economy.[94] And, users have been complicit, volunteering their information for fear of being left out.

These are just the conventional affordances of the Internet. Today, all manners of devices and appliances are connected.[95] Brick-and-mortar retailers, homebuilders, automobile manufacturers, and consumer appliance developers have over the past decade integrated networked communications technology into their products. Cars and homes are now equipped with remotely operated security and lighting systems. Clothes now share and collect location and biometric data about their wearers and the people immediately around them.[96] And all of these connections and transactions occur seamlessly, practically in real time, giving consumers the sense that, no matter where they are, they are always connected to the networked world.[97] This is what observers mean when they speak of the "Internet of Things."[98]

While much of this sounds like futurism, it is a core preoccupation of network communication technology firms today. Eric Schmidt, the Chairman of online search and advertising giant Google, recently forecasted that "the Internet will disappear" because "it will be part of your presence all the time."[99] Appliances, devices, and clothes, he predicts, will interact with the rooms we walk into and the people we meet, with our permission but mostly out of sight.[100] This "post-Internet" world will depend increasingly on algorithms and other automated systems that will interact with each other on our behalf.[101] The most dramatic, quasi-religious version of this portrayal envisions The Transhuman

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94. *See, e.g.*, Claire Cain Miller & Somini Sengupta, *Selling Secrets of Phone Users to Advertisers*, N.Y. TIMES (Oct. 5, 2013), http://www.nytimes.com/2013/10/06/technology/selling-secrets-of-phone-users-to-advertisers.html?pagewanted=all (discussing how companies like Google and Facebook are trying to find new ways to monetize their user bases by finding way to target them with specific ads); Danny Yadron, *FTC Says Brokers Bid Private Data*, WALL ST. J. (May 7, 2013 6:22 PM), http://www.wsj.com/articles/SB10001424127887323687604578469392421956334.

95. *See* PEW RESEARCH CTR., DIGITAL LIFE IN 2025 (2014).

96. Mat Honan, *The Future of Wearables Isn't a Connected Watch*, WIRED (Jan. 29, 2015, 5:00 AM), http://www.wired.com/2015/01/useful-wearables/.

97. *See* CHRISTOPHER STEINER, AUTOMATE THIS: HOW ALGORITHMS CAME TO RULE OUR WORLD 112 (2012).

98. *See, e.g.*, JEREMY RIFKIN, THE ZERO MARGINAL COST SOCIETY: THE INTERNET OF THINGS, THE COLLABORATIVE COMMONS, AND THE ECLIPSE OF CAPITALISM (2014); R.S. Raji, *Smart Networks for Control*, 31 SPECTRUM, IEEE 49 (1994).

99. Michael Moore, *Google Chairman Expects Internet to 'Disappear' Soon*, TECHWEEK EUROPE (Jan. 23, 2015, 12:06 PM), http://www.techweekeurope.co.uk/e-innovation/eric-schmidt-google-internet-disappear-160126.

100. *Id.*

101. *Cf.* Ian Wallace, *What Is Post-Internet Art? Understanding the Revolutionary New Art Movement*, ARTSPACE (Mar. 18, 2014), http://www.artspace.com/magazine/interviews_features/post_internet_art ("[P]ost-Internet artists have moved beyond making work dependent on the novelty of the Web to using its tools to tackle other subjects. And while earlier Net artists often made works that existed exclusively online, the post-Internet generation (many of whom have been plugged into the Web since they could walk) frequently uses digital strategies to create objects that exist in the real world.").

Singularity, in which all information is shared freely for the betterment of humanity.[102]

The Internet in this vein has become the general repository of our individual and shared identities. Information about us online reflects who we are individually and collectively. If you are not online, you might as well be invisible. The benefits of online participation greatly outweigh its costs. Full network integration is now imperative, and exclusion, potentially disastrous.

B. Internet Access Today as It Exists in Fact

The Internet's indispensability is not lost on most Americans. According to the Census Bureau's 2013 data, about 74% of American households use the Internet, up from 18% in 1997.[103] But its demonstrable growth masks the manner and rate at which lay users are connecting. To say that people are using the Internet more than they ever have does not say much about the character of their uses, or the purposes to which they are putting their connections.

In fact, many people do not have all of the affordances of the Internet at their fingertips. We know that users and application developers alike, no matter how savvy they might be, are only as innovative and sociable online as their physical points of contact with the Internet allow them to be. And for many users, bad or unreliable service is a feature of their service rather than a bug. The disparities between those with great service and those with typically poor or mediocre connections manifest themselves in a variety of complicated ways, but generally correlate with race, ethnicity, and class. In other words, we are very far from being "post-Internet" today.

Yet, most users just assume that high-speed Internet service is always available. In fact, however, it is neither speedy nor reliable for everyone. Only the most well-to-do have access to the best broadband service. That is, a relatively small fraction of Americans have platinum broadband service, a majority have limited but good enough service to engage a variety of high bandwidth applications like Netflix and other services simultaneously, and a small but notable fraction have poor or no service at all.[104] This breakdown is largely defined by a variety of demographic factors that affect users' willingness or ability to adopt service. In this regard, it is not unlike the market for goods and services in all of public life. From big-ticket necessities like healthcare and housing to more leisurely pursuits like air travel and fine dining, public

102. *See* Lanier, *supra* note 17, at 25–26.

103. Thom File & Camille Ryan, U.S. Census Bureau, Computer and Internet Use in the United States: 2013, at 2, 3 (2014).

104. Pew Research Ctr., Broadband Technology Fact Sheet (2013), http://www.pewinternet.org/fact-sheets/broadband-technology-fact-sheet/.

life in the United States is characterized by an unequal distribution of goods and services—a social arrangement in which the proverbial one percent can afford the best, a majority can afford passable goods and services, and a meaningful minority have little to nothing at all.[105]

In this regard, broadband service disparities are not random; they track the very same demographic fault lines of race, ethnicity, and class that define public life generally in the United States. Here, in this Subpart, I catalogue some of the ways in which these disparities manifest themselves nationally. To be clear, broadband service data is generally difficult to synthesize. Some reports, for example, rely on obsolete or inapposite speed benchmarks.[106] Others do not disaggregate between fixed and mobile broadband connections, let alone different kinds of fixed service, such as DSL, cable, and fiber.[107] Still others do not distinguish between service availability like the sheer existence of service that passes by the home and adoption, in essence, the choice to open a subscription. Nevertheless there is sufficient available data to make modest and incontrovertible observations about broadband service disparity today.

1. Access and Adoption

Availability rates correlate significantly with locality.[108] The FCC reported in 2012 that nineteen million Americans, six percent of the population, did not have fixed broadband service available to them in their local area.[109] Three-quarters of this group lives in rural areas where population density is very low. One reason for this disparity is that the "business case" for building and administering service to remote and sparsely populated areas is difficult to make. Without government subsidies, the building and administration of new networks is prohibitively expensive.[110]

105. *See generally* Thomas Piketty, Capital in the Twenty-First Century (Arthur Goldhammer, trans. 2014). This state of affairs is hardly something with which most people are comfortable. And, yet, disparities remain and, now, appear to have become one of the defining features of American life.

106. *See, e.g.*, Eighth Broadband Progress Report, *supra* note 19, at 10,364, 10,386–87 ¶¶ 29, 97 (referring to 3 Mbps/768 kbps benchmark rather than current regulatory standard of 4 Mbps/1 Mbps); Press Release, FCC, Connecting America: The National Broadband Plan 6 (Mar. 17, 2010) (on file with author) (recognizing dissonance between available data reported by providers and new benchmark).

107. *See, e.g.*, Pew Research Ctr., *supra* note 104.

108. Eighth Broadband Progress Report, *supra* note 19, at 10,379 ¶ 80; *see also* Olivier Sylvain, *Broadband Localism*, 73 Ohio St. L.J. 795 (2012).

109. Eighth Broadband Progress Report, *supra* note 19, at 10,359–58 ¶¶ 45–47. Cable and DSL providers account for the largest portion of the service. *Id.* at 10,374 ¶ 60.

110. *Id.* at 10,369–86 ¶¶ 44–93.

Meanwhile, the rate of adoption in the United States is around seventy percent today.[111] This is a substantial increase from 2000. The main barriers to user adoption are different from that for broadband deployment. Today's user adoption barriers include service cost, the lack of digital literacy, and the perceptions about the Internet's lack of relevance.[112]

To put a finer point on it, about one in four American households with access do not use the Internet.[113] About a quarter of that population reports that the monthly cost of broadband service is too expensive to justify.[114] Here, income is significantly correlated with the rate at which households actually adopt service when it is available in their area.[115] Many in this group, moreover, tend to be older, make less than $30,000 per year, and have less than a high school education.[116] In short, income is among the strongest determining variables of Internet access and use.[117]

Residence or geography, too, is a major factor, with states in the Deep South showing the lowest rates in the country of households that are connected to broadband.[118] This geographic trend further supports data showing that median household income is an important driver of broadband adoption rates.[119]

Nearly half of the people in households who choose not to subscribe but otherwise have access to broadband report that they simply do not want it.[120] The most commonly given reason for why members of this group do not subscribe to broadband (or even dial-up) is the perception that the Internet is not relevant or useful to their lives.[121] For example, many in this group find the Internet sufficiently irrelevant such that they

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111. *See* Pew Research Ctr., *supra* note 104; Eighth Broadband Progress Report, *supra* note 19, at 10,394 ¶ 120 (stating the FCC reported that about two-thirds of American households had adopted the service by 2012); *see also* FCC, Internet Access Services: Status as of December 31, 2013, at 11–13 (2014).

112. Eighth Broadband Progress Report, *supra* note 19, at 10,403–11 ¶¶ 139–56.

113. U.S. Census Bureau, *supra* note 19.

114. *Id.*

115. *See* Mark Dutz et al., *The Substantial Consumer Benefits of Broadband Connectivity for U.S. Households*, Internet Innovation Reliance 28 (July 2009) ("In 2008, 88% of high-income households (with annual household income exceeding $100,000) [subscribed] to broadband, while only 41% of low-income households (with annual income less than $25,000) had adopted it."); Smith, *supra* note 22, at 10 (finding, in 2010, that one-third of broadband users subscribed to a "premium" Internet access service, paying a little over forty-one dollars per month on average for it).

116. Smith, *supra* note 22, at 10; *see also* Eighth Broadband Progress Report, *supra* note 19, at 10,378 ¶ 75.

117. *See* Council of Economic Advisers, Mapping the Digital Divide (2015).

118. File & Ryan, *supra* note 103.

119. *See* Andrea Peterson, *Why the South Lags Behind When It Comes to Home Broadband Use*, Wash. Post (Nov. 17, 2014), http://www.washingtonpost.com/blogs/the-switch/wp/2014/11/17/why-the-south-lags-behind-when-it-comes-to-home-broadband-use/.

120. U.S. Census Bureau, *supra* note 19.

121. *Id.*; *see also* Zickuhr & Smith, *supra* note 22.

opt to not own a computer.[122] And, yet, about twenty-one percent of non-adopters admit to their lack of sophistication or literacy about the online world.[123]

2. *Race and Ethnicity*

Race and ethnicity also bear on availability and adoption rates. Tribal communities, for example, are more likely than others to lack service.[124] This, however, is largely because any group, irrespective of race or ethnicity, is less likely to have access in rural areas.[125] Most racial and ethnic minorities, on the other hand, live in and around urban areas where population density is characteristically very high and broadband is likely to be available. But, while access has increased dramatically across demographic groups in just the past five years, racial disparities in Internet access, adoption, and use persist even in cities. As of 2013, about sixty-five percent of Hispanic households and sixty percent of non-Hispanic Black households have broadband at home.[126] Compare this to the seventy-six percent of non-Hispanic White households with such connections.[127] Observers generally attribute the low adoption rate of Hispanic and non-Hispanic Black households to the prohibitively high cost of service or equipment.[128]

A recent Field Poll in California also found that adoption rates among Latinos are starkly lower than those for other demographic groups. While seventy-five percent of all adults in California have broadband service at home, that rate is thirty-two percent for those who

122. Eighth Broadband Progress Report, *supra* note 19, at 10,409 ¶ 152.

123. ZICKUHR & SMITH, *supra* note 22; *see also* JOHN B. HORRIGAN, DIGITAL READINESS: NEARLY ONE-THIRD OF AMERICANS LACK THE SKILLS TO USE NEXT-GENERATION "INTERNET OF THINGS" APPLICATIONS (2014), http://jbhorrigan.weebly.com/uploads/3/0/8/0/30809311/digital_readiness.horrigan.june2014.pdf. *See generally The Complexity of "Relevance" as a Barrier to Broadband Adoption*, BENTON FOUND. (Jan. 6, 2016 3:55 PM), https://www.benton.org/blog/complexity-relevance-barrier-broadband-adoption?utm_campaign=Newsletters&utm_source=sendgrid&utm_medium=email ("[S]uccessful interventions will need to unpack the relevance concept and address "ability to pay" instead of 'willingness to pay' for broadband at home. Further research, including additional questions on nationwide broadband adoption surveys, is also needed to establish a more in-depth understanding of relevance as an issue, particularly for individuals and families in low-income communities where cost remains the most significant barrier to adoption.").

124. *See* Eighth Broadband Progress Report, *supra* note 19, at 10,378 ¶ 73.

125. *Id.*

126. *See* Smith, *supra* note 90 (noting that Pew does not collect data on broadband adoption and use by Asian Americans largely because Asian Americans constitute "a very small slice of the population, 3.7 percent in the 2000 Census").

127. *Id.*

128. *See* Danielle Keh et al., *The Cost of Connectivity 2014: Data and Analysis on Broadband Offerings in 24 Cities Across the World*, OPEN TECH. INST. (Oct. 30, 2014), http://www.newamerica.org/oti/the-cost-of-connectivity-2014/.

have not graduated from high school and forty-six percent for Latinos.[129] The consequences of these disparities are significant. As one example, consider that Latinos, even as the most underinsured group in the country, have been the least likely to enroll in health insurance through HealthCare.gov under the Affordable Care Act largely because of the language barrier and a related distrust of government.[130]

Race and ethnicity also figure into the availability and quality of service in schools. According to one recent report, schools that serve large populations of African American and Latino students are nearly half as likely as predominately White schools to have access to broadband.[131]

Race, moreover, is significantly correlated with the kind of device on which users rely to access the Internet. According to the Pew Research Internet Project, for the past couple of years, Blacks and Latinos have become almost twice as likely as Whites to rely on their smartphones as their exclusive means of accessing the Internet.[132] Even if they are as likely as Whites to own any sort of mobile phone, researchers have found that Blacks and Latinos report outsized reliance on smartphones and other wireless devices to gain access to the Internet.[133]

In some regards, this mobile trend is good news because it suggests a way to close the "digital divide" in Internet access.[134] Blacks and Latinos use their wireless devices at greater rates to play music, record and watch videos, access social networking sites, check their bank balance, or participate in a video chat. Whatever intervention policymakers undertake, they should explicitly consider that mobile broadband is the main way through which historically underserved communities gain access.

But the new trend also is a peculiar kind of achievement since, today, mobile service is not as speedy or reliable as wireline service on a

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129. Patrick May, *Poll: California's Digital Divide Still Gaping*, SILICONVALLEY.COM (July 8, 2014, 8:58 AM), http://www.siliconvalley.com/ci_26108198/poll-californias-digital-divide-still-gaping. These statistics are notable because California is otherwise popularly understood to be where most online innovation occurs.

130. *See* Cheryl Corley, *Language Remains a Barrier in Latino Health Care Enrollment*, NPR (Jan. 20, 2014, 7:44 PM), http://www.npr.org/2014/01/20/263361444/language-remains-a-barrier-in-latino-health-care-enrollment; April Dembosky, *Selling Health Care to California's Latinos Got Lost in Translation*, NPR (Mar. 6, 2014, 7:59 AM), http://www.npr.org/blogs/health/2014/03/06/286226698/selling-health-care-to-californias-latinos-got-lost-in-translation.

131. *See* JOHN B. HORRIGAN, ALLIANCE FOR EXCELLENT EDUCATION, SCHOOLS AND BROADBAND SPEEDS: AN ANALYSIS OF GAPS IN ACCESS TO HIGH-SPEED INTERNET FOR AFRICAN AMERICAN, LATINO, LOW-INCOME, AND RURAL STUDENTS 8–9 (2014).

132. AARON SMITH, PEW RESEARCH CTR., 35% OF AMERICAN ADULTS OWN A SMARTPHONE 15 (July 2011) (finding specifically, thirty-eight percent of Black/Latino smartphone users rely on their smartphones while seventeen percent of non-Hispanic Whites do so); ZICKUHR & SMITH, *supra* note 22, at 19 (reflecting that this distribution might reflect the role of median income, since users with incomes of less than $30,000 were more than twice as likely as those with incomes of $50,000 or more to do so).

133. AARON SMITH, PEW RESEARCH CTR., AFRICAN AMERICANS AND TECHNOLOGY USE (2014).

134. FILE & RYAN, *supra* note 103, at 12.

variety of measures. First, the propagation characteristics of most wireless service today does not yet afford anything close to the transmission speed of fixed wireline service.[135] Second, while smartphone devices are interactive and user-friendly, they generally do not deliver services or opportunities anywhere near the range or depth as those offered by PCs.[136] Of course, mobile phones are more geographically flexible and, as a result, afford a range of sophisticated location-based applications that are less relevant for, say, a desktop computer. Still, the mobile device experience is hardly as immersive. Specifically, mobile users' search engine entries are not as detailed or probing and the possibilities for content creation are substantially limited. The most successful start-ups and homework assignments rarely spring from a mobile device alone.[137] In short, broadband access through smartphones and tablets are simply not a substitute for PCs.[138]

C. The Costs of Disparity

Race, ethnicity, and income determine Internet access, adoption, and use. Yet, we might downplay the disparities in broadband service as long as they are not as egregious as disparities in, say, education, health care access, or housing. We might just assume that the uneven distribution of broadband service in the United States is not as worthy of alarm if it just reflects a social arrangement that tolerates worse disparities in those and other important areas of public life.

If the Internet is the dominant general use technology of our time,[139] however, broadband service disparities pose a far more perilous problem than policymakers have yet to acknowledge. It does not matter that the marginal Internet user has the mere potential to realize her respective communicative capacity on a free and open Internet. Any regulatory approach that allows service providers to privilege users and edge providers with the wherewithal to pay for better connections would undermine the core objective of communications law. Such specialized treatment would effectively limit other users' ability to pursue online opportunities and curtail small developers' relative ability to innovate. Those who do not have the fastest broadband connections might be able to invent, study space science, obtain good healthcare, or organize movements. But they do so from a position of relative disadvantage. This is to say nothing of the multifarious forms of learning and social engagement that they would gain with faster or more reliable connections.

135. Noam, *supra* note 23, at 475 (explaining that fiber optic and cable technologies are "20 to 100 times as fast as optimistically projected 4G rates").

136. Napoli & Obar, *supra* note 18, at 323, 326.

137. *Id.* at 327–29.

138. *See* Crawford, *supra* note 24, at 2355–56.

139. *Cf.* Plotkin, *supra* note 15.

That broadband service disparities track deeply salient demographic factors like race, ethnicity, and income is doubly alarming because, again, if the Internet is the defining general use technology of our time, it will perpetuate inequalities across substantive areas, no matter how altruistic and innovative some networked elites are. This account undercuts the trickle down theory of Internet innovation. It suggests that, even when networks are open, extant structural patterns of exclusion will determine the ways through which users will gain access to and experience the Internet. Thus, to put it starkly, even though data transmissions on the Internet do not consider race, ethnicity, or incomes, the quality of users' respective connections refract through those persistent demographic variables.[140] Until policymakers do away with broadband service disparity, economically and sociopolitically disadvantaged groups will not be able to contribute to or enjoy the fruits of innovation online in the same way that others do. Without positive intervention addressed to disparity-qua-disparity, these disadvantages will worsen.

Of course, there are no guarantees that mere membership in networks will yield benefits.[141] The value of networks depends on so much more, including the duration, intensity, and reciprocity of their constituent connections.[142] The relative advantage that privileged groups hold in income, wealth, educational attainment, and job security, for example, reproduces itself online and offline over time until it eventually becomes entrenched in both. Unless substantially reversed, these advantages become "durable"—online and off.[143] Exclusion in this way worsens existing disadvantage.[144]

The costs of cumulative disadvantage over time are great. Social science research on social networks has shown that exclusion is costly because inclusion, its opposite, has benefits that only accrue to

140. *Cf.* Osagie K. Obasogie, Blinded by Sight 181 (2014).

141. *See* Robert D. Putnam, Bowling Alone: The Collapse and Revival of American Community 19 (2000); *see also* Ben Fine, Social Capital Versus Social Theory: Political Economy 179–80, 182 (2001); Nan Lin, *Building a Network Theory of Social Capital*, *in* Social Capital: Theory and Research 3, 11 (Nan Lin et al. eds., 2001).

142. *See* Mark S. Granovetter, *The Strength of Weak Ties*, 78 Am. J. Soc. 1360 (1973).

143. Daria Roithmayr, Reproducing Racism: How Everyday Choices Lock in White Advantage 5–7, 59–60, 110, 133 (2014); *see id.* at 88 (discussing work of Glenn Loury). Roithmayr discusses the divide between Blacks and Whites; but social science research shows similar trends across class and ethnicity as well. Residents in impoverished or otherwise materially underserved communities across the country tend to remain in those circumstances only because their relative opportunities are not as abundant. *Id.* at 89; *see also* William Julius Wilson, The Truly Disadvantaged: The Inner City, the Underclass, and Public Policy (1990); Loïc J. D. Wacquant & William Julius Wilson, *The Cost of Racial and Class Exclusion in the Inner City*, 501 Annals of Am. Acad. of Pol. & Soc. Sci. 8 (1989).

144. Crow, *supra* note 21.

networked members over time.[145] There is a measureable opportunity cost for every minute a user is not as well connected as others. By way of illustration, consider current controversies involving high-frequency trading ("HFT") in electronic securities exchanges.[146] Highly leveraged HFT firms design computer programs to execute high volume trades by the millisecond in order to achieve the firms' respective investment strategies.[147] By doing so, the firms expect to gain a quantifiable advantage over competitors. The idea is that, even if any single trade yields an infinitesimally small margin of profit, in the aggregate, such efforts can prove profitable in even the most stable sectors of the economy.

To be sure, the distributional problems in the broadband setting are far more complicated than those in electronic exchanges. But developments in HFT dramatically illustrate the relative costs of exclusion and disparity in informational networks. Firms with only mediocre or conventional access to "market-moving" information will fail to stay apace with better resourced competitors.[148] Such disparity in the context of electronic exchanges might be the cold reality of how capital markets work. But, in the broadband setting, the costs of exclusion are far direr because Internet access affords far more than the ability to trade on "market-moving" information.

This is not just a theoretical claim. Internet access has real implications in education, employment, and employability, for example. Elementary and secondary school students who do not have adequate online access at home risk falling behind their peers because, among other things, they cannot complete Internet-related homework as easily as their peers.[149] Indeed, children's grades improve when schools supply computers through which the students can access the Internet from home.[150] Macroeconomic indicators suggest moreover that, when more

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145. *See* PAUL BOURDIEU, *The Forms of Capital*, *in* HANDBOOK OF THEORY AND RESEARCH OF THE SOCIOLOGY OF EDUCATION 46, 47–48 (J.G. Richardson ed., 1986); JAMES S. COLEMAN, FOUNDATIONS OF SOCIAL THEORY 300–05 (1990); NAN LIN, SOCIAL CAPITAL: A THEORY OF STRUCTURE AND ACTION (2001); PUTNAM, *supra* note 141, at 19; BARRY WELLMAN, *Structural Analysis: From Method and Metaphor to Theory and Substance*, *in* SOCIAL STRUCTURES: A NETWORK APPROACH 19, 19–22 (Barry Wellman & S.D. Berkowitz eds., 1988).

146. The SEC only authorized electronic exchanges in the late 1990s.

147. In short, an HFT firm's algorithm monitors and processes market activity in one or more sectors of the economy. When some threshold strategic condition is met, the program executes an extremely high volume of trades on behalf of the firm in a matter of milliseconds. Rarely do these firms hold a position for long; they only hold it as long as the algorithm deems necessary to minimize risk and maximize gain of loss on every individual trade before other market actors can act.

148. To be sure, HFT helps bring more liquidity to the market and, as a result, arguably makes the markets more efficient. But emergent HFT practices sometimes violate the letter if not the spirit of SEC insider trading and fair disclosure rules meant to ensure that the investing public has equal access to market-moving information.

149. CONNECTED TEXAS, BROADBAND AND EDUCATION—CONNECTING STUDENTS IN TEXAS (2014).

150. *Id.*

people are well connected, society as a whole benefits.[151] For example, even the smallest increases in broadband penetration rates are strongly correlated with significant increases in the number of jobs and aggregate household income in some areas.[152] Users are also much more likely to be politically engaged or to access government services when they have reliable connections.[153]

It is for these reasons that Congress's primary charge to the FCC under the Communications Act is to attend to substantive distributional concerns. But the agency did not really evince any meaningful recognition of this charge in its recent network neutrality proceeding until public reaction forced it to do so. As I show in Part III below, the agency has focused myopically on finding the right innovation balance. To the extent the Commission has gestured toward redressing disparity, it has come as a result of public pressure to consider equality concerns.

III. The Unintended Opening in the Open Internet Rules

In February 2015, the FCC substantially circumscribed the extent to which access providers could leverage their market position to extract fees from users and edge providers.[154] The agency promulgated rules that control the manner in which access providers may administer Internet connections. The FCC asserts that the rules will ensure that access providers remain "neutral" in how they manage those connections; that is, access providers generally may not block or discriminate between different kinds of applications or content.[155]

Until very recently, the agency has had difficulty finding a statutory basis for the intervention that the courts have been willing to accept. This really was a problem of the FCC's own creation: until just this past February, the agency had classified the Internet under the Communications Act as an "information service" deserving of the lightest of regulatory oversight. In its final and most recent Open Internet Rules, however, the agency has departed from this approach, basing the new rules on its longstanding authority under the statute to regulate "telecommunications service," a regulatory category reserved for common carriers like telephone companies.[156]

151. *See* Dutz et al., *supra* note 115, at 35–36.

152. Connect Michigan, Broadband's Economic Impact in Michigan 2–3 (2013).

153. Connect Ohio, Making Government Accessible: E-Government Usage in Ohio 3 (2014). At the core of these material advantages of connection is the fact that users must be ready and comfortable with the technology. Thus, many observers have argued that "digital readiness" is above all else the most important determinant of online participation. *See* Horrigan, *supra* note 123, at 11–12.

154. *See* Protecting and Promoting the Open Internet, *supra* note 7.

155. *Id.*

156. *Id.*

The legal form of the rules has changed, but the substantive justification has not. The "virtuous circle of network innovation and infrastructure development" remains the prevailing regulatory ideology at the FCC. The agency's argument is that innovation in Internet applications will generate more user interest that, in turn, will induce access providers to invest in Internet infrastructure that, in turn, will benefit everyone. This is the trickle down theory of Internet innovation.

This Part describes and critiques the way in which innovation has manifested itself in communications policy, focusing in particular on the Open Internet proceeding. It reviews the general content and form of the rules that the agency proposed last spring and chronicles the agency's decision to settle on more robust regulation this past February. The FCC's decision to apply common carrier principles to the regulation of broadband evinced its recognition of the Internet's role and great potential as a platform for social and economic integration. That is, by classifying broadband as "telecommunications service" under Title II of the Act, the agency has opened up a range of regulatory possibilities to ensure that service providers take all users and edge providers as they are; they cannot discriminate or interfere with connections on the basis of content, applications, devices, or services.

This is an opening for the agency to recapture the statute's core objective. Part III demonstrates that, while innovation remains the animating concern for the agency and other federal policymakers, the FCC has shown a welcome interest in distributional fairness. But much must be done. This Part argues that while innovation is a powerful and useful concept, it is addressed to interests that are orthogonal to and potentially in tension with the broad distributional objectives of communications law.

A. The Proposed Rules

Last spring, the FCC proposed two different rules to promote the "open Internet."[157] The agency's stated objective for both was to encourage application innovation.[158] The proposed rules would do this by forbidding broadband providers from blocking user access to the Internet content, applications, service, and devices of their choice, as well as barring them from unreasonably discriminating against lawful Internet traffic.[159] The proposed rules also would require access providers to be transparent about their local broadband network management practices. The agency also proposed a more flexible rule for mobile broadband

157. FCC, Fact Sheet: Chairman Wheeler Proposes Rules for Protecting the Open Internet (Feb. 4, 2015), http://transition.fcc.gov/Daily_Releases/Daily_Business/2015/db0204/DOC-331869A1.pdf.

158. *Id.* at 1.

159. *Id.* at 2.

providers, forbidding them only from blocking websites or competitors' voice applications.[160] Mobile providers would not be barred from unreasonably discriminating against network traffic.[161]

But the two proposals took two different legal forms with important substantive implications. The first would allow access providers to negotiate "commercially reasonable" transmission terms with individual content developers (or "edge providers") who are willing to pay for the specialized treatment. If broadband service were to remain an "information service" under Title I of the Communications Act, and that is what this first proposal would require, the agency would be required to give access providers sufficient leeway to offer different transmission terms to users and content providers. Under this first proposed rule, broadband providers like Comcast, for example, would be able to deliver content from Google (an "edge provider") to subscribers much faster than content from abc.com (another "edge provider") as long as the transmission terms with either company are "commercially reasonable."[162] Under the proposal, the FCC would assess the validity of this kind of prioritization on an adjudicatory case-by-case basis.[163]

The FCC's second proposal would explicitly bar providers from discriminating between applications or application types, a practice that the agency would allow under the first proposal as long as prioritization is commercially reasonable. This second proposal would be authorized under the agency's statutory power to regulate "telecommunications service" providers under Title II of the Communications Act.[164] Under this proposal, then, all or a part of local broadband network management service would be reclassified as "telecommunications service" subject to the common carrier obligations under Title II.[165] That is, the agency would no longer treat broadband service as an "information service" under Title I, something it has done since 2002. Rather, pursuant to Title II, the agency could forbid access providers, for example, from engaging in "unjust or unreasonable discrimination" in charges or services to edge providers.[166] They could also require that access providers ensure that users and edge providers can connect with each other "seamlessly and

160. *Id.*
161. *Id.*
162. Brian Fung, *FCC Chair: An Internet Fast Lane Would Be 'Commercially Unreasonable,'* WASH. POST (May 20, 2014), http://www.washingtonpost.com/blogs/the-switch/wp/2014/05/20/fcc-chair-an-internet-fast-lane-would-be-commercially-unreasonable/; *see also* Press Release, FCC, Statement by FCC Chairman Tom Wheeler on Broadband Consumers and Internet Congestion (Jan. 29, 2015) (on file with author).
163. Fung, *supra* note 162.
164. FCC, *supra* note 157, at 1.
165. *Id.*
166. *See* 47 U.S.C. § 202(a) (2015).

transparently . . . between and across telecommunications networks."[167] Thus, under this second proposal, Comcast could not offer a better deal to Google on the basis of specialized (if also commercially reasonable) terms; it would have to hold itself out to the public as available to everyone on the same terms. The agency also invited comment on a variation of the Title II proposal that would classify traffic from major content developers as "telecommunications service." This would include, for example, remote delivery services or "'sender-side' traffic sent in response to the subscriber."[168]

With both proposals, the FCC responded directly to a D.C. Circuit panel's January 2014 decision that the agency's 2010 Open Internet proposal, premised solely on Title I, did not make any allowances for commercially reasonable bargaining between "information service providers" and "edge providers." The court concluded that, while the 2010 rules were rational enough to survive judicial scrutiny under the Administrative Procedure Act,[169] the Communications Act forbids them if they require "information service providers" to treat all affiliated and unaffiliated content equally.[170] Such obligations, the panel explained, resemble common carrier regulation that, according to the Communications Act, the agency may impose only on "telecommunications service providers."[171] The 2010 proposal could not stand because the FCC was bound by its earlier decision to classify broadband as an "information service" (and not as "telecommunications service").[172]

The first of the 2014 proposals, what I call the Title I proposal, addressed the court's concern by allowing for commercially reasonable bargaining between access providers and edge providers. The second proposal, what I call the Title II proposal, addressed the court's concern by reclassifying broadband as a telecommunications service that could be subject to common carrier regulations under Title II.

Until very recently, the agency telegraphed a clear preference for the Title I approach largely because the D.C. Circuit had already affirmed that the agency has valid authority under that provision.[173] The Title II approach would require the agency to relitigate the question of its authority.

After the close of the comment period, the FCC leaked a version of the rules that would be premised on its authority under both Title I and

167. *See* 47 U.S.C. § 256 (1996); *see also* 47 U.S.C. § 251 (2015).

168. *See* Protecting and Promoting the Open Internet, *supra* note 7.

169. *See* Verizon v. FCC, 740 F.3d 623, 649 (D.C. Cir. 2014) ("The Commission has offered a rational connection between the facts found and the choice made.").

170. *See id.* at 650.

171. 47 U.S.C. § 153(51) (2015).

172. *Id.*

173. *See Verizon*, 740 F.3d at 652.

Title II of the Communications Act.[174] This "hybrid" approach would divide broadband into two separate kinds of services: retail service for lay users that would be subject to Title I and "back-end" service for edge providers that would be subject to Title II common carrier requirements.[175] This hybrid approach would, on the one hand, allow access providers to differentiate lay users' service quality based on the latter's willingness to pay and, on the other hand, address the FCC's interest in promoting application innovation. Prominent advocates of network neutrality actually proposed this hybrid proposal in their public comments to the agency.[176]

The advantage of this approach is that it would not require the agency to reverse its decision issued over a decade ago to classify broadband service as an "information service" subject to Title I regulation. It would only require amending the existing regime to redress the wholesale distribution of edge providers' data flows.[177]

The hybrid approach, however, would also come with substantial risks and disadvantages. Most observers already assumed that access providers would challenge the rules no matter which form they took if any aspect of the new rule were to impose common carrier requirements.[178] Access providers made that clear within hours after the FCC first leaked the purported compromise.[179]

B. The Public Response

The public reaction to the Title I and hybrid proposals was record breaking for the FCC. The agency received nearly four million comments. Their substance varied, of course, but the vast majority supported some form of regulatory intervention that would limit access providers' ability to control transmission speeds and fees.[180] They were focused above all on the rank unfairness of allowing some users and edge providers to have better and faster service than others.[181]

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174. *See* Edward Wyatt, *F.C.C. Considering Hybrid Regulatory Approach to Net Neutrality*, N.Y. Times (Oct. 31, 2014), http://www.nytimes.com/2014/11/01/technology/fcc-considering-hybrid-regulatory-approach-to-net-neutrality.html?_r=0.

175. *Id.*

176. Adam Clark Estes, *Mozilla Is Helping Tor Get Bigger and Better*, Gizmodo (Nov. 10, 2014, 2:39 PM), http://gizmodo.com/mozilla-is-helping-tor-get-bigger-and-better-1656860653.

177. *See* Gautham Nagesh, *FCC 'Net Neutrality' Plan Calls for More Power Over Broadband*, Wall St. J. (Oct. 30, 2014, 7:41 PM), http://www.wsj.com/articles/fcc-net-neutrality-plan-calls-for-more-power-over-broadband-1414712501?autologin=y.

178. *See* Jenna Greene, *Telecoms Poised to Fight Obama's Net-Neutrality Proposal*, Nat'l L.J. (Nov. 17, 2014), http://www.nationallawjournal.com/id=1202676472698.

179. *Id.*

180. Lohr, *supra* note 27.

181. *Id.*

The cause was taken up by many others as well. Comedian and talk show host John Oliver sarcastically likened the FCC's Title I proposal to airline travel, with most users getting something like the least comfortable seats and large Internet companies like Google and Amazon routinely getting first class treatment.[182] Former FCC Commissioner Michael Copps similarly asserted in testimony before the Senate Judiciary Committee that, without aggressive regulatory intervention, the Internet could "become the playground of the privileged few that only widens the many divides that are creating a stratified and unequal America . . . [We are] heading toward an online future with fast lanes for the 1 % and slow lanes for the 99%[.]"[183]

The hybrid approach, too, encountered stiff opposition. The resistance came from public interest groups, public figures, and other advocates who argued that the hybrid approach would still allow access providers to offer tiered levels of service as long as they were offered at commercially reasonable terms.[184] Such tiering, opponents argued, would undermine innovation by users of all stripes.[185] Advocates also observed that the drafters of the hybrid approach would have to address the requirement that "telecommunication services" under Title II must offer their service "for a fee." Access providers do not currently charge websites and other edge providers a dedicated fee to connect to law users, nor would advocates of network neutrality want them to, as those fees would make it that much more costly for lay users to start online ventures.[186]

Apart from public concern about the legal form of the rules, there were also questions about how the rules would treat transmissions across the backbone of the Internet, from originating service provider to terminating provider. To focus solely on the positive duties of local access providers in the last mile would be naïve since local access providers are not the only administrators of Internet connections. Large transit network operators like Cogent and Level 3 manage Internet traffic between local providers on behalf of prominent edge providers like Apple, Netflix, and Google.[187] They do so through "peering"

182. *Last Week Tonight with John Oliver: Net Neutrality* (HBO television broadcast June 1, 2014).

183. *Preserving an Open Internet: Rules to Promote Competition and Protect Main Street Consumers: Sen. Judiciary Comm. Field Hearing* (2014) (testimony of Hon. Michael J. Copps).

184. *See* Jon Healey, *Possible 'Hybrid' Net Neutrality Rules Get Chilly Reception*, L.A. TIMES (Oct. 31, 2014, 3:01 PM), http://www.latimes.com/opinion/opinion-la/la-ol-fcc-net-neutrality-hybrid-20141031-story.html#page=1.

185. *See* Barbara van Schewick, *Will the FCC Ruin the Internet?*, CNN (Nov. 7, 2014, 4:17 PM), http://www.cnn.com/2014/11/07/opinion/van-schewick-net-neutrality/index.html.

186. *See id.*; Healey, *supra* note 184.

187. Robert McMillian, *What Everyone Gets Wrong in the Debate over Net Neutrality*, WIRED (June 23, 2014, 6:30 AM), http://www.wired.com/2014/06/net_neutrality_missing/; Dan Rayburn, *Apple Negotiating Paid Interconnect Deals with ISPs for Their Own CDN*, STREAMINGMEDIABLOG.COM (May

agreements on interconnection terms.[188] Second, and more importantly, some large edge providers are entering into their own co-location agreements with local providers. Companies likes Google and Netflix have built content delivery networks and dedicated servers within last mile providers' networks, giving them an advantage over competitors. The alternative is to rely on conventional "best effort" transmission protocols that are not well suited to their latency-sensitive high-bandwidth content that they transmit.

C. The Final Rules

The record-breaking public reaction to the proposed rules has to have a real impact on the agency's decisionmaking.[189] This past February, the FCC approved a flat ban on blocking, discrimination, and paid prioritization by fixed and mobile wireless providers.[190] In short, the new rules prohibit:

- blocking access to Internet "content, applications, services, and devices";
- impairing "Internet traffic on the basis of content, applications, services," and devices; and
- prioritizing any Internet traffic "in exchange for consideration" or prioritizing affiliated content, applications, and services.[191]

The agency relied on its authority under Section 706 in Title I of the Communications Act, as well as its separate authority under Title II.[192] The Commission cited the D.C. Circuit Court of Appeals' decision last year to affirm that Section 706 supplied sufficient authority to regulate last-mile providers. The agency also found support in the court's opinion for its claim to authority under Title II.[193] Thus, in unequivocal terms, in these new rules, the agency has classified broadband as a telecommunication service subject to the traditional common carrier bar on discriminating between content, applications, and services.

20, 2014, 10:15 AM), http://blog.streamingmedia.com/2014/05/apple-negotiating-paid-interconnect-deals-with-isps-for-their-own-cdn.html; *see also* Joan Engerbretson, *Level3 Wants FCC to Impose ISP Interconnection Requirements*, Telecompetitor (July 8, 2014, 6:00 AM), http://www.telecompetitor.com/level3-wants-fcc-impose-isp-interconnection-requirements/.

188. McMillian, *supra* note 187; Rayburn, *supra* note 187.

189. *See* Rob Faris et al., *Score Another One for the Internet? The Role of the Networked Public Sphere in the U.S. Net Neutrality Policy Debate*, Berkman Ctr. for Internet & Soc'y at Harvard U. 4 (Feb. 10, 2015).

190. It also reiterated the requirement that providers be transparent about their network management practices. The transparency requirement, however, was affirmed by the D.C. Circuit. Nothing in the rule altered or broadened this requirement.

191. *See* FCC, *supra* note 157, at 2.

192. Protecting and Promoting the Open Internet, *supra* note 7, ¶¶ 5, 7 & 273–84.

193. *Id.*

As enshrined in the Act, the nondiscrimination principle in no uncertain terms forbids service providers from imposing

> unjust or unreasonable discrimination in charges, practices, classifications, regulations, facilities, or services for or in connection with like communication service, directly or indirectly, by any means or device, or to make or give any undue or unreasonable preference or advantage to any particular person, class of persons, or locality, or to subject any particular person, class of persons, or locality to any undue or unreasonable prejudice or disadvantage.[194]

As broadly written as this provision and related provisions might be, the agency has chosen not to apply the full sweep of common carrier obligations. Congress authorized the FCC to "forbear" from enforcement of certain requirements under Title II if "the public interest" requires it. In the new rules, the agency has invoked this power to announce that it will refrain from imposing duties that are otherwise applicable to telephone companies and other common carriers. Specifically, in the new rules, the FCC announced that it will forbear from imposing rate regulations or tariffs, pro-competitive unbundling requirements, and filing or accounting requirements.[195] Such an approach, the Chairman has explained, is better tailored to the twenty-first century.

Even after forbearing on enforcement of some common carrier requirements, however, the rules are far more robust than what the Chairman was forecasting during the comment period last summer.[196] They are certainly more stringent than most of the alternatives that the FCC has publicly considered for over the past decade. Among other things, the new rules generally forbid broadband providers from privileging one edge provider's applications and content over another's, irrespective of whether the preference is commercially reasonable. The bar on paid prioritization in particular protects against a wide range of schemes through which providers could advantage specific content and applications for any legal "consideration." Drafted in this way, the rules ostensibly bar paid prioritization schemes as well as the emergent practice of "zero-rating" or "positive price discrimination."

The rules also implemented a wide range of procedures and obligations otherwise applicable to common carriers. For example, the

194. 47 U.S.C. § 202 (2015).

195. Forbearance here raises interesting questions. First, in the agency's framing, the "public interest" requires that it forbear from applying certain provisions of Title II. It is hard to know, however, how far the agency may go without more clarity on what the "public interest" entails in this setting. Second, the Administrative Procedure Act requires the agency to subject substantive regulatory revisions to public notice and comment. The agency's action also raises interesting questions about whether it must subject any modification of its forbearance decision in this most recent Order to notice and comment.

196. Tom Wheeler, *FCC Chairman Tom Wheeler: This Is How We Will Ensure Net Neutrality*, WIRED (Feb. 4, 2015, 11:00 AM), http://www.wired.com/2015/02/fcc-chairman-wheeler-net-neutrality/.

FCC would be able to investigate consumer complaints and enforce related provisions.[197] Providers will also have to abide by consumer privacy rules,[198] ensure equal access to indispensable physical infrastructure like poles and conduits to competitors,[199] and provide access to people with disabilities.[200]

Finally, the rules also address the interconnection terms between the large transit network operators like Cogent Communications (who carry Netflix and other major edge providers' data) and the local broadband providers.[201] The latter are the gatekeepers to users. The new rules assert for the first time that the FCC has the authority to review interconnection practices that are not "just and reasonable."[202]

Together, these new Open Internet Rules represent a modernization of the requirements under Title II in that they incorporate nondiscrimination and other principles in common carrier regulation. At the same time, however, by invoking its forbearance authority under Section 706, the agency has signaled its intention to be far more flexible than Title II would otherwise allow. Thus, the agency will refrain from imposing rate regulation, unbundling requirements, new taxes, new fees, "or other forms of utility regulation."[203]

IV. Toward Network Equality

The public's reaction to the FCC's original Open Internet proposal in 2014 was not as concerned with the form or pace of innovation as the unadorned problem of disparity. The main criticism was that the status quo is unfair to the extent it permits "fast lanes" for firms and developers who can afford prioritized treatment and slower connections for users and "start-up companies that do not have the cash to pay the tolls."[204] This response was consistent with contemporaneous polling that showed overwhelming majority support for more robust Open Internet Rules.[205]

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197. FCC, *supra* note 157, at 2; *see also* 47 U.S.C. § 208 (2015); *id.* §§ 206, 207, 209, 216, 217.

198. FCC, *supra* note 157, at 3; *see also* 47 U.S.C. § 222 (2015).

199. FCC, *supra* note 157, at 3; *see also* 47 U.S.C. § 224 (2015).

200. FCC, *supra* note 157, at 3; *see also* 47 U.S.C. §§ 225, 255 (2015).

201. *See* Todd Shields, *Netflix Deals with Broadband Providers Said to Be Getting New FCC Oversight*, Bloomberg Bus. (Jan. 28, 2014; 4:07 PM), http://www.bloomberg.com/news/articles/2015-01-28/netflix-deals-with-broadband-providers-said-to-get-fcc-oversight.

202. *See id.*

203. FCC, *supra* note 157.

204. *See* Wyatt, *supra* note 27.

205. Mario Trujillo, *Poll: Voters Support Broad Concept of Net Neutrality*, Hill (Jan. 21, 2015, 10:31 AM), http://thehill.com/policy/technology/230226-poll-voters-support-broad-concept-of-net-neutrality (showing support for restrictions on "blocking, discriminating against, slowing down, or charging for Internet traffic to certain websites"); *see also* Press Release, Univ. of Del. Ctr. for Political Commc'n, National Survey Shows Public Overwhelmingly Opposes Internet "Fast Lanes" (Nov. 10, 2014) (on file with author).

The FCC Chairman was clearly affected by the public reaction. By the time the agency published its final rules, he explicitly acknowledged the naïveté of the unmodified trickle down approach, even assuming personal responsibility for the agency's position before the switch.[206] The rules accordingly now subject broadband service to unequivocal nondiscrimination and other common carrier rules.[207] So, even as policymakers at the FCC continue to believe above all that the Internet is a platform for innovation, it also now seems to recognize that the relative quality of users' access should be a part of the public policy calculus.

Although welcome, the FCC's approach is insufficient to remedy the deep disparities outlined in Part II. Policymakers can and must do much more. Under the view I propose here, the Internet is not simply a boutique curiosity with which engineers and computer scientists should be allowed to tinker. Nor is it simply a data rich resource for inventors and companies to exploit. The controlling view ought to be that broadband is a service like electricity—that it is an essential general use resource to which everyone should have the same or nearly the same access as a matter of course.[208] Accordingly, the longstanding and uncontroversial central objective of communications law and policy—universality—should displace (or at least complement) the preoccupation with innovation.

The statutory commitment to universal broadband deployment is better understood as a concern for substantive equality in the delivery of communication services. As explained in Part I, the amended Communications Act speaks in relative terms about broadband availability. It provides, for example, that telecommunications and information service and rates in all areas of the country must be "reasonably comparable to" the best available service.[209] The clear implication is that the success of deployment depends on whether broadband is available to all users on relatively similar terms, no matter whom or where the subscribers are.

206. *See* Wheeler, *supra* note 196 ("Originally, I believed that the FCC could assure internet openness through a determination of 'commercial reasonableness' under Section 706 of the Telecommunications Act of 1996. While a recent court decision seemed to draw a roadmap for using this approach, I became concerned that this relatively new concept might, down the road, be interpreted to mean what is reasonable for commercial interests, not consumers.").

207. This shift does not raise notice problems under the Administrative Procedure Act because the agency made clear in its notice of public rulemaking that it was also considering reclassifying broadband as a Title II common carrier. *See generally* Chocolate Mfrs. Ass'n of U.S. v. Block, 755 F.2d 1098, 1102 (4th Cir. 1985) ("Section 4 of the Administrative Procedure Act (APA) requires that the notice in the Federal Register of a proposed rulemaking contain 'either the terms or substance of the proposed rule or a description of the subjects and issues involved.'").

208. *See* Tom Vilsack & Penny Pritzer, *Broadband: The Electricity of the 21st Century*, WHITE HOUSE (Jan. 15, 2015, 10:20 AM), http://www.whitehouse.gov/blog/2015/01/15/broadband-electricity-21st-century.

209. 47 U.S.C. § 254(b)(3) (2015).

This final Part lays out the contours of what network equality requires as a matter of policy and research. First, I make the positive argument for its distinctiveness—that is, in relation to the prevailing approach. Second, I identify several examples in current federal policymaking that showcase how a particularized focus on network equality has begun (and should continue) to shape communications policymaking. In the end, I offer this Part as the foundation for more policy and scholarly work in the area.

A. Substantive Communications Equality

As demonstrated above, the prevailing view of the Internet among communications policymakers and scholars is that it is something like an innovation machine. Some scholars, however, have developed modified versions of the view favoring innovation that are not as myopically devoted to the trickle down theory. One prominent claim, for example, is that the Internet, in addition to being an engine for commerce, is also a "public and social infrastructure" whose social value "is tied to the range of capabilities it provides for individuals, firms, households, and other organizations to interact with each other and to participate in various activities and social systems."[210] According to this conception, Internet participation has spillover effects that benefit the most active users, as well as those who are not online.[211] YouTube, for example, is not just beneficial because it creates value for Google, its parent company, or for users who post videos, but because it also "incidentally generate[s]" value for the users who watch the content.[212] Sometimes these secondary benefits are small in scale; sometimes they are big. But all users are beneficiaries.

This approach is essentially a restatement of the prevailing trickle down theory to the extent it posits that everyone in society is the downstream beneficiary of innovation on the Open Internet.[213] It asserts that the Internet's main value is generated by the transformative "killer apps" designed by networked elites.[214] Here, universality is also important, but only instrumentally or secondarily so.

Other scholars are far more direct in their claim that universal deployment ought to guide public policy. Even for these scholars, however, universality is an instrumental good that helps to stimulate

210. Brett M. Frischmann, Infrastructure: The Social Value of Shared Resources 336 (2012).
211. *Id.* at 337.
212. *Id.* at 338–39.
213. *Id.* at 337.
214. *Id.* at 338.

economic growth.[215] This view holds that, if robust nondiscrimination rules are in place, every additional participant and connection increases the probability of new synergies and collaborations, which, in turn will contribute to economic growth.[216]

To be sure, broad and unimpeded connections to YouTube or Facebook can generate socially valuable macroeconomic spillover effects for society at large.[217] But my claim here is both more general and particular than this. I argue that, apart from the increases in general social welfare, universal access and use create opportunities for social integration for users who are excluded or otherwise structurally disadvantaged in society generally. This contention is partly born from the positive terms of the Communications Act itself: that all Americans must have reasonably comparable broadband service irrespective of whom or where they are.[218] Under law, it does not matter whether they contribute to innovation in any appreciable way.

This claim for universality, however, really flows from the normative commitment that communications are social and relational by their nature, and that they generate a sense of inclusion and solidarity that is itself valuable.[219] This claim is especially salient for the least fortunate among us. That is, promoting and protecting communications equality is redistributive in the same way racial integration is. Internet connections are the means by which people associate with and otherwise engage their culture in ways that are harder to do without a network connection. We might frame this in purely welfarist terms. As I observe in Part II, there are strong correlations between online participation rates in local communities and higher employment rates and income. With greater connectivity, historically disadvantaged communities are likelier to become active participants in the economy and culture.

But we can go further: regulations and programs that promote and protect network equality help to redress the structural barriers that historically disadvantaged groups in the United States routinely experience in all other aspects of public life. We might assume that this is nothing more than a question of semantics—that I employ the language of equality and integration, where the prevailing approach relies on tropes in economics and network theory.[220] That assumption, however, would misunderstand the point of my argument here. I argue for a reorientation

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215. *See* Crawford, *supra* note 47, at 390; Richard S. Whitt & Stephen J. Schultze, *The New "Emergence Economics" of Innovation and Growth, and What It Means for Communications Policy*, 7 J. Telecomm. & High Tech. L. 217, 263 (2009).

216. *See* Crawford, *supra* note 47, at 390; Whitt & Schultze, *supra* note 215, at 263.

217. *Cf.* Sylvain, *supra* note 30.

218. *See* 47 U.S.C. § 254(b) (2015).

219. *Cf.* Sylvain, *supra* note 30.

220. *Cf.* Kang, *supra* note 31, at 6–7.

toward network equality because the prevailing approach has things backwards. At least, the prevailing trickle down theory overemphasizes the material consequences of broadband deployment at the expense of the statutory and normative reasons for equality and integration. The statutory command to ensure network equality matters, I argue, because it charges policymakers to take affirmative steps to give everyone an opportunity to engage (that is, benefit from and add to) online opportunities and associations irrespective of who or where they are. And the reasons for this are important. Broadband is the gateway to a vast world of services and opportunities otherwise beyond many users' structurally impaired reach; the Internet is a transformative general use technology that could reverse historical and existing patterns of oppression, discrimination, bias, and harassment because it is so pervasive and indispensable.

In this way, my argument here takes up an observation that scholar Jerry Kang made eight years ago. In *Race.Net Neutrality*, Kang presciently puzzled through the contrasting ways in which scholars conceived of nondiscrimination in the network neutrality debate (back then) by comparing it to the law and language of civil rights.[221] In the network neutrality debate, he explained, consequentialist arguments tended to predominate; in the context of civil rights, however, scholars and policymakers were likelier to invoke non-welfarist deontological concerns.[222] Kang argued that, at a theoretical level, however, there is nothing inevitable or natural about the contrast in approaches. After all, he observed, many grassroots network neutrality activists invoked deontological concepts of democratic participation and free speech.[223] But, for whatever reasons, Kang continued, those deontological concerns did not have currency in the mainstream policy debate about broadband network management policy where welfarist considerations prevailed.

Little had changed until the FCC adopted the current Open Internet Rules. Today, the deontological equality concerns that animate civil rights policymaking have found themselves in the FCC's rationalization for network neutrality. To be sure, the agency continues to rely above all on the trickle down theory to frame the legal basis of the rule. But, as discussed above, the agency has also evinced worry about disparity as such. This pivot has not merely been semantic. The agency relied on this concern in part to overtly reject the argument that service providers should be able to discriminate between users or edge providers, or apportion the quality of service based on the underlying service, applications, or content as long as commercially reasonable. To do so,

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221. *Id.*
222. *Id.*
223. *Id.* at 8.

the agency now asserts, would create disparities between the haves and the have-nots.

To be clear, my argument here is not to remove consequentialism from policymaking in this area altogether. Even civil rights law and policy today recognizes that the best evidence of illegal discrimination is often in its quantifiable ex post discriminatory impact. Illegal discrimination is not just measured by the evidence of the wrongdoer's bigotry because most bigots now know better than to advertise their biases. Policymakers and courts recognize that the most useful measure of illegal discrimination in most settings is in the lived and calculable effects on protected groups.[224] It is for this reason that most progressive civil rights laws attend to the ways in which the decisions of policymakers or private actors have a discriminatory impact on protected classes. Importantly, however, the measure of discriminatory impact operates in service of the core interest in promoting equality. Similarly, communications policymakers should come to understand the nature of disparity by understanding the empirical measure of "discrimination on the basis of race, color, religion, national origin, or sex."[225]

B. Current Interventions in Furtherance of Equality

Outside of the network neutrality debate, equality concerns have taken center stage in communication policy generally. This new focus has found expression, first, in fiscal policy and, second, in the positive regulation of broadband service generally. The first is comprised of substantial subsidies through the FCC as well as the Departments of Agriculture and Commerce to support broadband to the underserved and unserved. These take the form of means-tested discounts on monthly service fees, as well as direct grants to schools. The second set of interventions showcases the agency's broad positive authority to redress disparity. Three recent interventions in particular are worth considering here. They generally include, of course, the Open Internet Rules, but here, I focus in particular on the decision by the FCC to treat mobile and fixed broadband providers equally. Other interventions along these lines, however, include the FCC's recent decisions, first, to increase the regulatory definition of broadband and, second, to preempt state laws that forbid municipal participation in the market for broadband service delivery.

All of these efforts seek one way or another to ensure that users and communities everywhere in the United States have an equal or at least a "reasonably comparable" opportunity to access the affordances of the

224. *See, e.g.*, Texas Dep't of Hous. & Cmty. Affairs v. Inclusive Cmtys. Project, 135 S. Ct. 2507, 2521 (2015).

225. 47 U.S.C. § 151 (2015).

Internet. In this vein, the new Open Internet Rules are just a piece of the FCC's regulatory turn toward broadband equality. Together, these interventions come far closer to actualizing the core objectives of the Communications Act than does the mere focus on innovation.

1. Fiscal Policy

Policymakers have employed a variety of regulatory strategies to ensure that as many members of the public have broadband service as possible, notwithstanding the limitations imposed by access providers. The most direct interventions to this point have been in fiscal policy.[226]

Congress devised a partial solution for broadband disparity in the amended Communications Act. Among other things, it established federal subsidy programs with the intention of addressing structural disparities in the availability of communications services. Section 254 of the amended Communications Act in particular establishes a relatively elaborate process for assuring universal service. Under this provision in particular, the quality and cost of broadband service in all rural and high-cost areas are on par with service and cost in cities.[227] The FCC explicitly recognized that these provisions could very well apply pursuant to the agency's decision to classify broadband as a telecommunications service.[228]

Moreover, in 2009, as part of the American Recovery and Reinvestment Act ("ARRA"), Congress allocated a little over $7 billion in grant and loan programs to expand deployment and adoption in unserved and underserved areas throughout the country. Under that law, Congress charged the Departments of Commerce and Agriculture with the responsibility of administering these programs.[229]

Congress has attempted to close the service gap in other ways as well. In 1996, for example, it created the "E-Rate program" in order to make broadband connectivity more affordable for schools and libraries.[230] Recently, the FCC announced that it would modernize the program in order to tackle deficient service in schools and libraries.[231] The new rules require greater pricing transparency and consolidated purchasing systems, as well as expand funding to provide Wi-Fi networks at schools

226. *See* Sylvain, *supra* note 108.
227. 47 U.S.C. § 254(b) (2015).
228. Protecting and Promoting the Open Internet, *supra* note 7 (asserting that it will not forbear from applying aspects of § 254).
229. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111–5, 123 Stat. 115, 128 (2009); *see also* Sylvain, *supra* note 108.
230. *See* FCC, UNIVERSAL SERVICE PROGRAM FOR SCHOOLS AND LIBRARIES (E-RATE) (2014).
231. *See* FCC, FACT SHEET: FCC CHAIRMAN WHEELER'S PLAN TO REBOOT THE E-RATE PROGRAM TO MEET THE NEEDS OF THE 21ST CENTURY DIGITAL LEARNING, http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db1117/DOC-330508A1.pdf.

and libraries in rural and poor school districts and to better enforce current rules.[232]

Very recently, moreover, FCC Chairman Wheeler announced an initiative to expand the current means-tested program for telephone service to cover broadband as well. Since the 1980s, the Lifeline program sought to build on the recognition that landlines "had become crucial to full participation in our society and economy."[233] Chairman Wheeler's proposed reform would allow eligible residential subscribers to use the same subsidy of about ten dollars per month that they get for phone service to help cover the cost of broadband at home.[234]

The FCC also has made it one of its top priorities over the past few years to extend and accelerate fixed and mobile broadband deployment to all of the places in which Americans live, work, and travel.[235] Among other things, for example, it administers the high-cost universal service program and the Connect America Fund.[236] The high-cost universal service program provides direct subsidies toward deployment. Through the Connect America Fund, the FCC invests in the construction of broadband networks in cooperation with access providers.[237] There, the FCC has invested more than $438 million to bring service to 1.6 million people and intends on spending almost $9 billion in remote rural areas in the next five years.[238] Other programs, while not as ambitious, are directed at resolving the same problem. The Mobility Fund, for example, provides one-time grants to construct next-generation mobile networks for communities in which there is none.[239]

President Barack Obama, moreover, signed Executive Order 13616 in 2012 in order to promote broadband deployment in federal buildings and rights-of-way.[240] The Order's central objective is to coordinate procedures and policies across federal agencies that have substantial land ownership or management responsibilities in order to assure that, when

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232. Modernizing the E-Rate Program for Schools and Libraries, WC Docket No. 13-184, Report and Order and Further Notice of Proposed Rulemaking (July 23, 2014).

233. MTS and WATS Market Structure, and Amendment of Parts 67 & 69 of the Commission's Rules and Establishment of a Joint Board, 50 Fed. Reg. 939 (Jan. 8, 1985).

234. *See* Press Release, FCC, FCC Chairman Wheeler Seeks Comment on Modernizing Lifeline to Make 21st Century Broadband Affordable for Low-Income Households (May 28, 2015) (on file with author).

235. Connect America Fund, Report and Order and Further Notice of Proposed Rulemaking, WC Docket No. 10-90 (Nov. 18, 2011).

236. Eighth Broadband Progress Report, *supra* note 19, at 10,345–46 ¶ 4.

237. *Id.*

238. Sean Buckley, *FCC's Connect America Fund II Receives Mixed Response*, FierceTelecom (Apr. 25, 2014), http://www.fiercetelecom.com/story/fccs-connect-america-fund-ii-receives-mixed-response/2014-04-25.

239. Eighth Broadband Progress Report, *supra* note 19, at 10,351–52 ¶ 12.

240. *See* Press Release, White House, Office of the Press Sec'y, Executive Order—Accelerating Broadband Infrastructure Deployment (June 14, 2012) (on file with author).

possible, federal resources are used to lay infrastructure in service of broad deployment.[241]

All of these efforts appear to have had a positive effect on deployment and adoption rates. The postmortem has yet to be written on the ARRA's investment in broadband infrastructure, but that single intervention has gone further than most initiatives to bring high-speed broadband service to underserved communities. Clearly, however, fiscal policy interventions like these are not sustainable if they depend on shifting political winds. Something more will be needed in policy and law.

2. *Standardized Minimum Speed Thresholds*

Another way in which policymakers have promoted broader and more equal access is by requiring Internet access providers to supply a minimum quantum of transmission speed to qualify as a broadband provider. The threshold is a purely regulatory term of art, not an engineering concept. The agency has used it to create incentives for the deployment of broadband in high-cost and rural areas. The speed definition operates as a carrot rather than stick, because providers are entitled to some of the funding I identify above in Part IV.B.1 if they supply broadband service.

Pursuant to its obligation to "review and reset" the broadband standard periodically,[242] the FCC in January 2015 upgraded the threshold definition of broadband to 25 Mbps for downloads and 3 Mbps for uploads. This reform represents a substantial change from the 4/1 benchmark it set just in 2010 which, at the time, was a remarkable increase from the now laughable 200 kbs standard, which only supports applications like e-mail.[243] Before 2010, when the FCC implemented the 4/1 standard, the speed benchmark was 200 kbps in both directions, which afforded little more than e-mail and the most elemental web surfing.[244] The 2010 4/1 Mbps benchmark, on the other hand, enabled users to send and receive high-quality voice and video services.[245]

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241. *Id.*

242. *Id.* at 10361 ¶ 20; FCC, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN 135 (2010).

243. Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, Amended by the Broadband Improvement Act, GN Docket No. 11-121, 25 FCC Rcd. 9556, 9559 ¶ 4 (2010).

244. The FCC revisits the benchmark every four years. Eighth Broadband Progress Report, *supra* note 19, at 10,361 ¶ 20; FCC, *supra* note 242, at 135.

245. For context: today, users need about 3 Mbps to 4 Mbps to support video chatting, 5 Mbps to stream high definition movies, and 10 Mbps to 20 Mbps to support digital software distribution. *See generally* Peter Bowen & Shawn Hoy, *OBI Broadband Performance* 9 (FCC, Technical Paper No. 4, 2011) (listing types of online content and services and the broadband data rates required by that content or service); *Help Center*, *Internet Connection Speed Recommendations*, NETFLIX, https://help.netflix.com/en/node/306 (last visited Feb. 8, 2016).

Service providers are likely to take up the FCC's lead since consumers continue to demand faster broadband speeds to support new applications. Cloud storage, teleworking, gaming, and video streaming applications have become central to everyday life for many Americans,[246] and all, one way or another, require or accommodate speeds that far exceed conventional consumer-grade service of just five years ago.

The new standard also better represents the current state of affairs since most providers purport to make at least 25 Mbps available to their subscribers. Generally, users who can afford it already have download speeds of 30 Mbps or higher. But, under the new definition, nearly twenty percent of homes in the United States would be in areas without such service.[247] The majority of these areas are in rural areas.[248]

Google, meanwhile, has invested in fiber optic networks in a few major U.S. cities that support more or less one gigabit per second upload and download speeds, one thousand times faster than the current FCC benchmark for upload connections.[249] The Google Fiber service, moreover, costs about as much if not a little bit more than the most basic broadband service elsewhere around the country. The company accordingly offers casual users the same service speed for which generally only the largest companies pay ten times the price.[250]

To be sure, some of the Google Fiber project is promotional gimmickry for the online search and advertising giant. On the other hand, the promise of new data capacity and fast transmission speed has spawned a niche market for innovative applications. The right question is not: why would anyone need "ultra high-speed" broadband? Rather, the better question is: which will be the next "killer application" to make us wish we all had such service? The robust competitive threat that Google Fiber poses could also motivate incumbents to invest more and improve service for consumers in the near future, at least in the markets in which Google has invested.

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246. *See* Exec. Office of the President, *supra* note 12.

247. Jon Brodkin, *Tons of AT&T and Verizon Customers May No Longer Have "Broadband" Tomorrow*, ArsTechnica (Jan. 28, 2015, 10:10 AM), http://arstechnica.com/business/2015/01/tons-of-att-and-verizon-customers-may-no-longer-have-broadband-tomorrow/. The FCC assumes that about seventeen percent of the population lacks access to this level of service, with over half of all rural Americans lacking access. *See* Press Release, FCC, FCC Finds U.S. Broadband Deployment Not Keeping Pace: Updates Broadband Speed Benchmark to 25 Mbps/3Mbps to Reflect Consumer Demand, Advances in Technology (Jan. 29, 2015) (on file with author).

248. Press Release, *supra* note 247.

249. Minnie Ingersoll & James Kelly, *Think Big with a Gig: Our Experimental Fiber Network*, Google Blog (Feb. 10, 2010), http://googleblog.blogspot.com/2010/02/think-big-with-gig-our-experimental.html.

250. Farhad Manjoo, *What Do You Do with the World's Fastest Internet Service?*, Slate (Mar. 12, 2013), http://www.slate.com/articles/technology/technology/2013/03/google_fiber_review_nobody_knows_what_to_do_with_the_world_s_fastest_internet.html.

In any event, Google Fiber is just the beginning. Further improvements beyond one gigabit per second are on the horizon. Recently, for example, engineers discovered a method by which existing copper phone lines could actually support broadband speeds of up to ten gigabits per second at a fraction of the cost of current service.[251] XG-Fast, as it is called, will enable providers to supply much faster service at far cheaper cost than they do today with existing fiber optic transmission technologies. The researchers behind this finding expect that users will begin to benefit from the discovery within the next year.

XG-Fast represents the state of the art in transmission speed. In its most recent action, the agency explicitly asserted that it was merely upgrading the definition in order to meet consumer demand for new services that require more generous speed thresholds. In fact, providers around the country already had been providing speeds well over 25 Mbps.[252] The new standard just keeps the FCC up to speed on current services already available to most Americans. On this reasoning, the agency surely will have to reform the standard before long yet again.

But the reform does more than keep up with current trends in service and new applications. The agency explicitly concluded that the speed upgrade would also reduce disparities experienced by underserved communities. After all, more than half of rural inhabitants lack access to high-speed broadband service.[253] Current high-speed broadband service, it explained, is too valuable to be available to only a portion of potential users. The agency explicitly invoked its responsibility under Section 706 to "expand robust broadband to all Americans in a timely way" to justify the benchmark reform.

There are notable regulatory consequences of the agency's reform of the broadband speed benchmark. As noted above, the agency subsidizes providers to improve and more widely deploy broadband infrastructure. Only companies that provide broadband as the agency defines it could be entitled to such support. Support like this could make it easier for smaller emergent high-speed providers to enter markets in which incumbents have failed to provide high-speed service. In these

251. *See* Brian Fung, *This Practically Ancient Internet Technology Supports Speeds 1,000 Times the National Average*, WASH. POST (July 10, 2014), http://www.washingtonpost.com/blogs/the-switch/wp/2014/07/10/this-practically-ancient-internet-technology-supports-speeds-1000-times-the-national-average/.

252. Today, users generally require about 3 to 4 Mbps to support video chatting and 5 Mbps to stream high definition movies. *See* Bowen & Hoy, *supra* note 245; *Help Center*, *Internet Connection Speed Recommendations*, *supra* note 245. Users need at least 15 Mbps download speed to perform "basic functions plus more than one high demand application running at the same time." Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act, GN Docket No. 14-126, Tenth Broadband Progress Notice of Inquiry 7 (2014).

253. Press Release, *supra* note 247.

ways, the standard is another lever on which the agency can rely to assure delivery of high quality service to all Americans.

3. *The Same Rules for Wireless Devices*

A third way by which federal policymakers have redressed racial, ethnic, and class disparities in broadband use is by requiring mobile providers to adhere to the same rules that fixed providers must follow. The Open Internet Rules do this by banning discrimination based on the device users rely on to connect to the Internet.

Over half of Internet traffic travels over wireless networks. And more people today are relying on very high-quality wireless services to receive and transmit high-quality content and applications. Where, in 2010, about 200,000 Americans subscribed to the fastest mobile broadband services, today, more than 120 million do, and almost 300 million users subscribe to some high-speed mobile network service.[254] Today, distinguishing wireless service from fixed service makes little sense; they all comprise broadband service.

Recognizing as much, the FCC decided to address its final rules to all broadband providers—fixed and wireless—and, accordingly, extended protection to all users in equal measure no matter which devices they use to go online. This is a shift from the agency's proposal in May 2014 to impose fewer requirements on mobile providers. The argument then, as it was four years before, was that wireless service was in its infancy and that service rules would impede innovation.

The FCC's Open Internet Rules reflect the important recognition among policymakers that, while wireless transmission speeds are closing in on fixed broadband speeds, different communities gain access to the Internet in different ways. That is, while mobile broadband use rates have climbed steadily across demographic groups from about thirty percent in 2010 to around fifty-five percent today, it remains the primary way of going online for a disproportionately higher number of rural residents and low income users, as well as Blacks and Latinos. Nearly two-thirds of Latinos rely on mobile connections to go online. And, according to some research, Blacks and Latinos have been early adopters of mobile technology, or at least are more likely to own a smartphone than Whites.[255] The new rules accordingly redress another piece of disparity by recognizing that different communities access the Internet

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254. *See* Edward Wyatt, *F.C.C. Revisits Net Neutrality Exemption for Mobile Broadband*, N.Y. TIMES (Sept. 15, 2014), http://www.nytimes.com/2014/09/16/technology/fcc-revisits-net-neutrality-exemption-for-mobile-broadband.html?_r=0.

255. AARON SMITH, PEW RESEARCH CTR., SMARTPHONE OWNERSHIP (2013); *see also* U.S. DEP'T OF COMMERCE, NAT'L TELECOMMS. & INFO. ADMIN., EXPLORING THE DIGITAL NATION: EMBRACING THE MOBILE INTERNET (2014).

with different devices. Consider, moreover, that the FCC is considering applying the 25 Mbps speed threshold to wireless.[256]

4. *Community Broadband for Everyone*

Finally, the fourth way in which federal policymakers have helped to redress broadband service disparities is by supporting efforts to operate or otherwise support broadband service by municipal governments. Private providers are an essential piece of the federal government's advocacy of deployment and adoption. But they are not the only ones capable of delivering high-speed service to residents. Local governments across the country, too, have been developing or supporting broadband in their communities in cooperation with local anchor institutions and major stakeholders.[257] Widely touted projects in Chattanooga, Tennessee and Wilson, North Carolina, for example, provide extremely high-speed one gigabit service to their residents at relatively competitive subscription rates.[258] The former repurposed existing electricity infrastructure in ways that have since inspired other cities and towns.[259] These services now are so fast and reliable that they rival anything else offered by local providers at the same rate, and has even drawn the interest of neighboring rural communities.

Policymakers at the local and federal levels today advocate community broadband projects because those are generally the most effective ways of diversifying service options in communities with just one or two providers.[260] Municipal service creates competition for broadband where there sometimes is little to none. Competition in the local market for service, they argue, stimulates innovation and investment in broadband infrastructure and generally inures to the benefit of local residents irrespective of how isolated their region may be. And, indeed, there are strong indications already that in every locality in which cities and towns have pursued municipal projects alone, or in partnership with a major stakeholder like Google Fiber, service providers have responded by offering comparable or near-comparable service.[261]

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256. *See* Press Release, FCC, FCC Launches Inquiry for Annual Broadband Progress Report (Aug. 6, 2015) (on file with author).

257. *See* Sylvain, *supra* note 108; SHARON E. GILLETT ET AL., TELECOMMUNICATIONS POLICY RESEARCH CONFERENCE, LOCAL GOVERNMENT BROADBAND INITIATIVES 11 (Sept. 18, 2003).

258. Nestor Davidson & Olivier Sylvain, *Cross Country: An Old Tobacco Town Battles over Smokin' Fast Broadband*, WALL ST. J. (Sept. 5, 2014, 6:38 PM), http://www.wsj.com/articles/nestor-davidson-and-olivier-sylvain-an-old-tobacco-town-battles-over-smokin-fast-broadband-1409956682.

259. *See, e.g.*, DAVID TALBOT ET AL., BERKMAN CTR., HOLYOKE: A MASSACHUSETTS MUNICIPAL LIGHT PLANT SEIZES INTERNET ACCESS BUSINESS OPPORTUNITIES (2015).

260. Jon Brodkin, *Fed Up, US Cities Take Steps to Build Better Broadband*, ARSTECHNICA (Oct. 27, 2014, 6:00 AM), http://arstechnica.com/business/2014/10/fed-up-us-cities-try-to-build-better-broadband/.

261. *See* Jeff Baumgartner, *AT&T Takes on Google Fiber in K.C.*, MULTICHANNEL NEWS (Feb. 17, 2015, 9:36 AM), http://www.multichannel.com/news/technology/att-takes-google-fiber-kc/388021.

Consistent with this vision, the President announced a new program late in 2014, BroadbandUSA, to promote municipal broadband by offering technical assistance to interested communities and publishing guidelines on infrastructure planning, financing, construction, and operations.[262] In this regard, their advocacy of municipal broadband coheres with the broad policy objective of the Open Internet Rules to promote deployment.

Local projects to provide broadband service could remedy racial, ethnic, and income disparities because those factors are so closely related to residency.[263] But such laws face a significant obstacle in states that prohibit or significantly curtail municipalities' legal authority to enter the market for service. At least nineteen states have such laws.[264] Proponents of these restrictions argue, among other things, that municipal participation in the market for broadband service would undermine competition rather than encourage it because governments do not have to bear the same risks or pay the same operational costs and taxes as private corporations. They also argue that some municipal broadband projects are mismanaged.

In any case, the FCC recently approved an application from Wilson and Chattanooga to preempt state laws in North Carolina and Tennessee that prevent them from offering broadband service to local residents.[265] Over the objection of providers from all over the country, the agency cited its authority under Section 706 of the amended Communications Act to remove barriers to infrastructure development.[266] Congress, too, may intervene. The Senate is currently considering a bill that would amend the Communications Act to bar states from blocking municipal broadband.[267] The FCC's action here is in furtherance of competition in the market for broadband service. But it also advances the distributional concerns at the heart of the Communications Act to the extent it assumes all communities have a stake in ensuring its residents have high quality access to broadband.

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262. *See* Press Release, White House, Office of the Press Sec'y, Fact Sheet: Broadband That Works: Promoting Competition and Local Choice in Next-Generation Connectivity (Jan. 13, 2015) (on file with author).

263. Crow, *supra* note 21.

264. Sylvain, *supra* note 108, at 795.

265. *See* Press Release, FCC, FCC Finds FCC Grants Petitions to Preempt State Laws Restricting Community Broadband in North Carolina, Tennessee (Feb. 26, 2015) (on file with author).

266. 47 U.S.C. § 1302(a) (2015). The agency might also rely on its authority under a separate provision of the Communications Act under Title II to ensure that states do not impose rules that "prohibit or have the effect of prohibiting the ability of any entity to provide" service. 47 U.S.C. § 253 (1996).

267. Brian Fung, *Cory Booker's Introducing a Bill to Help Cities Build Their Own, Public Internet Services*, WASH. POST (Jan. 21, 2015), http://www.washingtonpost.com/blogs/the-switch/wp/2015/01/21/cory-bookers-introducing-a-bill-to-help-cities-build-their-own-public-internet-services/.

C. New Possibilities

A reorientation toward redressing disparities in broadband deployment, adoption, and use could have significant implications for policymakers and scholars in a variety of other policy areas and ways today. The next Subparts briefly explore some of these implications in the specific contexts of housing and disparate law enforcement and surveillance.

1. *Housing and Broadband Use Patterns*

Consider housing policy. The intersection of residential segregation and broadband use has not been significantly studied by social scientists, legal scholars, or policymakers. But this intersection should be studied because such service patterns also track longstanding patterns of racial segregation in housing and, accordingly, correspond with the very problems to which fair housing laws are addressed.[268] Indeed, in the wake of the Supreme Court's recent decision to affirm disparate impact rules under the Fair Housing Act,[269] federal officials have recently elaborated existing rules against housing segregation and expanded the number of resources they will devote to enforce such rules in recognition that residential housing patterns entrench a range of other structural disadvantages.[270]

So, apart from attending to policy interventions that promote the same treatment of wireless and wired devices or that protect municipal broadband, federal communications policymakers could also help to redress racial disparities in Internet access and use by aligning federal civil rights laws addressed to residential housing patterns with residential broadband service patterns.[271] Current statutory and regulatory authorities do not provide legal remedies to broadband subscribers against providers. Yet, fair housing laws suggest that, first, authorities should provide legal remedies, and, second—and just as importantly—that local, state, and federal agencies might be complicit in furthering disparities in access along racial lines if they do not act to prevent it. Government policies on municipal franchising of cable broadband service, for example, arguably frustrate nondiscrimination norms in fair housing law if they further entrench racial disparities. This intuition

268. *See supra* Part II.B.1.

269. *See* Texas Dep't of Hous. & Cmty. Affairs v. Inclusive Cmtys. Project, 135 S. Ct. 2507 (2015).

270. *See* Julie Hirschfeld Davis & Binyamin Appelbaum, *Obama Unveils Stricter Rules Against Segregation in Housing*, N.Y. Times (July 8, 2015), http://www.nytimes.com/2015/07/09/us/hud-issuing-new-rules-to-fight-segregation.html.

271. Here and elsewhere, I have written about the significant correlation between geography and the quality of broadband service. *See* Sylvain, *supra* note 108.

would have much to learn from and contribute to the rich scholarship on redressing inequality in housing policy.[272]

The U.S. Department of Housing and Urban Development ("HUD") seems to appreciate the important overlap between housing patterns and broadband access levels. In the past year, it has initiated an endeavor in collaboration with nonprofits and private actors to extend affordable broadband access to families living in HUD-assisted housing in twenty-seven cities and one tribal area across the country.[273] HUD has launched, moreover, a related demonstration project to measure the reach and impact of broadband connectivity in public housing.[274]

2. *Disparate Law Enforcement Surveillance and Broadband Use*

Such an approach might also cause scholars and policymakers to more consistently examine the ways in which the scope of privacy protection varies among the demographic groups, tracking the historically entrenched demographic fault line of race, for example. Scholars might begin to study, for example, how, if at all, race, ethnicity, and class interact with electronic surveillance practices of mobile device by law enforcement. Media reports already strongly suggest that the public social media accounts of prepubescent, teenage, and young adult Black men are disproportionately surveilled by law enforcement officials.[275]

Focus on these questions and patterns would have much to learn from scholarship on privacy law and the disparate uses of networked devices.[276] In any event, findings on these questions could have implications for a whole set of scholarly and regulatory interventions.

D. Equality's Limits

In spite of the substantial gains that the equality framing offers, full and equal user participation has its limits and pitfalls, too. First, Congress's charge to the FCC to ensure reasonably comparable service to all Americans does not require that all Americans actually do the same things or even good things when they go online. Nor must users be equally entrepreneurial or sociable once they are online. Rather, as ambitious as the goal of universality is, the statutory command is limited

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272. *See, e.g.*, Olatunde C.A. Johnson, *Beyond the Private Attorney General: Equality Directives in American Law*, 87 N.Y.U. L. Rev. 1339, 1339 (2012).

273. Press Release, U.S. Dep't of Housing & Urban Dev., President Obama and Secretary Castro Announce Initiative to Extend High Speed Broadband Access for Students in HUD-Assisted Housing (July 15, 2015) (on file with author).

274. Housing and Urban Development Notice, 80 Fed. Reg. 18248 (Apr. 3, 2015).

275. Rose Hackman, *Is the Online Surveillance of Black Teenagers the New Stop-and-Frisk?*, Guardian (Apr. 23, 2015, 8:00 AM), http://www.theguardian.com/us-news/2015/apr/23/online-surveillance-black-teenagers-new-stop-and-frisk.

276. *See*, *e.g.*, Napoli & Obar, *supra* note 18, at 326.

to ensuring that high-quality broadband service is available to all Americans.[277]

For starters, users will have to go online. Many, however, just choose to stay disconnected out of defiance. There is little that communications policy can do on its face to require engagement. Indeed, there are good reasons users might choose not to be engaged, in so far as that choice is well informed.

It is not at all clear, moreover, that everyone who is underserved or unserved will do much once they are online. We already know, for example, that users have varying degrees of "digital readiness." According to one prominent report, nearly one-third of Americans self report low levels of knowledge of and confidence in using computers or finding information online.[278] Around twenty percent of Americans, moreover, report low levels of digital readiness even though they have broadband at home.[279] And about one-eighth of American households do not subscribe to broadband because they do not think the Internet is relevant to their lives.[280] So, irrespective of the range of new applications and services that will be at their disposal, particularly after the FCC implements the reforms I outline above, many users will continue to stay disconnected.

For those who do choose to connect, however, it is not at all clear that they will have the ambition to do more than interact in the most superficial or ephemeral ways. And, in any event, dangers await users nearly everywhere online. To begin, there are myriad incursions on privacy and consumer sovereignty that all users experience when they go online.[281] But, in addition to these routine costs of online participation, historically disadvantaged groups are likely to confront a variation of the same obstacles and problems they experience in the physical world. The forms of racial bias in real estate and on the job market in the physical world, for example, are also likely to appear on the Internet. Consider Airbnb, the social networking service that enables people to rent out their homes to strangers. White users of the service generally earn twelve percent more than Black users.[282] Or consider that, a couple years ago,

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277. It is worth noting here that the Departments of Agriculture and Commerce have launched training and grant programs for people and institutions interested in improving digital readiness. *See Community Connect Grants*, U. S. DEP'T OF AGRIC., http://www.rd.usda.gov/programs-services/community-connect-grants (last visited Feb. 8, 2016); *see also* DIGITALLITERACY.GOV, http://www.digitalliteracy.gov (last visited Feb. 8, 2016).

278. HORRIGAN, *supra* note 123, at 2.

279. ZICKUHR & SMITH, *supra* note 22.

280. *Id.*; *see also supra* Part II.B.1.

281. PASQUALE, *supra* note 93, at 143–45; Ohm, *supra* note 92.

282. Benjamin Edelman & Michael Luca, *Digital Discrimination: The Case of Airbnb.com*, (Harvard Bus. Sch., Working Paper 14-054). Rating systems on share sites like Airbnb and Uber, for example,

search terms on Google that included Black-identified names generated advertisements suggestive of an arrest of a person with that name at an alarmingly high rate.[283] Or consider that new forms of Internet data mining might introduce new forms of employment discrimination—discrimination that is not easily accounted for under existing civil rights laws.[284] Or consider that baseball cards or iPhones sell for significantly more when the hand showcasing the items in the listing photograph on an online shopping forum is White rather than Black.[285] We might also suspect that improvements in broadband access could increase opportunities for law enforcement, insurance companies, creditors, and others to survey or collect information about historically disadvantaged communities in ways that perpetuate existing biases and structures of discrimination.

All of these developments suggest that the pivot toward distributional concerns and equality in broadband policymaking could not have come any sooner. Presumably it means that policymakers will now attend to disparity and discrimination online in the same ways they have in the physical world.[286] These developments also suggest an agenda for scholarship in communications and information law that is far less preoccupied with innovation for its own sake.

Conclusion

Communications scholars and policymakers have been myopically focused on promoting Internet innovation. They do so at the expense of the core distributional objectives of communications law. It is time they break free from their innovation fixation, and do the hard work of considering how everyone, including and especially members of historically marginalized groups, engage and participate in the Internet's rich affordances. Scholars and policymakers must now ensure that law and policy affirmatively further substantive broadband equality. This Article provides a theoretical and positive legal roadmap for this work, which is an essential first step in redressing ongoing racial and income disparities that continue to mark our society.

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might also skew against Blacks. *See* Nancy Leong, *The Sharing Economy Has a Race Problem*, SALON (Nov. 2, 2014, 3:58 AM), http://www.salon.com/2014/11/02/the_sharing_economy_has_a_race_problem/.

283. *See* Latanya Sweeney, *Discrimination in Online Ad Delivery* 4 (Harvard Univ., 2013), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2208240.

284. *See* Solon Barocas & Andrew D. Selbst, *Big Data's Disparate Impact*, 104 CALIF. L. REV. (forthcoming 2016) (on file with author).

285. *See* IAN AYRES ET AL., RACE EFFECTS ON EBAY 22–23 (Sept. 27, 2011), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1934432&download=yes; *see also* Jennifer L. Doleac & Luke C.D. Stein, *The Visible Hand: Race and Online Market Outcomes*, 123 ECON. J. F469, F490–91 (2013).

286. *Cf.* Keats Citron, *supra* note 29, at 66.

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Lifeline Needs Revolutionary, Not Evolutionary, Change

Daniel A. Lyons

Universal service has long been an integral component of American telecommunications policy—and rightly so. As more activities move online, it becomes increasingly important to narrow the digital divide by helping those who cannot afford Internet access to get onto the network.

Regrettably, the proposal from the Federal Communications Commission (FCC) to expand Lifeline is unlikely to help solve this problem. The agency proposes to spend $2.25 billion annually to transform a Reagan-era telephone assistance program into a broadband subsidy. Yet when prompted by the GAO, the agency admitted it has no proof that the existing subsidy of $9.25 monthly per household meaningfully increases telephone penetration rates, and independent academic studies suggest that as much as 88 percent of program funding is wasted each year.

Now the FCC proposes to extend the same monthly subsidy to broadband access, but it offers no plan to limit the proposed subsidy to households that otherwise would not purchase Internet access and no proof that an extra $9.25 each month would entice those households to buy Internet access. Its definition of qualifying broadband service is inconsistent with earlier agency rulings, and its desire to phase out telephone support is unnecessarily paternalistic. The proposal would increase Lifeline expenditures by 50 percent without addressing serious structural flaws in the existing program, such as runaway costs and an unsustainable funding mechanism. Even if it passes, a broadband Lifeline program does nothing to address other, potentially more significant barriers to Internet adoption, such as low interest in buying household Internet access and the high cost of computers. The FCC's proposal amounts to a $2.25 billion annual bet that giving a little bit of money to millions of low-income households will somehow solve the broadband gap.

We can, and must, do better.

Lifeline needs revolutionary, not evolutionary, change. Congress should adopt a comprehensive approach to closing the digital divide that encompasses digital literacy outreach programs and low-cost equipment plans as well as monthly service plan subsidies. The subsidy should be data-driven, and rather than arbitrarily choosing minimum download speeds, the program should define a minimum set of activities that recipients should be able to do online, and target plans that will allow recipients to do those things. Consistent with President Obama's ConnectALL initiative, this subsidy should be direct and portable: recipients should receive the subsidy directly and be able to choose how best to use this credit toward the bundle of telecommunications services that best fit their household needs.

The program should be placed on a fixed budget subject to congressional control and oversight, to increase incentives to deploy funds efficiently and reduce opportunities for fraud and waste. Finally, Congress should consider moving the program to another agency, such as the Department of Health and Human Services, that has a better understanding of poverty-related issues.

The Need to Narrow the Digital Divide

The basic tenet of universal service—that the government should assist those who cannot afford basic access to the telecommunications network—has been a cornerstone of telecommunications policy for nearly a century. One of the FCC's primary obligations is to "make available, so far as possible, to all the people of the United States . . . a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges."[1] To an economist, this policy is justified by *network effects*: the value of a network connection to a consumer generally increases as the number of people the consumer can reach on the network increases.[2] Therefore, a policy that encourages low-income consumers to subscribe to telecommunications service benefits not only those consumers, but also all other subscribers as well. Universal service also helps maximize the utility of the network for society as a whole, by improving civic participation levels, economic opportunities, and public safety.

The case for a robust universal service program is even stronger in the digital age. As more of our daily activities move online, it becomes increasingly important to make sure that low-income consumers can continue to participate in society and benefit from the information revolution. These activities include:

- **News.** Internet access lowers the cost of information, making it easier to be an informed citizen. More Americans report getting their news each week via laptop or computer (70 percent) than via traditional newspapers and magazines (61 percent).[3]
- **Commerce.** FCC Chairman Tom Wheeler notes a 2012 study showing that broadband access helps a typical consumer save $8,800 each year by providing access to bargains on goods and services.[4]
- **Jobs.** A recent study from the Council of Economic Advisers shows that young unemployed individuals who use the Internet to find jobs are re-employed 25 percent faster than those using only traditional methods.[5]
- **Education.** FCC Commissioner Jessica Rosenworcel has highlighted the role of Internet access for schoolchildren and the need to avoid a "Homework Gap" for those who lack access at home.[6]

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[1] 47 U.S.C. § 151.

[2] See, e.g., Steve G. Parsons and James Bixby, "Universal Service in the United States: A Focus on Mobile Communications," *Federal Communications Law Journal* 62, no. 119 (2010): 135–136, http://www.fclj.org/wp-content/uploads/2013/01/10-PARSONS_FINAL.pdf.

[3] American Press Institute, "The Personal News Cycle: How Americans Choose to Get Their News," March 17, 2014, https://www.americanpressinstitute.org/publications/reports/survey-research/how-americans-get-news/.

[4] See Tom Wheeler, "A Lifeline for Low-Income Americans," Federal Communications Commission, May 28, 2015, https://www.fcc.gov/news-events/blog/2015/05/28/lifeline-low-income-americans.

[5] See Council of Economic Advisers, "The Digital Divide and Economic Benefits of Broadband Access," *Issue Brief*, March 2016, https://www.whitehouse.gov/sites/default/files/page/files/20160308_broadband_cea_issue_brief.pdf, citing Peter Kuhn and Hani Mansour, "Is Internet Job Search Still Ineffective?" Institute for the Study of Labor (Bonn), September 2011, http://ftp.iza.org/dp5955.pdf.

Despite these clear benefits, almost one-third of American households lack high-speed Internet access at home. The disparity is greater when segmented by income: 95 percent of households earning $150,000 or more annually are connected, compared with only about half of households earning less than $25,000.[7] As the Internet displaces the telephone as the nation's primary telecommunications network, the case for modernizing our traditional universal service mandate to fit the 21st century is becoming increasingly strong.

Extending Lifeline Is Not the Answer

The FCC's proposed solution is to extend the existing Lifeline program to subsidize broadband access.[8] While the agency has correctly diagnosed the problem, its proposal is unlikely to help solve it.

As an initial matter, there is no proof that the existing Lifeline telephone subsidy has any effect on telephone adoption rates. Lifeline was born in the 1980s, as a political compromise following the breakup of the Bell monopoly. During the monopoly era, Bell used cross-subsidies to cover some costs of local telephone service. After divestiture the FCC implemented a monthly per-line fee on local consumers to recover that lost revenue.[9] Concerned that this new monthly fee might harm telephone adoption rates, the agency established Lifeline to subsidize monthly service for low-income consumers, although as the GAO notes, the FCC found no evidence that this new fee would cause low-income consumers to cancel their telephone service.[10]

Currently, the program offers most eligible recipients a $9.25 subsidy for their monthly phone bills. But when pressed by the GAO, the FCC admitted that it does not know whether the Lifeline program has helped boost telephone penetration rates.[11] The agency instead pointed the GAO to independent studies that suggest that demand for telephone service is relatively insensitive to changes in price or income, even for low-income households.[12] One such study finds that only one in eight households that receive Lifeline subscribes to telephone service because of the subsidy. That suggests that 88 percent of Lifeline dollars are wasted on households at little risk of losing telephone service absent the subsidy, and the rate is higher for wireless Lifeline recipients. The GAO concluded that Lifeline "may be a rather inefficient and

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[6] See Jessica Rosenworcel, "How to Close the 'Homework Gap,'" *Miami Herald*, December 5, 2014, http://www.miamiherald.com/opinion/op-ed/article4300806.html.

[7] See "Lifeline and Link Up Reform and Modernization," 30 FCC Rcd. 7818, 7822, 7829, and n.232 (2015).

[8] See Federal Communications Commission, "Fact Sheet on Lifeline Modernization Proposal," March 8, 2016, https://www.fcc.gov/document/fact-sheet-lifeline-modernization-proposal.

[9] US Government Accountability Office, "Improved Management Can Enhance FCC Decision Making for the Universal Service Fund Low-Income Program," GAO-11-11, October 28, 2010, 5, http://www.gao.gov/products/GAO-11-11.

[10] Id.

[11] See US Government Accountability Office, "FCC Should Evaluate the Efficiency and Effectiveness of the Lifeline Program," GAO-15-335, March 24, 2015, 14, http://www.gao.gov/products/GAO-15-335.

[12] See, e.g., Olga Ukhaneva, "Universal Service in a Wireless World," Social Science Research Network, November 17, 2015, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2430713; and Daniel A. Ackerberg et al., "Estimating the Impact of Low-Income Universal Service Programs," CES-13-33, US Census Bureau, Center for Economic Studies, June 2013, http://www2.census.gov/ces/wp/2013/CES-WP-13-33.pdf.

costly mechanism to increase telephone subscribership among low-income households."[13] At a minimum, the FCC admits that it spent $1.6 billion last year on Lifeline without any evidence that the program achieves any good.

Similarly, the agency offers no reasonable basis to conclude that extending the existing program to broadband will measurably close the low-income broadband gap. As a preliminary matter, the agency makes no effort to target only unconnected households, meaning that the agency risks replicating its existing error of spending significant resources on recipients who are not at risk of falling on the wrong side of the digital divide. Perhaps more significantly, the agency offers no reason to believe its proposal will entice unconnected households to buy Internet access. The GAO recommended that, before expanding into broadband, the FCC conduct an assessment of the telecommunications needs of low-income households and use the results to design a well-informed and effective broadband subsidy program.[14]

The FCC appears to have rejected this advice, proposing instead simply to allow recipients to use their $9.25 monthly subsidy to purchase broadband access rather than telephone service.[15] Even if one assumes without evidence that this subsidy convinces low-income households to buy telephone service, there is no logical reason to conclude that the same amount would also persuade unconnected homes to purchase Internet access, which is typically more expensive than phone service. Without conducting a study to determine the factors driving low adoption rates, the FCC cannot conclude that offering $9.25 per month to 13 million households will boost adoption rates more than offering a larger amount to a smaller number of households: for example, $46.25 per month to 2.6 million recipients, which would cost the same amount of money.

In fact, what little data the FCC has generated suggests that a small monthly subsidy is unlikely to boost broadband adoption rates. From 2012 to 2014, the agency conducted a series of broadband subsidy pilot programs. The agency estimated that 74,000 low-income consumers would receive broadband service through these trials, but only one-tenth of this number were enticed to sign up.[16] The GAO noted that insufficient sample sizes and methodological flaws in pilot design may limit the conclusions that can be drawn. But the FCC noted a preliminary finding that the highest participation rates came from those programs offering deeply discounted or free monthly rates. For example, one project offering a choice between a plan with an upfront cost and no monthly fee and a plan with a $20 monthly fee saw 100 percent of plan participants enroll in the free option.[17] An independent study of the broadband pilot data by Technology Policy Institute's Scott Wallsten similarly showed that participants were willing to trade off speed for lower out-of-pocket prices.[18] These findings are consistent with the traditional Lifeline service, which saw a spike in enrollment when the FCC allowed recipients to get a free wireless plan rather than a subsidized landline service. Broadband providers may make qualifying plans

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[13] US Government Accountability Office, "FCC Should Evaluate," 14.
[14] US Government Accountability Office, "Improved Management," 42.
[15] See Federal Communications Commission, "Fact Sheet on Lifeline Modernization Proposal."
[16] See US Government Accountability Office, "FCC Should Evaluate," 33.
[17] Id. at 33–34.
[18] Scott Wallsten, "Learning from The FCC's Lifeline Broadband Pilot Projects," Technology Policy Institute March 2016, available at https://techpolicyinstitute.org/wp-content/uploads/2016/03/Wallsten_Learning-from-the-FCCs-Lifeline-Broadband-Pilot-Projects.pdf.

available at little or no cost to Lifeline households. Comcast, for example, has offered its 10 megabits per second (Mbps) Internet Essentials plan to certain families on the school lunch program for only $9.95/month. But if the $9.25 subsidy instead goes to plans that require a significant monthly payment from the consumer as well, the data suggest that the subsidy is unlikely to convert unconnected households into broadband adopters and will instead flow primarily to homes that already have broadband service.

Moreover, the Lifeline proposal does little to address the other, potentially more significant, drivers of the low-income broadband gap. According to the latest Pew Research Center survey, only about one-third of non-broadband users cite monthly cost as the most important reason for their lack of service.[19] While this is the most commonly cited factor, it is far from the only driver cited by respondents. Moreover, for the 20 percent of Americans who have *never* had Internet access, the vast majority (70 percent) are uninterested in subscribing at any price.[20] As *Forbes* commentator Larry Downes notes, earlier Pew studies suggest that many in this group cite relevance or usability as reasons not to adopt broadband. To overcome this obstacle, a program should include digital literacy outreach and other initiatives to make Internet access more attractive and less of a mystery—initiatives that are missing in the current proposal.[21] In addition, 10 percent of Pew respondents also cited the high cost of computer equipment as a barrier to broadband adoption.[22] This highlights a significant distinction between telephone and broadband subsidy programs. Telephones are fairly inexpensive, and the market has developed tools to allow consumers to finance more expensive wireless handsets over time. But there is not a similar program in place for home computer equipment. This means that the consumer faces a potentially significant upfront cost to cross the digital divide, a factor that the current Lifeline telephone program never faced. A subsidized monthly plan is worthless to a consumer who lacks the hardware to get onto the Internet. The FCC's Lifeline proposal does little to address these other drivers, limiting its overall effectiveness at reaching and converting non-adopters.

The FCC proposal also raises significant questions regarding which services would be eligible for the subsidy. The proposal would require qualifying fixed plans to offer at least 10 Mbps download speed and a minimum of 150 gigabytes per month. This service falls short of the 25 Mbps minimum that the FCC has defined as "broadband service," meaning that the agency proposes to offer low-income consumers plans that it has determined are inadequate to meet consumer needs in other contexts. One can perhaps justify this choice by proving that 10 Mbps is sufficient to allow eligible recipients to participate meaningfully in cyberspace. But the proposal does not do so, instead simply stating that 10Mbps is what a substantial majority of consumers receive. Absent a more data-driven explanation, the inconsistency between the 10 Mbps minimum here and the 25 Mbps minimum used elsewhere raises significant questions.

Also concerning is the plan to phase out the existing, and popular, subsidy for mobile phone service. Support for mobile phone service will continue only until 2019, after which mobile plans

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[19] See John B. Horrigan and Maeve Duggan, "Home Broadband 2015," Pew Research Center, December 21, 2015, 4, http://www.pewinternet.org/files/2015/12/Broadband-adoption-full.pdf.

[20] Id. at 8; see Larry Downes, "Smartphones Are Completing the Broadband Revolution," *Forbes*, December 23, 2015, http://www.cnet.com/news/broadband-adoption-shifts-to-mobile.

[21] See Downes,"Smartphones Are Completing the Broadband Revolution."

[22] Horrigan and Duggan, "Home Broadband 2015," 16.

must include a broadband component. This seems unnecessarily paternalistic. As noted above, a substantial majority of consumers who have never purchased broadband access are unlikely to do so at any price. One can imagine a variety of potential consumer profiles within this group, such as impoverished senior citizens who lack interest in Internet access but who value basic mobile telephone service to communicate easily with grandchildren and friends. The 2008 expansion of Lifeline to include mobile voice service was incredibly popular, helping drive a 166 percent increase in Lifeline subscribers from 2008 to 2012.[23] The GAO estimates that wireless carriers received 85 percent of all Lifeline disbursements in the third quarter of 2014.[24] These plans are popular in part because they involve little or no monthly contribution from the consumer. Replacing this standalone mobile service with a presumably more expensive bundled voice and broadband offering, while holding the subsidy constant, is likely to drive up consumer costs and reduce Lifeline participation rates at the margin.

Finally, the proposal does little to address Lifeline's longstanding structural flaws, most significantly its financial stability. In short, the proposal seeks an alarming 50 percent increase in a program that has been growing significantly in recent years, without addressing the anachronistic and unsustainable contribution mechanism that would fund this growth. Although the FCC's 2012 anti-fraud measures have reduced some Lifeline costs, the program still spent $1.6 billion in 2015, which is about double the amount spent in 2008. This runaway growth has prompted some, most prominently FCC Commissioner Mike O'Rielly, to demand that Lifeline be subjected to a hard budget to curb its astronomical growth. Yet the FCC proposes raising annual expenditures to $2.25 billion annually, indexed to inflation. The proposal suggests an annual Lifeline budget, but there appears to be little enforcement of this budgetary limit, meaning that it will likely do little to curb program growth. Lifeline, like the FCC's other universal service programs, is funded by a surcharge on interstate and international telecommunications calls (what used to be called "long-distance"), which is ultimately passed along to consumers. For the past 15 years, Universal Service Fund (USF) costs have been rising, while the revenue base is falling because people make fewer traditional long-distance calls. As a result, the USF surcharge has grown astronomically, from 3 percent in 1998 to a whopping 18.2 percent in the first quarter for 2016. A 50 percent increase in Lifeline costs will likely raise that number further, despite the growing criticism that the current level is unsustainable and deters consumers from using the telecommunications networks that the program is designed to promote.

Ultimately, the FCC's proposal amounts to spending $2.25 billion or more annually to expand a troubled telephone subsidy program into cyberspace, hoping that some of this money will measurably increase low-income broadband adoption rates, but without any proof that this is likely and despite significant evidence suggesting otherwise.

Toward a Better Model

To solve the low-income broadband gap, Lifeline needs revolutionary, not evolutionary, change. The myriad difficulties with the FCC's proposal show the need for a more comprehensive

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[23] US Government Accountability Office, "FCC Should Evaluate," 24.
[24] Id. at 25.

approach to this problem. The remainder of this paper sketches the broad strokes of a program that is more likely to achieve meaningful reform.

First, policymakers should take a more tailored, data-driven approach to the low-income broadband adoption problem. Rather than simply offering assistance to anyone who qualifies for other forms of government assistance, policymakers should study the profile of low-income non-broadband households in particular, and design an application system tailored to this segment of the population. This will reduce the risk of spending program dollars on those who would have bought Internet access anyway. The study should also identify metrics to determine just how much of a monthly subsidy eligible households would need to entice them to purchase Internet access. This would help solve the question of whether a small subsidy to a large number of recipients or a larger subsidy to fewer recipients will be more effective at reducing the broadband gap.

At the same time, the plan should involve a more comprehensive solution than Lifeline currently offers. In addition to the monthly cost subsidy, an effective broadband Lifeline program should include ways for low-income recipients to acquire computers and other equipment they need to get online. This can be done with a one-time equipment subsidy for new participants (perhaps drawing appropriate lessons from the FCC's now-defunct Link-Up program that funded installation costs for telephone service) or by allowing low-interest financing options for participants to purchase equipment. The program should also include digital literacy outreach programs in local communities, so those who are unconvinced or uncertain about Internet use can gain a greater appreciation of the importance of connectivity to everyday life.

The program should also take an activity-based approach to defining eligible plans. Rather than arbitrarily choosing a minimum download speed from the bevy of available options, the program should identify which online activities would empower low-income consumers. This list might include access to email, news, job boards, or digital voice service to reach public safety officials. Once this list is completed, the program can estimate the minimum speed necessary to accomplish these tasks online and use this to define the target plans for the monthly subsidy. Many define broadband as 25 Mbps or more, an amount driven by estimates about the minimum speed necessary to stream high-definition video online. But it is unclear that a broadband Lifeline program should provide a subsidy large enough for low-income recipients to stream Netflix. After all, the traditional universal service program never subsidized cable subscriptions. An activity-based approach would allow the program to target its dollars more efficiently toward the goal of allowing low-income consumers to engage in a basic set of important activities online.

To avoid concerns about paternalism, the program should design the subsidy to empower consumers. The primarily difficulty facing low-income consumers is lack of purchasing power. A competitively neutral, consumer-empowering subsidy would solve this problem by increasing the purchasing power of eligible recipients with limited strings attached. In the words of President Obama's ConnectALL initiative, the subsidy should be "direct and portable." One potential solution would be to offer consumers a voucher that can be redeemed for a variety of services. The voucher should be set at the amount necessary to subsidize a basic broadband plan that offers at least the necessary minimum speed. But the consumer should have the freedom to use the voucher to purchase a (presumably less expensive) voice-only plan or as a credit toward a larger bundle of telecommunications services, if the consumer is willing to pay more out-of-pocket.[25] This approach would be a more market-based approach to universal service, empowering low-income consumers with greater purchasing power to influence providers to compete for their attention. This would also bring the subsidy program in line with other government benefit programs, such as SNAP and MedicAid, that seek to increase purchasing power and market freedom of low-income recipients.

Finally, the program should be administered very differently than the current model. Rather than funding it off-budget through a shaky and unsustainable surcharge mechanism, Congress should make the broadband subsidy program a line item in the federal budget, subject to a hard cap on annual expenditures. This would make the program more transparent and subject to greater congressional oversight to discourage the fraud, abuse, and waste that until recently marked the Lifeline program. A firm annual budget tied to clear metrics such as adoption rates would encourage program managers to spend the money efficiently, in ways that maximize the likelihood that these annual expenditures will actually reduce the digital divide. Congress should also consider shifting oversight of the program from the Federal Communications Commission to another agency, such as the Department of Health and Human Services, that better understands the issues facing those in poverty. It may ultimately decide not to shift the program, but this decision should be based on a rational assessment of the FCC's institutional strengths compared with other potential departments.

Conclusion

The Federal Communications Commission should be credited for shining a spotlight on an important problem in need of urgent attention, but it has not shown that its proposal is likely to solve the problem. Rather than extending a flawed telephone-era subsidy program into cyberspace—an exercise in pounding the metaphorical square peg into a round hole—Congress should design a more comprehensive, data-driven and market-based approach to the low-income broadband gap. This approach is more likely to narrow the digital divide and equip low-income consumers to take advantage of the many and growing opportunities made available by the digital revolution.

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[25] See Daniel Lyons, "Reforming the Universal Service Fund for the Digital Age," in *Communications Law and Policy in the Digital Age*, Randolph May, ed. (2012), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2321881.

Appendix: Draft Proposal for Universal Service Reform

Overview: Congress should eliminate the wasteful, off-budget Federal Universal Service Program and transition its core functions to a new office within the Department of Health and Human Services. This new department will be responsible for administering a targeted subsidy program to help low-income Americans to participate in the digital revolution. The subsidy program will use data-driven analysis to improve the purchasing power of low-income consumers in telecommunications markets, which will help those markets function more effectively and will enhance competition among telecommunications providers in a technology-neutral fashion. Unlike the current program, the new department will focus solely on low-incme households and will be subject to a hard budget and more significant congressional oversight.

Congress Should Establish an Office of Broadband Lifeline Support

- The mission of the Office shall be to provide assistance to low-income households that cannot afford telecommunications services, with a focus primarily upon encouraging greater broadband adoption by low-income households.
- The primary function of the Office is to administer Broadband Lifeline Support program through data-driven analysis, and to undertake such other initiatives as Congress permits to encourage broadband adoption.
- The Office shall he led by a Director of the Office of Broadband Lifeline Support, who reports to the Secretary of Health and Human Services.

Broadband Gap Study

- The Office should first conduct a needs assessment, in accordance with the proposal outlined in GAO 11-11, to determine the telecommunications needs of low-income households.
- It should identify and quantify the drivers of broadband non-adoption by low-income households, such as disinterest in broadband, equipment startup costs, and monthly service costs.
- It should also determine what monthly subsidy level would be sufficient to induce non-adopting households to order broadband.

Broadband Lifeline Voucher Program Eligibility

- Informed by the results of the study, the Office will establish and administer the Lifeline Voucher Program.
- The program will be limited to households with incomes below 135% of the federal poverty line guidelines who do not currently subscribe to broadband service and have not subscribed to broadband service within the preceding six months.
- Participation will be further limited by eligibility criteria established by the Office, based upon study results, to minimize payments to households that would likely purchase broadband service without a subsidy

Lifeline Voucher Program Amount

- The Office shall, by rulemaking, compile a list of online services that are important for low-income households to access. This list shall include, but not be limited to, access to email, websites, news, and job listings.

- The Office shall determine the minimum service requirements of a broadband plan that will allow eligible recipients to accomplish these tasks, known as *basic broadband service*.
- The Office shall conduct annual surveys to determine the market price of basic broadband service throughout the United States by service area
- Informed by the results of the Broadband Gap Study, the Office shall determine the amount that an eligible household can afford to pay for basic broadband service, known as the *subsidized rate*.
- The Office shall set the *voucher amount* as the difference between the subsidized rate and the market rate for basic broadband service within a service area.
- If the office determines that a broadband provider has market power in a service area and is abusing its market power to charge supracompetitive rates, it may set the voucher amount as the difference between the subsidized rate and the price sufficient to assure a reasonable rate of return to a reasonably efficient broadband provider in the service area.

Lifeline Voucher Administration

- The Office shall issue a nontransferable voucher monthly to each eligible household equal to the voucher amount.
- Any telecommunications provider that accepts a voucher must agree to offer basic broadband service to voucher recipients at a rate no greater than the subsidized rate plus the voucher amount.
- Voucher recipients may use the voucher to purchase basic broadband service or as a credit toward an alternative telecommunications product (such as voice-only telecommunications service or bundled voice, video, and broadband packages).
- The Office may place reasonable limits upon telecommunications products eligible for voucher subsidies.
- Telecommunications providers may seek reimbursement monthly from the Office for the face value of each voucher accepted.

Lifeline Voucher Funding

- The Lifeline Voucher shall be funded by an annual budget set by Congress for purposes of administering the voucher program.
- The Office shall take reasonable measures to assure that the voucher program does not exceed its annual budget

Other Programs

- The Office may petition Congress for additional funding to support a digital literacy outreach program and/or an equipment subsidy program, if the broadband study supports a finding that these are additional barriers to broadband adoption
- If enacted, the digital literacy outreach program shall be designed to reach communities with high proportions of eligible households
- If enacted, the equipment subsidy program shall be designed to subsidize the purchase of a desktop, laptop, tablet, or mobile device capable of receiving basic broadband service. The subsidy amount shall be set by the Office at an amount sufficient to induce eligible households to purchase the equipment necessary to adopt broadband service. An eligible household shall receive no more than one equipment subsidy every three years.

Legacy Universal Service Fund Program

- Upon commencement of the Lifeline Voucher Program, the Federal Universal Service Fund's Lifeline program shall be terminated.
- The Federal Communications Commission shall undertake a rulemaking proceeding to phase out the High-Cost Fund/Connect America Fund over the next five years.
- The Federal Communications Commission shall also undertake a rulemaking to phase out the E-Rate and rural healthcare programs over the next five years.
- Upon elimination of these programs, the Federal Communications Commission shall eliminate the federal universal service program and its associated monthly surcharge to carriers.

Common Carriage Privacy Redux

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ABSTRACT: In a landmark regulatory shift, the Federal Communications Commission's (FCC) in its 2015 Open Internet Order subjected for the first time broadband internet access services (BIASs) to the Communication Act's section 201 common carrier regulation. The FCC also subjected BIASs to section 222 privacy protections, placing numerous requirements on their collection and use of proprietary network information (CPNI). However, section 201 gives the FCC power to regulate in traditional areas of common carriage—which includes common carriers' duties not to disclose the content of messages entrusted to them. Looking into long-ignored 19th century precedent, this article examines how the FCC could use section 201 to impose privacy obligations on internet firms—and how this power is significantly different from that which section 222 grants for the purposes of protecting CPNI. The paper also examines how this potential regulatory burden, focused only on BIASs, exacerbates the regulatory inequality between BIASs, regulated as common carriers, and fringe providers, which are not—even though they often engage in the same commercial activities.

Introduction

The Federal Communications Commission's (FCC's) 2015 Open Internet Order, one of the most controversial regulations in recent memory, has exerted federal power, for the first time, over the entire internet network.[1] The FCC received over 3.5 million comments from interested individuals and organizations, reflecting a groundswell of popular interest that, in fact, crashed the agency's computers.[2] And, the Open Internet Order was probably the first rulemaking proceeding ever to be the subject of commentary from late night comedians such as John Oliver,[3] Jimmy Kimmel[4] and Saturday Night Live's Gennifer Owens.[5]

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[1] Fed. Comm. Comm'n., In the Matter of Protecting and Promoting the Open Internet, GN Docket No. 14-28, Report and Order on Remand, Declaratory Ruling, and Order (2015), https://www.fcc.gov/article/fcc-15-24a1 [hereinafter "2015 Open Internet Order"] The Order hedges on the precise parameters of its jurisdiction. While previous orders considered only consumer relations with their broadband providers, the Order now exerts jurisdiction over transit between broadband providers, i.e. the internet backbone. *See id*. ("we find that broadband Internet access service is a 'telecommunications service' and subject to sections 201, 202, and 208 (along with key enforcement provisions). As a result, commercial arrangements for the exchange of traffic with a broadband Internet access provider are within the scope of Title II, and the Commission will be available to hear disputes raised under sections 201 and 202 on a case-by-case basis: an appropriate vehicle for enforcement where disputes are primarily over commercial terms and that involve some very large corporations, including companies like transit providers and Content Delivery Networks (CDNs), that act on behalf of smaller edge providers. But this Order does not apply the open Internet rules to interconnection.").

[2] Stephanie Mlot, *Net Neutrality Public Comments Top 3M***,** PC MAG. (Sept. 16, 2014, 9:55 AM), http://www.pcmag.com/article2/0,2817,2468576,00.asp.

[3] Amanda Holpuch, *John Oliver's cheeky net neutrality plea crashes FCC website*, THE GUARDIAN

Beyond the public discussion, remarkable for an arcane regulatory matter, the 2015 Open Internet Order enacted a change that advocates of a more regulatory FCC stance long sought: reclassification of internet service from Title I's ancillary jurisdictional authority to Title II's common carriage jurisdictional authority. This legal change is momentous, for as the FCC learned through a series of set-backs from the D.C. Circuit, Title I jurisdiction proved a weak vessel for virtually any ambitious policy of internet regulation.[6] Title II, on the other hand, has formed the basis of the FCC's 70 year old, comprehensive regulation of interstate communications. Faced with its Title I regulatory impotence and strong political pressure—including some from President Obama, FCC Chairman Wheeler in the 2015 Open Internet Order classified broadband internet service as Title II common carriage.[7]

Even though the FCC used its authority under section 160[8] to forbear from many duties found in Title II of the 1934 Communications Act,[9] the FCC will apply many portions of Title II of the Communications Act to the internet. Most notably, the FCC will apply Section 201 that gives power to the FCC to require common carrier interconnection and

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(June 3, 2014, 2:33 PM), http://www.theguardian.com/technology/2014/jun/03/john-oliver-fcc-website-net-neutrality; Marvin Ammori, *John Oliver's Hilarious Net Neutrality Piece Speaks the Truth*, SLATE (June 6, 2014,3:17PM), http://www.slate.com/articles/technology/future_tense/2014/06/john_oliver_s_net_neutrality_segment_speaks_the_truth.html.

[4] Jimmy Kimmel Live, *People with Funny Names Arrested*, YOUTUBE (Sept. 10, 2014), https://www.youtube.com/watch?v=xqgmUURct4I.

[5] *Saturday Night Live*: *Episode 14 Net Neutrality* (NBC television broadcast Feb. 28, 2015), http://www.nbc.com/saturday-night-live/video/net-neutrality/2850291.

[6] Formal Complaint of Free Press and Public Knowledge Against Comcast Corp. for Secretly Degrading Peer-to-Peer Applications, Memorandum Opinion and Order, 23 F.C.C.R. 13,028 (2008), vacated Comcast Corp. v. FCC, 600 F.3d 642 (D.C. Cir. 2010) (holding that the FCC acted beyond its statutory authority when punishing Comcast for protocols aimed at discouraging peer-to-peer traffic).*Preserving the Open Internet, Report and Order, GN Docket No. 09-191, WC Docket No. 07-52*, 25 FCC Rcd. 17905 (2010) [hereinafter cited as 2010 Open Internet Order] aff'd in part, vacated and remanded in part sub nom. Verizon v. FCC, 740 F.3d 623 (D.C. Cir. 2014), on remand, *Protecting and Promoting the Open Internet, GN Docket No. 14-28, Notice of Proposed Rulemaking*, 2014 WL 2001752 (rel. May 15, 2014) [hereinafter cited as 2014 Open Internet NPRM].

[7] Ezra Mechaber, *President Obama Urges FCC to Implement Strong Net Neutrality Rules*, WHITEHOUSE.GOV (Nov. 10, 2014 9:15 AM), https://www.whitehouse.gov/blog/2014/11/10/president-obama-urges-fcc-implement-stronger-net-neutrality-rules ; Mark W. Davis, *Sneaky, Stealthy and Serpentine*, US NEWS (Feb. 27, 2015 5:45 PM), http://www.usnews.com/opinion/blogs/mark-davis/2015/02/27/obama-net-neutrality-underhanded-power-grab-is-bad-for-the-internet.

[8] 47 U.S.C. §160 (date).

[9] Although the FCC did "forbear from 30 statutory provisions and render over 700 codified rules inapplicable," it did *not* forbear from the Communications Act's section 201 (common carriage), 202 (discriminatory or unreasonable charges or practices); 206 (enforcement); 207 (enforcement); section 208 (enforcement); 209 (enforcement); 216 (application to receivers and trustees); 222 (consumer protection); 224 (pole access); 225 (consumer protection); 229 (CALEA obligations); 251(a)(2) (disabilities access) 254 (universal service), and 255 (consumer interest). *See* FCC Open Internet Order, ¶¶ 51-57.

"establish . . . regulations for operating such through routes."[10] Section 201 goes on to state that "[a]ll charges, practices, classifications, and regulations for and in connection with such communication service, shall be just and reasonable, and any such charge, practice, classification, or regulation that is unjust or unreasonable is declared to be unlawful." Section 202, which the FCC will also enforce, makes illegal for any "common carrier to make any unjust or unreasonable discrimination in charges, practices, classifications, regulations, facilities, or services . . .any undue or unreasonable preference or advantage to any particular person, class of persons, or locality, or to subject any particular person, class of persons, or locality to any undue or unreasonable prejudice or disadvantage."[11]

Section 201 is, as Gary Lawson, the great critic of the administrative state would say, a "niceness and goodness" statutory provision,[12] giving the FCC power broad powers not only over the rates common carriers charge, but also the terms and conditions of offering their services to ensure that they are "just and reasonable." What firm qualifies as a common carrier is far from clear as the definition is completely statutory.[13] In short, section 201 is an open invitation for the FCC to regulate in broad ways. As this Article argues, section 201 could have enormous, and some unintended, consequences—particularly for privacy.

When struggling to interpret section 201's vague terms, courts, in general, look to the historical meaning of common carriage for guidance.[14] And, there's the rub. Common carriage, the law that governs common carriers, is, of course, an ancient, and notoriously sprawling, set of rules that can trace its history to the 17th century and governs transportation, communications, and other "essential" industries.

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[10] 47 U.S.C. § 201(a).

[11] 47 U.S.C. §§ 202-03.

[12] *See* Gary Lawson, *The Rise and Rise of the Administrative State*, 107 HARV. L. REV. 1231, 1239 (1994)

[13] Under 47 U.S.C. § 153(h), a common carrier is defined as "any person engaged as a common carrier for hire. . . ."

[14] Nat'l Ass'n of Regulatory Util. Com'rs v. F.C.C., 533 F.2d 601, 608 (D.C. Cir. 1976) ("the circularity and uncertainty of the common carrier definitions set forth in the statute and regulations invite recourse to the common law of carriers'); Nat'l Ass'n of Regulatory Util. Com'rs v. F.C.C., 525 F.2d 630, 640 (D.C. Cir. 1976) ("For purposes of the Communications Act, a common carrier is 'any person engaged as a common carrier for hire . . . The Commission's regulations offer a slightly more enlightening definition: 'any person engaged in rendering communication service for hire to the public.' However, the concept of 'the public' is sufficiently indefinite as to invite recourse to the common law of carriers to construe the Act.").

Most important for this Article's concern is a large, and largely forgotten, set of rules governing common carriers' privacy obligations. These rules mostly involve a telegram company's duties to keep messages secret. Telegrams were often carelessly delivered or delivery boys too curious or gossipy. Presumably, with the advent of the telephone, the need for these sorts of protections diminished. Telephone conversations are private by their nature, save technically difficult wiretapping, and, therefore, experience fewer privacy breaches.

Nonetheless, by ruling that section 201 governs broadband access service providers, the FCC has opened the door for these wide-ranging common carriage privacy protections—much wider than the privacy protections afforded in section 222. Nineteenth century and early twentieth century common carriage privacy law gives the FCC the power to demand that internet actors keep customers' *messages* private. This duty is different, if not broader, than simple customer protection network information (CPNI) confidentiality as required by section 222.

The Article proceeds as follows. First, it surveys the case law outlining the common carriage duties and liabilities and, in particular, examines a subset, the common carrier duty to keep messages private and secret. This body of law largely derives from the late 19th and early 20th century telegraph cases. Second, we examine the interplay between section 222 and section 201. Section 222 does create certain specific duties—and courts could interpret them as overriding any privacy duties derived from section 201. This section, however, concludes that courts would likely *not* read section 222 given previous precedent on reading the original 1934 Communications Act along with the amendments that the 1996 Telecommunications Act made. Finally, we examine the wisdom and practicability of applying 19th century privacy principles, developed primarily for telegraphs, to the modern internet age. In particular, the Article observes that application of section 201 on BIASs creates a bizarre regulatory asymmetry in email and other communications: email and other communications services provided by BIAS face a large mountain of potential privacy regulation under section 201 which edge providers do not.

I. Common Carriage Liability & Privacy

In a musty attic of telecommunications law, one finds common carriage liability. Given the "public" nature of common carriers' business, courts required "character and degree of care, diligence and skill commensurate with their undertaking."[15] Under common law, common carriers, such as telephone and telegraph companies, had a duty to deliver messages in good faith and a non-negligent manner.[16] State and federal courts developed a body of law dealing with transmission omissions and errors of all sorts committed by telegraph and telephone companies.

[15] Tedson J. Meyers, *Liability Limitations in International Data Traffic: The Consequences of Deregulation*, 16 CASE W. RES. J. INT'L L. 203, 214 (1984)

[16] BARBARA A. CHERRY, THE CRISIS IN TELECOMMUNICATIONS CARRIER LIABILITY (1999).

Common carrier common law liability, as discussed in Section IV, became obsolete with the emergence of state public service commissions, the Interstate Commerce Commission (ICC), the Federal Communications Commission, and the development of the filed tariff doctrine as discussed in Section III. In short, common carrier liability became a regulatory concern, not a matter for common law courts. Nonetheless, as this section shows, virtually all matters that came under the purview of common carrier common law liability remain within the FCC's authority under section 201.

"It is in the telegraph cases, rather than the telephone cases, that expansive interpretations of the carriers' basic duties are found."[17] The relative importance of telegraphy in case law is probably due to technological differences between telegraphy and telephony. A common carrier's duty is to transmit and deliver a message, and there are more possible instances of error or mistake in telegraph messages than in telephone messages, which are much more automated. For instance, the telegrapher could make errors of transcription, failure to send at all, or an error of delivery. Nonetheless, there can be errors in early telephone systems as well, which typically required more human oversight, i.e., a connecting operator, than more automated, modern telephone systems.

The types of negligent or, willful, injuries that telegraph and telephone companies could commit seem a bit quaint to our modern legal notions of injury, although they were apparently quite real to those in the late 19th and early 20th centuries. These injuries fall into several categories, ranging from the telegram or telephone operator who failed to be on duty as required or operate a machine correctly[18] -- or even willfully fail to connect a phone call.[19]

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[17] Meyers, *supra* note 15, at 214, citing Holman v. Southwestern Bell Tel. Co., 358 F. Supp. 727 (D. Kan. 1973), quoting with approval Wilkinson v. New England Tel. & Tel. Co., 327 Mass. 132, 97 N.E.2d 413 (1951) ("Because of the complexities and intricacies of the modern telephone system in which the personal element has been substantially eliminated and much if not all of the means of making usual telephone calls is left to mechanical devices, such a regulation [limiting liability] is not unreasonable.").

[18] Jennings v. SW. Bell Tel. Co., 307 S.W.2d 464, 467 (Mo. 1957) ("that an operator of the defendant was given all of this information and requested to make the connection with the fire department, but that the operator failed to do so"); Arndt, Inc. v. Wisconsin Tel. Co., 58 N.W.2d 682, 684 (Wis. 1953) ("The extent of the undertaking by the defendant, whether the communication by the unnamed person was sufficient to inform the operator that the caller wanted to be connected with the fire department, whether there was unreasonable delay in making the connection or whether the caller hung up before the connection was completed, the extent of the unreasonable delay and whether it was a proximate cause, if proven, of the damages of the plaintiffs, and the extent of the damages attributable to any unreasonable delay proven, are all questions of fact"); Peterson v. Monroe Indep. Tel. Co., 182 N.W. 1017, 1018 (Neb. 1921) ("Telephone companies are under the duty of furnishing to their subscribers reasonably prompt and efficient service in the way of giving them connections with other subscribers, and they are liable for any pecuniary loss directly traceable to a breach of such duty as the proximate cause thereof."); Christenson & Vinson v. Southern Bell Tel. & Tel. Co. 188 Ala 292, 66 So 100, (1914) (failed switchboard operator).

[19] Texas Cent. Tel. Co. v. Owens, 128 S.W. 926, 927 (Tex. Civ. App. 1910) ("appellant's operator made no effort to get the doctor to the telephone, but that he, in fact, answered the call, pretending to be the

First, with the telegram, there could be an error in telegraphic transcription or copying. ("Buy seventy thousand porkbellies rather than "Buy seven thousand porkbellies"). Courts typically recognized liability in such instances, based upon general common carrier duties. But, courts did allow carriers to limit damages contractually under certain conditions. The Supreme Court recognized that while a telegraph company can contract out of liability for an erroneous telegraphed message, it could not so contract if the sender paid extra for a "repeat message.[20] This meant that telephone companies had to offer customers the option of sending an "insured" repeated message, i.e., a message that was sent twice and which the telegrapher compared for errors, but full liability did not attach to telegraphs sent the normal "unrepeated" way. In this manner, courts gave telegraph and telephone companies more flexibility in liability compared to shippers and railroads, which could not contract out of liability. On the other hand, common law courts required communications common carriers to at least offer to assume liability using "repeated messages."[21]

Second, given the large number of people who handled a telegram (the operator, delivery boys, and other office employees), there was ample opportunity for willful delivery error or accidental mis-delivery. A telegraph company could be liable for injuries caused as well as emotional injury.[22] Third, a telegraph company could be liable for a delay or failure in delivery or transmission of a message, and aggrieved parties had a remedy in tort.[23]

Finally, and of most immediate importance for this Article, there is a largely

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doctor, and thereby deceived the plaintiff into believing that the doctor would make an immediate call upon, and relieve the sufferings of, his wife.").

[20] Primrose v. W. Union Tel. Co., 154 U.S. 1, 14, 15-16 (1894) ("Telegraph companies resemble railroad companies and other common carriers, in that they are instruments of commerce . . . .the telegraph company has not undertaken to wholly exempt itself from liability for negligence; but only to require the sender of the message to have it repeated, and to pay half as much again as the usual price, in order to hold the company liable for mistakes or delays in transmitting or delivering or for not delivering a message, whether happening by negligence of its servants or otherwise."). Interestingly, when the ICC took jurisdiction over interstate messages, it abandoned this rule. C. S. Potts, *Limitation of Liability in Interstate Telegraph Messages*, 1 TEX. L. REV. 336, 341 (1923) ("The soundness of the rules promulgated by the Interstate Commerce Commission, in refusing to allow public service concerns to contract against the negligence of themselves or their servants, and the success of these rules in bringing about a reasonable relation between the charges made and the liabilities assumed by the companies in the transmission of the different kinds of messages, together with the great convenience to the public in having uniform rules throughout the country, strongly suggest the wisdom of similar action by the several states with reference to intrastate messages.'); *see also* C. C. Marvel, *Liability of telephone company for mistakes in or omissions from its directory*, 92 A.L.R.2d 917 (1963).

[21] BARBARA A. CHERRY, THE CRISIS IN TELECOMMUNICATIONS CARRIER LIABILITY (1999).

[22] Baker v. Western U. Teleg. Co. (1923); Paton v. Great Northwestern Teleg. Co. 141 Minn. 430, 170 N.W. 511(1919);18; Western U. Teleg. Co. v. Cunningham 99 Ala. 314, 14 So. 579 (1892); *see also* Arkansas & L. Ry. Co. v. Stroude, 77 Ark. 109 (1905).

[23] Bluefield Milling Co. v. Western Union Telegraph Co., 139 S.E. 638 (1927); Western Union Tel. Co. v. Hearn, 110 Ark. 176 (1913); Wood v. Western Union Telegraph Co61 S.E. 653 (1908); Western Union Telegraph Co. v. Bickerstaff, 100 Ark. 1 (1911); Western Union Telegraph Co. v. Elliott, 115 S.W. 228 (1909); Western Union Telegraph Co. v. Merrill, , 39 So. 121(1905).

forgotten body of law holding that telephone telegraph companies had a duty, qua common carriers, to keep secret the contents of their customer's messages. An American legal commentator, citing an English case, made this point in a legal note about a West Virginia case. The author writes:

> It is alleged that the telegraph company turned over to a jealous husband a bunch of telegrams passing between his wife and certain friends of hers, and as a result of the information thus gained the husband has threatened to sue for a divorce. The wife thereupon has brought suit against the telegraph company for $25,000 damages. Under the doctrine laid down with respect to banks in *Tournier v. National Provincial and Union Bank of England* (1924)1 K.B. 461 the cause of action would seem to be well founded, the obligation of secrecy being as much implied in the contract of the sender of a telegram as in that of a bank depositor. The implication of such a duty is strengthened by the fact that in many states statutes forbid under penalty the disclosure to unauthorized persons of the contents of any telegram.[24]

As this excerpt shows, courts widely acknowledged the right to privacy, or more precisely, the common carrier's duty not to disclose the contents of messages.[25] This

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[24] 28 Law Notes Edward Thompson Co. 104, 104 (1924); *see also* 74 AM. JUR. 2D *Telecommunications* § 57 (2016) ("It is part of a telegraph company's undertaking with respect to the transmission and subsequent handling of a message that its contents must not be disclosed to any unauthorized person, and the company acts at its peril if it divulges the contents of a message without the consent of either the sender or the addressee and will be liable to the extent of actual damages.").

[25] Newfield v. Ryan, 91 F.2d 700, 704 (5th Cir. 1937) ("One of those conditions is that telegraph companies are common carriers, subject to federal regulation and control, and that messages filed with them while protected from the prying of the merely curious, and from other unauthorized disclosures, are not protected from 'the demand of other lawful authority."); W. Union Tel. Co. v. Aldridge, 66 F.2d 26, 27 (9th Cir. 1933) ("The evidence is undisputed that when the young lady who disclosed the contents of the telegram was employed by the telegraph company she was informed of her duty to maintain inviolate the contents of telegraphic messages"); Barnes v. Postal Tel.-Cable Co., 72 S.E. 78, 79 (N.C. 1911) ("It is a part of the undertaking of the telegraph company, with respect to the transmission and subsequent handling of the message, that its contents shall not be disclosed to any person whomsoever, without the consent of either the sender or addressee, and, if it does divulge the contents without being released from the obligation of secrecy, it acts at its peril."); W. Union Tel. Co. v. McLaurin, 66 So. 739, 740, 741 (Miss. 1914) ("It also appears that the messenger of the company at Selma disclosed the contents of the telegraphic correspondence. . . .The telegraph company did . . . violate its public duties."); Cock v. W. Union Tel. Co., 36 So. 392, 392 (Miss. 1904) ("Involved in every contract for the transmission of a telegraphic dispatch is an obligation on the part of the transmitting company to keep its contents secret from the world."); In re Renville, 61 N.Y.S. 549, 554 (App. Div. 1899) ("No statute requires a telegraph company to communicate to the public dispatches which it has received from other individuals, to be transmitted to specified persons. On the contrary, such a communication is prohibited [by New York state statute]."); *see also* Hearst v. Black, 87 F.2d 68, 71 (D.C. Cir. 1936) ("if a Senate Committee were to attempt to force a telegraph company to produce telegrams not pertinent to the matters the committee was created to investigate, the company could be restrained at the instance of the sender of the telegrams."); Hellams v. W. Union Tel. Co., 49 S.E. 12, 14 (S.C. 1904) ("We do not think that the law imposes upon telegraph companies the duty to telephone a message, as that would seriously impair the confidential relations assumed in the delivery, receipt, and transmission of telegraphic communications."); Barnes v. W.U. Tel. Co., 120 F. 550, 553 (C.C.N.D. Ga. 1903) ("If a telegram has enough upon its face to show that it relates to the value of property offered for sale, it would seem sufficient to put the company on its guard

recognition was widespread. Indeed, even the United States Supreme Court acknowledged the duty as discussed *infra.*[26] At the same time, the rights of the parameters are not clear. The following section, which is probably the first analysis of this case law in a century, attempts to reconstruct the nature of this duty.

II. Origin of the Duty Not to Disclose

Courts consistently have recognized the duty not to disclose telegraph messages. Courts have been less consistent, however, as to the origin and basis of the right. Some courts have pointed to state statutes that set forth a duty not to disclose the contents of messages. Indeed, in the 19th and early 20th century, several states, including New York[27], Mississippi[28], and Wisconsin[29] had laws prohibiting the telegraph operators from disclosing the contents of telegraphs.

Others courts point to an implied contractual provision, stemming from telegraph's and telephone's common carriage "public" calling, just like the other common law liabilities and obligations discussed in the previous section.[30] Still, other courts simply assume the duty exists without specifying the duty's precise basis, suggesting that the duty not to disclose was simply a matter of common sense.[31]

There is an important and interesting line of cases in which plaintiffs allege the antitrust laws required telegraph companies to provide open access to public stock market quotations and other exchange information. Stock markets quite naturally only wanted to provide this information to their subscribers and other affiliated parties. In its consistent rejection of such suits, courts would often reason that because telegraph companies have a duty not to disclose transmissions, they cannot be forced to make the information they transmit public. Typically, however, courts would simply assume the duty existed without stating the exact basis of the right.

The United States Supreme Court, in *Moore v. New York Cotton Exchange*,[32] reflects this analysis. In *Moore*, the New York Cotton Exchange contracted with the Western Union Telegraph Company for receiving and distributing market quotes and prices to such persons as the exchange approves. The Odd-Lot Exchange challenged this contract under the antitrust laws. In rejecting the claim, the Court simply stated,

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against errors in transmission."); W. Union Tel. Co. v. Bierhaus, 36 N.E. 161, 162 (Ind. Ct. App. 1894) ("the legislature of this state also passed an act prohibiting in express terms the disclosure of telegraphic messages, and giving a remedy in damages to the party injured to the extent of such injury, and making such company liable for failure or negligence in the performance of their duties generally.").

[26] Moore v. New York Cotton Exch., 270 U.S. 593, 605 (1926) ("As a common carrier of messages for hire, the telegraph company, of course, is bound to carry for alike. But it cannot be required-indeed, it is not permitted-to deliver messages to others than those designated by the sender.").

[27] *See* In re Renville, 61 N.Y.S. 549, 554 (App. Div. 1899).

[28] *See* Cock v. W. Union Tel. Co., 36 So. 392, 392 (Miss. 1904).

[29] *See* Marlatt v. Western Union Telegraph Co., 167 N.W. 263, 265

[30] Barnes v. Postal Tel.-Cable Co., 72 S.E. 78, 79 (N.C. 1911); W. Union Tel. Co. v. McLaurin, 66 So. 739-41 (Miss. 1914).

[31] W. Union Tel. Co. v. Aldridge, 66 F.2d 26, 27 (9th Cir. 1933).

[32] 270 U.S. 593, 601 (1926).

> As a common carrier of messages for hire, the telegraph company, of course, is bound to carry for alike. But it cannot be required-indeed, it is not permitted-to deliver messages to others than those designated by the sender.[33]

Similarly, in *Hearst v. Black*, a case involving the unauthorized release of telegraphs from William Randolph Hearst to an investigating Senate committee, the Court stated "[t]elegraph messages do not lose their privacy and become public property when the sender communicates them confidentially to the telegraph company. Indeed, in many of the States their publication without authorization . . . is a penal offense; and this is so because of an almost universal recognition of the fact that the exposure of family confidences and business and official secrets would as to telegrams equally with letters, 'be subversive of all the comforts of society.'"[34] While this article does not take a position on the "correct" basis of the common carriage duty to not disclose, the weight of the cases demonstrates that this duty is deeply linked to common carriage.

The duty not to disclose is straightforward. A telegraph company employee could not disclose the contents of a telegraph—that much is clear, but beyond that basic principle, the legal rules become somewhat fuzzy. For instance, many court decisions examine the level of malfeasance (negligence or willfulness) required to permit recovery and whether punitive damages are available for disclosure of information.[35] While the courts are not completely consistent, they seem to require willfulness.[36] There were also numerous limitations on the right, which we might find quaint. For instance, courts tended not to allow recovery for disclosure of embarrassing facts that cast shadows on the plaintiffs' moral character.[37] These courts reasoned that the immoral telegrammer bore contributory liability for the damages caused. [38]

III. The Twilight of Common Carrier Common Law Liability

The growing administrative state absorbed common law common carrier liability. The process took several decades. Federal regulation of interstate communications began in 1910, when the Mann-Elkins Act placed interstate telephone and telegraph services under the supervision of the Interstate Commerce Commission.[39] The Act empowered the ICC to investigate rate complaints and, upon reaching a conclusion that rates were

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[33] Moore v. New York Cotton Exch., 270 U.S. 593, 605 (1926)
[34] 87 F. 2d 68, 70 (D.C. 1936).
[35] W. Union Tel. Co. v. Aldridge, 66 F.2d 26, 27 (9th Cir. 1933); Cock v. W. Union Tel. Co., 36 So. 392, 392 (Miss. 1904); Marlatt v. Western Union Telegraph Co., 167 Wis. 176, 167 N.W. 263, 265.
[36] Barnes v. Postal Tel.-Cable Co., 72 S.E. 78, 79 (N.C. 1911); W. Union Tel. Co. v. McLaurin, 66 So. 739-41 (Miss. 1914).
[37] Cock v. W. Union Tel. Co., 36 So. 392, 392 (Miss. 1904).
[38] *Id.*

[39] Commerce Court (Mann-Elkins) Act, Pub.L. No. 218, ch. 309, Section 7, 36 Stat. 544 (1910) (amending the Interstate Commerce Act of 1887, ch. 104, Section 1, 24 Stat. 379 (1887)) (provisions relating to telegraph, telephone, and cable companies repealed 1934 with the passage of the Communications Act).

"unjust" or "unreasonable," to declare those rates unlawful.[40] Western Union and other telegraph companies filed tariffs that contained warranties for levels of service.

Interpreting this Act, the Supreme Court, in *Western Union Tel. Co. v. Esteve Bros. & Co.*, adopted the filed tariff doctrine, ruling that any tariff lawfully filed with the ICC cannot be challenged in a common law court. Rather, the tariff had to be challenged at the ICC. In *Esteve Brothers*, Western Union limited the liability of unrepeated messages, and the Court concluded that "the limitation of liability attached to the unrepeated cable rate is binding upon all who send messages to or from foreign countries until it is set aside as unreasonable by the Commission."

In this way, the terms and conditions that telegraphs and telephone undertook when accepting and sending messages were set forth in filed tariffs. These tariffs contained-and continued to contain throughout the 20th century—liability provisions. Common law courts accepted these terms and conditions as valid, and consumers could not challenge tariffs in court. Only the administrative agency could review their validity.

The FCC took off where the ICC left off, assuming regulation of interstate telephone and telegraph companies under the Communications Act of 1934. Section 203 of the Communications Act of 1934 mandates that all common carriers file tariffs showing "all charges" for the "interstate and foreign wire or radio communications services" they provide, as well as "the classifications, practices, and regulations affecting such charges."[41] For many years, the "filed rate doctrine barred all actions to enforce payment arrangements other than those delineated in the tariff" for all interstate telecommunications services.[42]

Western Union continued to file telegraph tariffs into the 1990s as did other even more esoteric communications like international data cables. These tariffs contained, to a greater degree than telephone tariffs, liability obligations for mis-deliveries. There are a few areas in which the FCC continues to require tariff filing to this day.[43]

On the other hand, the FCC (and Congress) have eliminated tariffing requirements for virtually every other telecommunications service. With the emergence of competitive long-distance firms in the 1980s such as MCI and Sprint, "the burden [of accepting and reviewing countless tariffs] proved too onerous for the FCC, and thus the Commission began its unrelenting campaign in favor of detariffing."[44] The FCC began to eliminate the requirement that telephone companies file tariffs for long-distance and other

[40] Kathleen B. Levitz, *Loosening the Ties That Bind: Regulating the Interexchange Services Mkt. for the 1990s*, 2 F.C.C. Rcd. 1495, 1495-96 (1987).

[41] 47 U.S.C. § 203 (1994) .

[42] 7 Bus. & Com. Litig. Fed. Cts. § 85:58 (3d ed.).

[43] *See* Electronic Tariff Filing System (ETFS), https://apps.fcc.gov/etfs/etfsHome.action; *see also*

[43] Meyers, *supra* note 15, at 215-16

telecommunications services.[45] Rather, they could charge what they will. At first, the FCC attempted to deregulate by administrative fiat, but the courts rejected its efforts, ruling that section 203 required tariffs.[46] In response, Congress passed section 160 to allow forbearance, *inter alia*, from section 203's tariffing requirement.[47]

Detariffing, however, did not revive common law actions against common carriers. Rather, courts ruled that the FCC's decision to de-tariff preempted federal and most state common law actions.[48] Courts viewed the decision *not* to regulate was a kind of negative decision to regulate. This decision to forbear regulation foreclosed federal and state common law. The only recourse individuals now have against the dread "unjust" interstate telephone rates prohibited in section 201 is to file a complaint under section 208. Of course, with the radical transformation of electronic communications since the 1980s, market mechanisms no doubt keep carriers from abusive power, at least of the sort that the old common carrier liability regime attempted to control. But, the power to regulate in these areas remains with the FCC under section 201, and it is to this power we now turn.

IV. Sections 201 and 222 and CPNI

With the exception of section 605, a strange provision that has played little role in communications law and policy,[49] the Communications Act's only privacy requirements can be found in section 222, the provision concerning customer proprietary network information (CPNI). Passed as part of the Telecommunications Act of 1996, Section 222

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[45] Interstate Interexchange Marketplace, 14 FCC Rcd. 6004 (1999); Interstate Interexchange Marketplace, 11 FCC Rcd. 20,730 (1996); Interstate Interexchange Marketplace, 12 FCC Rcd. 15,014 (1997).

[46] MCI Telecomms. Corp. v. AT&T, 512 U.S. 218, 221 (1994); MCI Telecomms. Corp. v. FCC, 765 F.2d 1186 (D.C. Cir. 1985).

[47] The FCC attempted to eliminate the requirements of section 203 during the 1980s, but the courts rejected the effort. Joseph D. Kearney & Thomas W. Merrill, *The Great Transformation of Regulated Industries Law*, 98 COLUM. L. REV. 1323, 1337-38 (1998) ("After experimenting in the early 1980s with making tariffs optional for non-dominant carriers the FCC attempted in 1985 to prohibit non-dominant carriers from filing any tariffs for their services . . . This mandatory detariffing was struck down by the D.C. Circuit as inconsistent with the Communications Act.").

[48] Boomer v. AT & T Corp., 309 F.3d 404, 422 (7th Cir. 2002) ("detariffing does no alter the fundamental design of the Communications Act, nor modify Congress's objective of uniformity in terms and conditions for all localities"); Dreamscape Design, Inc. v. Affinity Network, Inc., 414 F.3d 665, 670 (7th Cir. 2005) ("[T]he FCA continues to provide federal remedies for customers seeking to challenge the justness and reasonableness of long-distance charges and practices."); Christy C. Kunin, *Unilateral Tariff Exculpation in the Era of Competitive Telecommunications*, 41 CATH. U. L. REV. 907 (1992).

[49] Lauritz S. Helland, *Section 705(a) in the Modern Communications World: A Response to DiGeronimo*, 40 FED. COMM. L.J. 115, 116-17 (1988) ("one of the wordiest provisions in the Communications Act has sailed the seas for more than three-quarters of a century without any significant attempt . . . to explain its purpose or intended effect.").

of the Communications Act places requirements on telecommunications carriers to protect CPNI.[50] The statute defines CPNI as follows:

> information that relates to the quantity, technical configuration, type, destination, location, and amount of use of a telecommunications service subscribed to by any customer of a telecommunications carrier, and that is made available to the carrier by the customer solely by virtue of the carrier-customer relationship; and . . . information contained in the bills pertaining to telephone exchange service or telephone toll service received by a customer of a carrier.[51]

As the FCC states, "practically speaking, CPNI includes information such as the phone numbers called by a consumer; the frequency, duration, and timing of such calls; and any services purchased by the consumer, such as call waiting."[52]

On February 26, 1998, the Commission released the CPNI Order that set forth regulations implementing section 222.[53] The FCC amended these rules a few times afterward.[54] The rules create an opt-in regime under which telecommunications carriers must obtain a customer's knowing consent before using or disclosing his or her CPNI to a third-party.[55] However, the CPNI rules only covered "telecommunications carriers" which meant (in the early 2000s) almost exclusively traditional telephone companies.[56] Thus, they only covered information related to traditional phone calls. The regulations were, of course, limited in this fashion because at the time section 222 was passed and its

[50] Telecommunications Act of 1996, § 702, 47 U.S.C. § 222.

[51] 47 U.S.C. § 222(a).

[52] In the Matter of Implementation of the Telecommunications Act of 1996: Telecommunications Carriers Use of Customer Proprietary Network Info. & Other Customer Info., 21 F.C.C. Rcd. 9990, 9991 (2006).

[53] Implementation of the Telecommunications Act of 1996: Telecommunications Carriers' Use of Customer Proprietary Network Information and Other Customer Information; and Implementation of the Non-Accounting Safeguards of Sections 271 and 272 of the Communications Act of 1934, as amended, Second Report and Order and Further Notice of Proposed Rulemaking, 13 FCC Rcd 8061 (1998).

[54] *See, e.g.,* Implementation of the Telecommunications Act of 1996: Telecommunications Carriers' Use of Customer Proprietary Network Information and Other Customer Information; Implementation of the Non-Accounting Safeguards of Sections 271 and 272 of the Communications Act of 1934, as Amended; and 2000 Biennial Regulatory Review -- Review of Policies and Rules Concerning Unauthorized Changes of Consumers' Long Distance Carriers, CC Docket Nos. 96-115, 96-149, and 00-257, Third Report and Order and Third Further Notice of Proposed Rulemaking, 17 FCC Rcd 14860 (2002).

[55] In the Matter of Implementation of the Telecommunications Act of 1996: Telecommunications Carriers Use of Customer Proprietary Network Info. & Other Customer Information, 21 F.C.C. Rcd. 1782, 1784-85 (2006).

[56] *Id.* at 1785-86.

implementing regulations promulgated, the FCC only regulated telephones under Title II, having exercised only more limited Title I authority over internet access.[57]

The 2015 Open Internet Order, as discussed above, greatly expanded the FCC's jurisdiction, reclassifying large swathes of the internet as Title II and subjecting much of the internet to section 222. While the order is somewhat unclear over the extent of its jurisdiction, the FCC made clear that it regulates—and subjects to section 222—what it terms "broadband internet access service" or "BIAS." As discussed, *supra*, this category includes most traditional telephone and cable companies, such as Verizon or Comcast, but not fringe providers such as Google or Facebook.

Under the proposed rules, the data coming under CPNI protection include: (1) service plan information, including type of service (e.g., cable, fiber, or mobile), service tier (e.g., speed), pricing, and capacity (e.g., information pertaining to data caps); (2) geo-location; (3) media access control (MAC) addresses and other device identifiers; (4) source and destination Internet Protocol (IP) addresses and domain name information; and (5) traffic statistics.[58]

These proposed rules are creating quite a furor and will no doubt have a large impact on internet privacy. They might keep BIASa at a significant disadvantage in marketing because Facebook and Google and other "fringe" or "content" provider will, under these rules, still be able to collect and control CPNI. Indeed, the rules create an unexplainable regulatory inequality that will likely not protect privacy. Customer proprietary information is not truly "protected" if Google, Ebay, Apple, and every other fringe provider can collect it, but every BIAS must go through the expense and trouble of complying with section 222.

Regardless of the effect of the new section 222 regulations, this Article has shown that section 222 is but one weapon in the FCC's arsenal. Section 201 offers the FCC the power to impose another type of privacy protection. Notice the important difference between section 222 and traditional common carrier privacy obligations. Section 222 requires information *about* a subscriber, like service plan information and information *about* pricing and capacity. Traditional common carrier non-disclosure, on the other hand, goes to protecting the privacy, integrity, and content of messages.

Of course, the content of messages is highly compromised in the internet. For instance, Google and other email providers typically "read" email to discover words that might reveal the buying preference of their senders—and better sell advertisements. Facebook, of course, does the same thing. Texts and other electronic messages receive similar treatment.

[57] Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities, Declaratory Ruling and Notice of Proposed Rulemaking, 17 F.C.C. Rcd. 4798, 4801-18 (2002).

[58] In the Matter of Protecting the Privacy of Customers of Broadband & Other Telecommunications Services, FCC 16-39, 2016 WL 1312850, ¶ 41.

A first, straightforward application of section 201 common carrier privacy obligations would be to broadband providers—and presumably any email or message-sending services they provide. They would have to keep secret any emails or text entrusted to them. Alternatively, following *Primrose v. W. Union Tel. Co.*,[59] courts could create some sort of split the baby alternative, where BIASs would have to offer confidential communication services. This option could cost more, of course, just as telegraph companies charged more for repeated messages.

The old common carriage disclosure cases do not answer the question of whether BIASs would be liable for confidentiality breeches that interconnecting providers or services that fringe providers offer. While this obligation could be an extension of common carrier privacy duties, it underscores the almost ludicrous regulatory asymmetry that the 2015 Open Internet Order creates. Only services that BIASs offer face this potential regulation; every other message sending service on the internet does not face such regulation.

The FCC, however, could expand its jurisdiction to require all internet actors to protect the inviolability of messages. In this way, section 201 and traditional common carrier obligations present an entirely new and quite radical approach to FCC privacy regulations. The details of such regulation—let alone the wisdom of any such regulation—are vague. The point of this article is not to argue for or against such regulations—or even suggest ways to implement them. The article makes the more simple point that has remained largely unrecognized in the brouhaha over the Open Internet Order: the order has a potential to make radical transformations in privacy law. And, it is worth observing that section 201 obligations—and their concomitant common carrier privacy obligations—create an unbalanced playing field with BIASs at extreme disadvantage. Beyond the inequities of such an asymetrical regime, it would be unlikely to protect consumer privacy.

Conclusion

Radical, of course, derives from the Latin word for "root" and originally connoted dramatic change returning to some essential core. For better or worse, section 201 places 19th century common carriage law, an inconsistent and sprawling body of law, at the core of United States telecommunications regulations. Its principles continue to inform the limits of FCC power. The FCC's recent re-classification of the internet, or at least large portions of it, as Title II common carriage asserts this ancient core of regulation over the modern world's most modern communication medium.

As this paper shows, traditional common carriage regulation gives the FCC a power to impose a type of privacy not provided by any other part of the Communications Act. Unlike section 222, which simply protects information, traditional common carriage

[59] 154 U.S. 1, 14, 15-16 (1894).

common law protects the content, privacy, and integrity of messages. The immediate application of this common law principle would give the FCC the power to prohibit broadband providers from "revealing" email or texts to third-parties, even for marketing purposes. Of course, the FCC could simply require a knowing waiver of that right—or perhaps require the broadband provider to offer at least one "private" email service. Similarly, the FCC could expand its jurisdiction to cover email and texts services provided by non-BIASs such as Google or Facebook. But, regardless of the form of any such hypothetical regulation, it would fall exclusively on BIASs, not any other provider of internet services. Such a regime is neither fair nor likely to provide meaningful consumer privacy.

Cyberensuring Security

Justin (Gus) Hurwitz

Abstract

Cybersecurity is one of the most pressing and legally difficult issues facing this country today. It touches every aspect of modern political and social life, the economy, and national security. From the OPM and IRS breaches, to the Sony hack, to attacks on hospitals and health insurers, to attacks on domestic and international infrastructure, to domestic and international surveillance, cybersecurity concerns are omnipresent. For technical, legal, and practical, reasons, they also have proven extremely difficult to address.

This article draws from the economic literatures on strict liability and insurance to argue that cyber incidents generally, and data breaches in specific, should be treated as strict liability offenses. But that is only the starting point of this article's argument. The economic literature on strict liability recognizes that it is, in fact, a form of insurance – potential tortfeasors subject to strict liability effectively are required to insure others against harms caused by their conduct. This article's core argument is that pervasive cyber-incident insurance is the best approach to addressing the full range of cybersecurity concerns.

The characteristics of the model proposed in this article compare favorably to the current status quo – one in which users are largely helpless, firms are largely unknowledgeable, software is generally insecure, federal agencies are generally impotent to bring about meaningful change, and attackers are largely judgement-proof. As an initial matter, it would offer consumers redress when cyber-incidents occur. But more important, it would facilitate education about and monitoring of cybersecurity practices; it would facilitate the collection, analysis, and use, of aggregate information about the causes and costs of these incidents; and it would put that information the hands of parties in a position to improve the existing ecosystem.

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[Discussion draft; Footnotes omitted]

Introduction

Securing Internet-connected computers and information stored on those computers is legitimately hard. On one side of the equation, any Internet-connected computer affords any number of potential attackers any number of paths to compromise that computer for any number of reasons. On the other side of the equation, it is unclear who can or should be responsible for taking action to prevent, mitigate, or respond to an attack. Users are rarely sophisticated enough to understand, let alone meaningfully take action to address, computer security – and they are wholly unable to protect their information once it is in the hands of a bailee third party; it is remarkably difficult to design "secure" computer software (indeed, it is mathematically provable that any program beyond a trivial level of complexity cannot be provably secure); providers of software and communications infrastructure are generally immunized by contract or law, and in any event are generally too remote from specific incidents to be held liable for harm; private law mechanisms have proved wholly inadequate to address security incidents – even if a victim can identify a tortfeasor from whom recover is possible, proving causation and harm is difficult; and public law institutions simply lack the resources to meaningfully stem the rising tide of security incidents.

This article draws from the economic literatures on strict liability and insurance to argue that cyber incidents generally, and data breaches in specific, should be treated as strict liability offenses. This stands in contrast to the approach taken to date in the United States, which can be characterized as a mish-mash of sector-specific regulations backed up by a largely ineffective effort by the Federal Trade Commission to develop negligence-like general data security norms. The challenges of ensuring cybersecurity suggest that a strict-liability approach is more appropriate to the nature of both the risk and the potential harms.

But that is only the starting point of this article's argument. The economic literature on strict liability recognizes that it is, in fact, a form of insurance – potential tortfeasors subject to strict liability effectively are required provide insurance for those who may be harmed. Indeed, it is often the case that entities subject to strict liability purchase third-party insurance on behalf of those who may bring claims against them. Following in this vein, this article's core argument is that pervasive cyber-incident insurance is the best approach to the full range of cybersecurity concerns.

While surely not a silver bullet solution – no such solution exists – this approach has many advantages. First, drawing on the theory underlying strict liability, it places the burdens of avoiding and redressing harm on the relatively sophisticated and least-cost party in the consumer-firm relationship. Second, it creates substantial incentives for the rapid development of a robust market for security insurance products. To date, his market has been slow to develop – and, to the extent that it has developed, it has focused on exposure by large firms to coarsely-defined incidents. The establishment of a robust insurance market will have myriad beneficial secondary effects. Through the claims process, insurers are natural, neutral, data aggregators – data breach insurance will have much the same effect of information sharing legislation recently considered by Congress. Through the underwriting and renewal process, insurers can educate users and firms about good security practices, and audit firms for compliance with those practices. And insurers also overcome collective action problems that have historically advantaged some participants in the information economy – especially software developers and online intermediaries, both of whom are substantially shielded from liability today, and the actual malfeasing attackers who in the civil context rarely face sophisticated adversaries with the ability or incentive to pursue them.

To facilitate the turn to pervasive cyber-incident insurance, this article proposes relatively simple statutory approach. This approach is based upon a two-stage liability regime. The first stage is the creation of a new federal cause of action imposing strict liability upon entities that experience cyber-incidents resulting in harm to third parties. The Federal Trade Commission (or another agency) would be empowered to define both specific types of incidents and harms which would trigger this liability, and also specific statutory damages for these harm (based upon reasonable empirical evidence) – though it would not necessarily have enforcement authority of its own. The second stage of this liability regime provides both a carrot and a stick in favor of cyber-incident insurance: firms that *do not* have effective cyber-incident insurance policies at the time of an incident would be subject to a statutory damages multiplier; firms that *do* have effective cyber-incident insurance, on the other hand, would only be subject to actual, provable, damages. In this latter case, the FTC's schedule of statutory damages would be persuasive evidence to be considered by a court in determining damages, but insurers would have the opportunity to contest that schedule based upon their own empirical actuarial data.

The characteristics of this model compare favorably to the current status quo – one in which users are largely helpless, firms are largely unknowledgeable, software is generally insecure, federal agencies are generally impotent to bring about meaningful change, and attackers are largely judgement-proof. As an initial matter, it would offer consumers redress when cyber-incidents occur. But more important, it would facilitate education about and monitoring of cybersecurity practices; it would facilitate the collection, analysis, and use, of aggregate information about the causes and costs of these incidents; and it would put that information the hands of parties in a position to improve the existing ecosystem.

This article proceeds in four parts, outlined below.

The article begins in Part I by outlining the basic challenges facing the cybersecurity landscape. This discussion starts with the technical difficulty of designing and implementing a secure system. It is, simply, hard to do right. Once a system is implemented, it is then extremely difficult to monitor that system in a way to effectively detect intrusion; once an intrusion is detected it is difficult to mitigate its ongoing effects in the short run; and it is even harder to effectively respond to them in the long-run. And even if we *could* overcome these largely technical difficulties, it is unlikely that we actually *would* do so, due to the large number of actors involved in the security ecosystem and their myriad, and oftentimes conflicting incentives.

The discussion turns to the legal challenges of cybersecurity. Part II looks at the difficulties that have faced – really, plagued – both private law and public law efforts to address these concerns. Courts have effectively made it impossible to bring suit over cybersecurity-related harms. From declining to treat software as a product, to allowing its sale to be governed by indemnifying contracts and licenses, to refusing to find probably causation or cognizable harm – at every step of a possible lawsuit the courts have made it very difficult for a legal challenge to survive. On the public law side, various regulatory efforts to improve cybersecurity have largely failed. While they effectively punish a small subset of firms that experience cyber-incidents, they have done very little to improve the overall quality of the cybersecurity ecosystem. Moreover, with the exception of the FTC, most regulatory efforts have focused narrowly on specific industries – and the FTC's efforts are largely inadequate to regulate the vast majority of entities subject to potential cybersecurity-related harms: individuals and small and mid-size business.

Having explained why the cybersecurity landscape is so difficult, both to navigate and to improve, Parts III and IV turn to a solution. Part III argues that a transition to strict liability for cybersecurity-related harms would remedy the majority of the concerns raised in Parts I and II, allowing standard private law institutions to function and bring about dramatic improvements to the cybersecurity ecosystem. In addition, Part III offers some suggestions for how to implement such a transition, addressing specifically the need for statutory damages to accompany strict liability and suggesting the Federal Trade Commission be tasked with establishing a schedule of damages.

Transitioning to strict liability would address many current cybersecurity difficulties. But there is another, more powerful, benefit to strict liability: strict liability is an insurance regime. Part IV argues that broad adoption of strict liability would foster the development of a vibrant market for data-breach and other cyber-incident insurance policies. This offers an approach to addressing cybersecurity concerns that is substantially than any liability-based model. This is because cybersecurity-related risks are based in systemic problems that affect users throughout the cybersecurity ecosystem – they rarely result from individual-scale problems. Such risks are better managed on a pooled, insurance-scale basis. And, importantly, insurance-based systems have powerful regulatory characteristics that can both improve the behavior of individuals operating in the current cybersecurity ecosystem and improve the overall state of that ecosystem moving forward.

This article concludes with a brief summary of its arguments, structured to highlight key elements as a coherent policy proposal.

I. The Cybersecurity Challenge

Computer security, especially for Internet-connected devices, presents legitimately hard problems. This section offers a brief overview of the technical, practical, and some legal, difficulties of protecting data in the online environment.

I.A. The *ex ante* Cybersecurity Challenge

The basic task of cybersecurity is seemingly simple: to allow that those, and only those, authorized to access data or computers systems are allowed to do so. The difficulties of accomplishing this easily-stated task, however, are myriad. We can begin with just scoping the elements of the task: we need a way to specify who does and does not have access to a secured system, a way to identify those users, and a way to specify and control the level of access they may have. This alone decomposes into requirements to specify and authenticate individual users, specify the various resources they may be able to access, and specify various levels of access each user is allowed to each resource. The number of combinations of users, resources, and permitted access levels permutes quickly, imposing substantial costs (mostly in the form of managing a complex system) both on those managing and those using the secured system.

Indeed, this complexity is one of the fundamental trade-offs in the world of security: allow for finer-grained control, which increases complexity (imposing higher burdens on those subject to the security model and also increasing the likelihood the mistakes in implementing that model will be made, leading to security faults), or reduce the complexity of the system and need to either allow some users greater access to secured resources than is necessary or deny some trustworthy users access to resource of which they would otherwise be able to make beneficial uses. By analogy, one could imagine putting locked doors, each with a unique key, on every room in an office building, and providing employees with individual keys to each room to which they are allowed access – but no office would actually operate that way, because it imposes such great costs on both the office management and individual employees. And this also demonstrates another of the fundamental trade-offs in designing secure systems: if the cost of complying with security protocols is too great, users may find ways to bypass those protocols. This, too, is most easily seen by example: in the physical world, one may prop doors open instead of continually unlocking them; in the world of computers, users may leave passwords written on post-it notes, or use the same password for all of their online activity. [[[Discuss hygiene, cite reports that users are most common vector; discuss that users value usability, don't see security, so market provides usability over security]]]

The challenge created by complexity is much more problematic in the case of computer security than in that of the physical world. This is because every aspect of computer security needs to be implemented in computer code. There are two basic reasons that this is difficult. First, it requires every aspect of the security protocols to be *completely* specified *ex ante*, and, second, these security protocols must be specified (in computer code) *accurately*. Again taking the physical world as a counter-example: one need not "program" a door to allow the fire department in in the case of an emergency (either humans will intervene and, smelling smoke, will allow entrance, or the door will be forcibly circumvented); one need not "program" employees to comply with a court order or warrant; and individual actors can accommodate many otherwise incompletely-specified actions on an ad-hoc basis (for instance, an employee could make photocopies for a contractor who does not have a copier code). In the computer context, each of these actions would need to be specified *ex ante* – otherwise the system may need to be taken offline and reprogrammed, or otherwise circumvented on a case-by-case (and likely complex) basis. Of course, we could imagine implementing computer-based security protocols in a way that allowed for greater human discretion (e.g., a bank teller could review every online-transaction a user makes, or a system administrator could confirm a users' credentials each time she logs into a system). But doing so would defeat one of the basic purposes of computer-based interactions: removing humans from routinized transactions so that those transactions can proceed at computer-scale, not human-scale, speeds.

The problem of *accurate* implementation is even more substantial than that of complete implementation. Indeed, one of the foundational theorems in computer science – the so-called "halting problem" – effectively states that it is effectively impossible to prove that any computer code beyond a trivial level of complexity operates as intended (that is, that it contains no bugs, such as those that could render a security protocol ineffective). We need not delve into the mathematical proofs that it is nearly impossible to prove that a given piece of computer code is defect-free. Rather we can point to some of the canonical examples of basic implementations mistakes in security related software. Examples include the Heartbleed bug, bugs in the Apache TLS implementation, attacks on encryption Certificate Authorities, the Shellshock bug, critical security vulnerabilities in the Linux operating system and related programs, encryption flaws in Apple iMessage, and LastPass. Each of these is an example of code that has been developed and scrutinized, often for years, by sophisticated, security-conscious, programmers that nonetheless contained critical flaws in how they were implemented. In other words, at a technical level security is hard – very hard – to do correctly.

I.B. The *ex post* Cybersecurity Challenge

The issues discussed above relate to the challenges of designing and implementing a system that is secure – that is, a system that prevents unauthorized activity. This is, however, only part of the cybersecurity challenge. Because no system is completely secure, any sound security design needs to anticipate and respond to security breaches. Incident response presents its own slate of problems, including technical challenges similar to those that make designing and implementing secure systems difficult, physical-world problems relating to coordinating human resources to respond to incidents, and legal challenges.

As an initial matter, systems need to be designed to allow for the detection of security breaches. Here, as above, the task of programming computers for this task is far more difficult than analogous physical-world challenges. To start, secured systems need to be instruments with monitoring capabilities that can observe and record how they are used. This is an onerous, and at times intractable, task. Adding such capabilities can substantially reduce system performance, such that any monitoring instrumentation needs to be deployed sparsely. We also face the same challenge of implementing it correctly. Attackers therefore already have two attack vectors: attack resources that are either unmonitored or ineffectively monitored. What is more, it is frequently the case that an attacker who breaches a secured system simultaneously (or as a result of the breach) obtains access to the system's monitoring capabilities. Generally, avoiding this conundrum requires implementing additional, separate, monitoring and logging systems (that is, computers) – but this has the unfortunate consequence of increasing overall system complexity even further, which can actually make it easier for breaches to occur!

One function of will-implemented monitoring tools is to detect security incidents in real time. But monitoring also serves the important function of recording system activity for later use and analysis. The simplest aspect of this to understand is allowing for the reconstruction of incidents. Reconstruction serves at least three important purposes: to figure out how an attack occurred so that future attacks can be prevented, to understand to effects of the attack (e.g., to see what data was compromised), and to serve as evidence in identifying and taking action against those responsible for the attack.

But there is another, as important, purpose behind monitoring: establishing a baseline of "normal" system operation. Unfortunately, data is rarely analyzed for these purposes. This is one of the reasons that the second part of the monitoring equation is rarely satisfactorily met: the ultimate purpose of *monitoring* a system is to *detect* abnormal behavior.

The seemingly key function of detecting attacks is often the most challenging to accomplish. In most computer security breaches investigated by security consulting firms, the attackers breach a system several months before their breach is detected. In this time, they may be engaged in malicious activity (such as exfiltrating information, or manipulating internal information to harm an attack target), or they may be using their initial breach as a beachhead to further penetrate a target's systems.

Once a breach has been detected, incident response becomes the order or the day. The first step in incident response is to *mitigate* any ongoing effects of the breach. For instance, compromised systems should be disconnected from any networks, sensitive accounts should be locked down, and appropriate resources should be engaged (e.g., law enforcement or security professionals.). Here too proper response can be both technical and difficult. For instance, one of the most important things to *not* do upon discovering a compromised system is to turn the system off – even though this is the intuitive response. Turning the system off will delete potentially important information stored in the computer's memory and terminate any active programs – information that can be used to figure out the source and scope of an attack. And turning a system back on can overwrite similarly important information.

Once the effects of the incident have been mitigated, the compromised party can turn to responding to the attack. This may include any number efforts. For instance, a compromised system should be repaired, and the source or cause of the compromise fixed to prevent future incidents. Parties harmed by an attack should generally be notified, both as a matter of best practices and often as a function of relevant law. Compromised data or systems may need to be replaced or repaired. The victims of an attack may want to work with law enforcement, insurers, or vendors to identify or take action against the attackers. And the victims of an attack may want or need to take legal action of their own (e.g., to bring a civil suit against their attackers, if possible, or to defend themselves against suits brought by the government or as a class action). Discussion of the viability, practicalities, and limitations of such legal action are the subject of Part II.

I.C. The Multiplicity of Actors

The technical difficulties of designing secure computer systems are dramatically compounded by the sheer number of actors in the security ecosystem. It is useful to identify these actors here, before discussing how their (often conflicting) incentives further complicate computer security.

On one far side of the web, we have "users" – those who actually use a (possibly) secure system. Even this basic unit of the ecosystem is more complicated than one would expect. "Users" can refer to the consumer end-users of a piece of software, such as Microsoft Windows. In a firm, users may refer to the employees of the firm who use software purchased or designed by the firm. The firm itself may be said to be the user of software purchased by use by its employees, or even of software that it designed (or bespoke software designed by a contractor). And, of course, the firms' customers are "users" of services offered by the firm, which may or may not rely upon systems designed or implemented by third parties.

Those third parties may be firms such as Microsoft , Apple, Google, or ExamSoft. They could also be vendors that sell turnkey solutions, designed by themselves or by others. They may be contractors, who design bespoke systems. Or they may be "integrators," who integrate various platforms designed by third parties with a firm's own systems. Connecting all of these systems are various Internet-based entities. This includes the ISPs that connect firms to the Internet, or a firm's customers to the firm's servers and services. It also includes cloud-based services, which often host information.

This multiplicity of actors makes establishing cybersecurity responsibility difficult. Each of the actors has some legitimate argument that at least some of the others bears responsibility almost any cyber-incident. Software was poorly designed or integrated; systems were improperly implemented or managed by firms or their contractors; ISPs should have detected harmful activity by malicious actors and informed their targets or cut off access; firms failed to train or monitor their employees, or employees failed to comply with established procedure; customers chose to work with unknown firms that had unknown or poor security practices, or firms failed to have satisfactory security practices. The response to any security incident will invariably be to assign blame to any number of other parties.

It is notable that responsibility for security breaches is rarely meaningfully attributed to the parties that are actually responsible: the attackers behind the cyber-incident. This is a nod to the practical reality that it is often impossible to identify the attackers, that it would typically be almost impossible to bring suit against the attackers if it were possible to identify them, and that even then one would be unlikely to recover meaningful damages from them. Amazingly enough (and as discussed in Part II), even if you could find the attacker, given the challenges discussed throughout this Part, it would be very difficult to establish the elements required to be awarded damages against them – given the multiplicity of actors and difficulties of designing secure systems, it can be difficult, if not impossible, to establish causation and (especially) harm.

On a final note, it is useful to discuss briefly the multiplicity of harms that may result from a cyber-incident – or, stated alternatively, the multiplicity of motivations that attackers may have. Starting with the most apparent motivations that attackers may have: they may seek to obtain information through hacking. This could be information about a firm's customers (e.g., passwords, personal information, correspondence, credit card information), or about the firm itself (as in the case of espionage). They may also intend to damage a firm, for instance by altering or deleting sensitive information, or damaging physical systems controlled by compromised computers. Attackers may use "ransomware" to demand money from a target. The compromised systems may in fact not even be an intended target: they could be a platform that attackers use in attacking other, third party, systems. Or attackers may have political or social purposes: they may intend to embarrass a firm or individuals, to cause reputational damage, or to advance a political agenda. This range of motivations further demonstrates the challenges discussed so far. For instance, if one expects attackers to target sensitive customer information, it may be possible to address this risk by minimizing the amount of customer information that is stored and encrypting what information must be kept. It is more difficult, however, to prevent control systems from being used to damage the systems that they control – to do so undermines the purpose of having computerized control systems. And this also demonstrates what will be an important challenge discussed in detail below: establishing harm for the purposes of liability. How should a court measure the harm caused by an attack that shuts down a firm for a few hours, or results in the disclosure of (truthful) information about a firm's customers, or that is the basis forcing the firm to adopt a new policy as part of a political agenda? Courts are generally reluctant to award damages for harms such as these – they are simply too speculative and difficult to measure.

I.D. The Multiplicity of (conflicting) Incentives

Each of the myriad actors in the cybersecurity ecosystem faces their own incentives in deciding how – or whether – to respond to security concerns. While each would likely benefit from an improved cybersecurity ecosystem, none has strong incentives to invest substantially in such benefits. And many, in fact, have incentives to adopt but security practices.

Perhaps the most important set of incentives echoes the fundamental trade-offs between security and usability described in Part I.A. Both users and those designing software and other computer systems are generally willing to forego security for greater usability and performance. [[[Cf. addition of "users want usability" discussion in I.A]]] This results in large part from the difficulty of holding designers liable for defective software – the threat of legal liability would of course be a powerful incentive for firms to improve their products' security. This is further exacerbated by firms' ability to attribute fault for security incidents to others in the security ecosystem – including attributing fault to users themselves. This reduces firms' ability (or need) to compete along a security dimension – especially when consumers are often more responsive to the usability and short-term cost dimensions. And there is reason to argue that users do, in fact, bear some responsibility for the poor state of the cybersecurity ecosystem: despite professed fears about the collection and use of sensitive date, and widespread concern about cybersecurity, consumers very readily engage in conduct online that exposes them to risks. This is surely, in some part, a reflection of putatively irrational decisionmaking by consumers. It is also, to some extent, a form of rational ignorance: consumers are not security experts, they do they have the time or knowledge necessary to evaluate most firms' security practices, and the reasonably believe that the law will protect them should they be harmed by malfeasing firms – so it is eminently reasonable for consumers to engage in what appears to ordinary users to be ordinary online activities.

Similarly, firms that make use of third party security systems in their broader business – that is, the vast majority of firms – face poor security incentives. Most security incidents target firms' customers' information, such that the firms themselves are unlikely to experience any loss from an attack – unless, that is, the fact of the attack becomes public, in which case a firm may face substantial reputational harms and may also bear some direct costs from responding to the attack. In other words, the incentive for most firms is to invest is very basic security – only enough to secure their systems from casual attackers – and otherwise pay no attention to security. These incentives were arguably even worse before the recent, and relatively widespread, adoption of state data breach notification laws – laws that require firms to notify affected consumers of data breaches that may affect their (the consumers') data. Before the adoption of such laws, firms often faced no incentive to disclose, or even to respond to, a data breach, and faced incentives to keep the fact of the breach secret. But even following adoption of these laws, firms still do not face substantial incentives to adopt strong security practices. This is in part because there is still little likelihood that a firm will be held liable for damages resulting from a data breach. More tragically, this is also largely because consumers have become inured to data breaches, such that the reputational harm to a firm of a data breach is much less today than it was even two or three years ago.

Perhaps the worst incentives are faced by the cybersecurity industry itself. Estimates vary, but the size of the cybersecurity "market" – comprising firms that specialize in various aspects of cybersecurity, from systems design, to consulting, to incident response and litigation – is currently pegged at somewhere around $75-100 billion. This amount is expected to grow to $150-170 billion by 2020, a growth rate significantly exceeding that of other parts of the economy. In other words, the status quo is working well for this industry. Its participants have little reason to improve the state of the cybersecurity ecosystem.

II. The Current (and Ineffective) Legal Approaches to Cybersecurity

Part I looked at why cybersecurity is difficult as a technical and practical matter. This Part looks at the difficulties of using the law to address cybersecurity concerns. It starts by considering the relationship between legal and technical institutions. It then considers the challenges that private law institutions have faced in responding to cybersecurity incidents, followed by consideration of the efficacy to date of public law institutions.

II.A. Law and Technology as Complementary Approaches to Cybersecurity

As discussed in Part I, there are many reasons that cybersecurity is a legitimately hard problem. It is technologically difficult to specify what is required of a secure system, it is extremely difficult to accurately implement the system once specified, and it is effectively impossible to verify that such a system is implemented correctly. Moreover, the costs of security – in terms of design, implementation, performance, and user experience – are substantial enough that they are often not justified by their benefits. This is particularly problematic when we consider the private incentives faced by almost every actor in the security ecosystem: almost no actor has strong incentives that are in line with best security practices, and almost every actor has strong incentives that run contrary to best security practices.

In other words, security is hard.

None of these problems, however, is new. Many systems and institutions are difficult to design or implement properly. Indeed, it is a basic fact of life that mistakes and accidents happen, and that people are often harmed by those mistakes. Moreover, it is very often the case that individuals' private incentives do not line align with socially-optimal conduct. Cybersecurity presents extreme cases of all of these problems.

Society manages to continue moving along despite these challenges. This is largely because the law operates as a backstop that mitigates the harms that may result from them. The law steps in where things go wrong. In general it does so through two mechanisms. First, it compensates parties that are harmed by bad actors or bad actions. In other words, it assures users of a system that if they are acting reasonably and are harmed by another actor who is acting unreasonably, that they can be compensated for that harm. And, second, it makes clear that parties who cause harm to occur are liable for that harm. This, in turn creates incentives for those who create systems used by others to do so carefully – to design their systems so that they will not cause undue harm, because they will be responsible for compensating others for those harms.

Law and technology are complementary approaches to the design of well-designed systems. We want systems to be well designed ex ante so as to limit harms. The availability of ex post remedies ensures that those designing systems will be held to account for their design decisions. At the same time, the law recognizes that risk is inevitable – that reasonable mistakes may happen. So the law generally works to assign liability for harms in ways that maximize the social value of activity, mitigating concerns that individual actors will be motivated solely by their private incentives at the expense of imposing costs on society.

But this synergy between law and technology assumes effectively designed and implemented legal rules. As suggested in Part I, the legal rules relating to cybersecurity have proven wholly ineffective. This has had the unfortunate consequence of exacerbating cybersecurity problems – as described in Part I, many actors in the cybersecurity ecosystem not only lack incentives to act well, but have incentives to act badly. These incentive mismatches result largely from the lack of effective legal rules.

The rest of this Part discussed the failings of current legal approaches to addressing cybersecurity concerns. This will provide a foundation for the discussion in Parts III and IV, presenting an alternative approach to these concerns.

II.B. Private Law Approaches to Cybersecurity

"Private law" refers broadly to legal causes of action that individuals are able to bring against one another. For instance, suits for trespass, breach of contract, or negligence are traditional private law causes of action. So too would be a civil cause of action created by statute that can be initiated by individuals, or a class action brought by a group of individuals. This is in contrast to "public law" causes of action, which are generally those initiated by the government. These include, for instance, criminal prosecutions, enforcement actions brought by regulatory agencies, rules created by federal agencies with which regulated parties must comply, and various forms of informal regulation exercised by government actors to channel the conduct of private parties.

Private law institution have proven largely ineffective at addressing cybersecurity concerns for much the same reason that cybersecurity is itself difficult. In order to successfully bring a civil lawsuit, one needs to be able to demonstrate various things, such as the identity of the actors that caused a harm; that they, in fact, did cause that harm; that the harm is legally cognizable; and that there is some adequate measure of damages. Each of these elements is difficult in the context of cybersecurity. The multiplicity of actors in the security ecosystem and the complexity of the interactions between them makes it difficult, and sometimes impossible, to attribute fault to any specific actor. And even when fault can be attributed to a single actor, there are likely other confounding factors (or actors) that make it difficult to prove that that actor's conduct was a proximate cause of the specific harm. For instance, a firm that failed to safeguard its customers' information may argue that the software it was using was defective, that the vendor hired to install and maintain its software failed to do so correctly, that an auditing firm it hired to ensure its systems were properly secured failed to detect the relevant faults, that its network providers failed to detect or alert it to suspicious activity, or even that the customers were contributorily negligent in providing their data to an untrustworthy party.

Even if the harmed party can demonstrate that a specific actor's conduct was improper and proximately caused an adverse security incident, courts have struggled with the concept of "harm" online – both in terms of recognizing that the subject of the cyber-incident has in fact experienced harm and in assessing the extent of that harm for purposes of damages. The canonical example here is the disclosure or theft of personal information. In one canonical case, for instance, courts found that an airline's disclosure – in violation of contractual assurances prohibiting such disclosure – of passenger information to the federal government's anti-terrorism efforts didn't represent a cognizable harm to the customers. In that case, the court dismissed the lawsuit because the lack of awardable damages rendered it moot. Similarly, courts have struggled with cases of identity theft or theft of credit cards, especially where credit monitoring services are provided to affected customers or banks refund fraudulent charges. And even where courts are willing to recognize that harms are real, the question often turns back to questions of proximate cause: we live in a world in which information such as credit card numbers is stolen with such frequency that it is difficult for a court to accept that fraudulent charges resulted from any specific theft of a consumer's information – it is simply too possible that the specific harm resulted from some other cyber-incident for the courts to award damages against a possibly-innocent third party without some greater evidence tying the fraudulent use of credit card information to a specific breach. Of course, such evidence is almost certainly impossible to gather.

There is another issue lingering in the background of the discussion so far. The sort of cases discussed above – in which a firm fails to properly protect its customers from adverse cyber-incidents – are governed by tort law, specifically negligence. Other forms of tort claims are similarly problematic (e.g., intentional torts, such trespass, which as a firm may want to bring directly against attackers, are problematic because it is very difficult to identify the attackers, to attribute a specific attack to them, prove causation, demonstrate no contributory factors that offer the attackers a defense, and demonstrate cognizable, recoverable, damages). But other issues are governed by contract law. Contract law is important in the cybersecurity context for two critical reasons. First, courts have generally upheld the use of contracts – including the sort of dense, boilerplate, consumer-facing contacts that are widely recognized as meaningless to consumers – in the cyber-domain. The contracts very often contain waivers of liability or other forms of indemnification. Unfortunately, liability is typically contractually assigned away from parties that are most likely to be provable liable, or otherwise limits damages. This further compounds the problems of determining liability discussed above. And second, contractual language is often imprecise – a reflection of the complexity inherent in the cybersecurity ecosystem – which in many cases creates further uncertainty rather than clarifying responsibility.

Importantly, private law has a relatively simple mechanism for dealing with many of the difficulties that have been discussed: strict liability. Under some circumstances the law will assign liability to a given party regardless of fault. The canonical area of strict liability in tort law is products liability: the manufacturer of a defective product that causes consumer harm is liable for any harms caused by that product no matter how negligently the consumer was in its use. Thus, for example, the manufacturer of a table saw would be liable for a injuries caused to a consumer by a failure of the saw, *even if* the consumer were using the saw for improper purposes, while intoxicated, after damaging the saw, and while wearing a blindfold and standing on crutches. Or, as another example, someone who chooses to engage in "ultrahazardous" or otherwise extreme activities – blasting with dynamite, or keeping dangerous animals like tigers as pets – is generally subject to strict liability.

The underlying policy rationales for strict liability are discussed in Part III, which argues that cybersecurity should be a strict liability regime. For the purposes of the present discussion, we need only say that courts have declined to treat services or computer software – the primary components of the cybersecurity ecosystem – as "products." They therefore have not been treated subject to the rules of strict liability. Rather, they have been subject to the traditional principles of contract and negligence.

II.C. Public Law Approaches to Cybersecurity

There are various public law institutions in the United States that address cybersecurity issues. While some of these efforts effectively address narrow problems that effect parts of the cybersecurity ecosystem, there are no effective public law institutions that address broader problems. In particular, there are no public law institutions that generally ensure parties harmed by adverse cyber-incidents can secure recovery for their losses, that alter the perverse incentives faced by the various actors in the cybersecurity ecosystem, or that generally improve the overall quality of that ecosystem.

In the United States we have no general law of data security. Rather, we have taken a sector-by-sector approach to regulating specify security concerns. There are, for instance, specific laws relating to the security of financial information, health information, information about students, and consumer credit information. Certain industries are also subject to security-related regulation, such as the energy and communications industries.

By and large, regulatory efforts to improve security such as these are inoffensive. Without question they draw additional attention and scrutiny to particularly sensitive areas and provide valuable resource towards the goals both of educating stakeholders about security concerns and of taking action against those who fail to address these concerns. At the same time, we should be aware of the limitations of targeted approaches such as these. In almost every instance, sector specific regulations are "consumer protection" statutes that impose strict controls on what information can be shared or used by those to whom it has been given. Firms generally implement these requirements by substantially limiting how information they hold can be access by employees or shared among their peers or partners. While this has the positive effect of protecting consumers, it has adverse effects of limiting the use of more efficient technologies or making more valuable uses of information. For instance, restrictions on the use and sharing of medical information dramatically hampers medical research – it is literally the case that medical researchers believe that we would have already cured many forms of cancer if not for HIPAA. Restrictions on financial transactions and disclosure of student records encourage firms to use outdated systems, impose burdens on consumers who need to authorize the disclosure or use of their information, and generally lead industry to make use of stale, but statutorily-clear, business practices instead of innovating new ones.

More problematic, because these rules are generally focused on protecting consumers, they are not focused on improving the overall state of the cybersecurity ecosystem. As such, they don't offer a systematic approach to addressing any of the issues that make cybersecurity difficult. Because these regulations are industry-specific, but the issues that make cybersecurity hard are generalized, none of the regulated industries is in a strong position to effect change to the broader cybersecurity ecosystem. Rather, each industry develops its own, costly, and largely inefficient (if not ineffective) means to protecting consumers.

[DISCUSS CISA]

The Federal Trade Commission is the great exception to the sector-specific approach to cybersecurity in the United States. Since the turn of the century, the Commission has been working to use its general authority to regulate "unfair and deceptive acts and practices" under Section 5 of the FTC Act to establish itself as a general regulator of consumer-facing data security issues. The FTC got into the business of regulating firms' data security practices largely in response to the failure of the private law described above. After courts began dismissing lawsuits because consumers could not establish harm, the FTC stepped in to take action against firms accused of mishandling consumer data, arguing that failure to protect consumer data was an unfair (or, if in violation of a firm's established security or privacy policy, a deceptive) business practice.

The FTC's efforts have been controversial, both lauded and criticized by many. Much of the controversy over the FTC's efforts relate to its use of broad and uncertain legal authority to regulate an large portion of the economy without clear Congressional authority to do so, and in particular its use of adjudication (as opposed to rulemaking procedures) to develop biding legal norms. What this means is that the Commission has not provided the industry with any formally-issued guidance regarding what constitutes "good" or "bad" security practices. Rather, it has offered informal guidance on an occasional, often ad-hoc, basis, which it has sought to formalize by taking legal action against firms that, in the FTC's own estimation, are engaged in bad behavior. Due to the procedures the FTC has used in approaching this issue, the legality (and constitutionality) of this approach has not been addressed by the courts – though one case is currently pending that may lead to such a resolution.

Regardless of the legality of the FTC's efforts to regulate data security practices, there are other reasons these efforts should raise concern. As an initial matter, the FTC approaches security from a consumer protection perspective. As such – and as with the sector-specific approaches – its efforts focus only on the outer border of the cybersecurity challenge. The FTC does not try, not does it have statutory power to try, to address the myriad actors and mixed incentives that make ensuring cybersecurity difficult. It is possible that the FTC's approach will, over time, indirectly influence the incentives of the myriad actors in the broader cybersecurity ecosystem: as firms become increasingly aware that they may face liability for failure to protect consumer data, those firms may demand more secure systems from the rest of the ecosystem. This effect, however, will likely be largely muted in the case of the FTC's enforcement actions. As an initial matter, firms may choose, instead, to adopt clear policies indicating that consumers use their services at their own risk, or otherwise limiting their liability. Indeed, on the FTC's own terms its efforts are only meant to hold firms to "reasonable" security practices, which should arguably be weighed in light of the current state of the art – these efforts therefore ought not to create any incentives to change the state of the art on their own.

Another important problem with the FTC approach to cybersecurity is that does not meaningfully inform or educate anyone about good security practices. The primary audience for the FTC's data security are a small cadre of data security lawyers and information security professionals who work at relatively sophisticated, mid- to large-sized, firms. This further insulates the effects of the FTC's efforts from the core cybersecurity challenges. First, to the extent that it is educating firms about good cybersecurity practices, the FTC is only communicating to those firms that already understand the challenges of cybersecurity, and that largely have the internal resources to address these challenges on their own. But the fast majority of online activity is undertaken by less-sophisticated actors – consumers, small businesses, and start-ups, who either lack sophisticated understandings of, or the resources to address, cybersecurity challenges. And, importantly, these are the same actors who depend on outside resources – the myriad parties with mixed incentives that permeate the cybersecurity ecosystem – to educate and protect them.

III. Strict Liability for Cyber-Incidents: The Sword

Part II explained that the law, when working well, can create powerful incentives that align individual conduct with socially-optimal goals – but that, in the case of cybersecurity, various factors confound the law's utility. This Part argues that a transition to strict liability for cybersecurity-related harms would remedy the majority of these concerns, thereby allowing standard private law institutions to function and bring about dramatic improvements to the state of the cybersecurity ecosystem. In addition, this Part offers some suggestions for how to implement such a transition. Importantly, this is only the first part of this Article's broader recommendation – in Part IV we will turn to the desirability of a vibrant cybersecurity insurance marketplace and the relationship between strict liability and such a marketplace.

III.A. Defining Strict Liability

The primary private law mechanism that has been used – or attempted to be used, as described above – to address cybersecurity concerns is negligence. Under this model, parties are only liable for harms that they cause to others through their own negligence. In the classic formulation, a party engaging in an action that causes harm to someone else has acted negligently if failed to take precautions against causing such harms commensurate with the reasonably foreseeable likelihood and magnitude of those harms. In other words, we expect people to take at least $50 of precaution to avoid a one in ten chance of causing $500 in harm to others.

The central idea behind the negligence model is that risk is unavoidable. Parties may be able to invest in mitigating risk, but cannot eliminate the possibility of risk entirely. If we were to hold parties responsible for any harms that they may cause to others, we are concerned that parties will either over-invest in precaution or avoid risky, but socially valuable, activity. For instance, driving is inherently risky – on any given drive there is a chance that you will get into a costly accident. If we put too high a burden on drivers to avoid such accidents, they may over-invest in safety or avoid driving. But by only holding parties responsibly for taking *reasonable* precautions – that is, those commensurate with foreseeable harms – we don't dissuade any socially-beneficial activity. In other words, modern negligence liability is designed to ensure parties engage in the socially optimal level of activities.

But negligence isn't the only approach to assigning liability. Starting in the 1960s, courts began to impose so-called strict liability in some cases. Under a strict liability regime, a given party is always responsible for the harm incurred by its counterparties, no matter how careful that party was to avoid such harm. The underlying theory is that one party may be in a better position to prevent or assess likelihood of certain harms than the other. An important situation where this is the case is where assigning liability to one party allows for risk pooling, such as where parties on one side of a transaction systematically may not be able to absorb costs, or the expected costs may be distributed too thinly to justify taking precautions. It is also the case where one party is in a better informational position than the other, or is in a better position to gather or disseminate information.

Counterintuitively, as will be considered further in Part IV, strict liability does not affect the level of care that a party will take. One intuitively expects that if we impose strict liability on a party that that party will take greater precautions to avoid such harms than if it is only liable in the event of its own negligence. But this is not the case: under either model, parties will only invest in avoiding harms up to the point that the cost of such investment is commensurate with the expected magnitude and likelihood of harm. In other words, it never makes sense to spend $75 to mitigate a one in ten chance of causing $500 in harm. Rather, under strict liability, one will spend $50 in precaution, and simply pay the balance of $450 if that $500 in harm happens to occur. The key difference between negligence and strict liability is how the $450 loss that results when the harm does occur. Both negligence and strict liability accept that bad things happen – and that no amount of precaution can prevent every risk, and in fact that we do not want people to invest in inefficient levels of precaution. The difference between the two systems is that in a negligence regime the harmed party bears the cost of the harm; in a strict liability regime it is born by the other party. While the strict liability model may seem grossly unfair, we will see in Part IV that it turns out to function much like an insurance system and that it can, in fact, be a very positive model in some circumstances.

III.B. Cybersecurity is a Classic Case for Strict Liability

Cybersecurity presents a near textbook case for strict liability. The policy rationales for strict liability – the challenges that strict liability evolved to address – match the challenges created by cybersecurity. Indeed, even the historical challenges that gave rise to modern strict liability map onto the issues faced today in the cybersecurity setting. And while there are a number of common concerns about strict liability – concerns that militate against its use in various settings – they are largely inapposite to the cybersecurity setting.

The origins of modern strict liability in the American legal tradition are generally traced to Judge Cardozo's famous opinion in *MacPherson v. Buick Motor Company*, which eliminated the privity requirements for suits brought in tort. Prior to *MacPherson*, individuals could only bring suit against those with whom they shared some direct connection (that is, with whom they had privity). In other words, if a driver were injured in an automobile accident caused when a component of her car failed, she could only sue the person who sold her the car – she could not sue either the car manufacturer or a third-party manufacturer of the component that failed (for instance, if the component that failed had been bought by the manufacturer and integrated into the final component, as is often the case with many automotive components, such as tires). All of these parties only have an indirect relationship with the driver, so are said to lack privity. Under the pre-*MacPherson* model, the driver would be expected to sue to person who sold her the car, and that person could then countersue other third parties, either under separate legal theories or seeking indemnification.

MacPherson changed all of this, opening the door to direct suits by drivers (or other end-users) against manufacturers (or other responsible parties in the supply chain). The underlying rationales were intended to address the same sort of challenges that we see in the cybersecurity context. The multiplicity of parties in a supply chain make it difficult to figure out who to sue and make it difficult to establish or apportion liability. In both the case of *MacPherson* and the modern cybersecurity setting, this effectively externalizes risk onto consumers, and creates perverse incentives for how the various entities through the relevant product ecosystems design their products and services.

MacPherson was only the first step towards the modern understanding of strict liability. While it allowed parties to bring suits in the absence of privity, those suits were still brought under a negligence standard. Starting in the 1960s some courts began developing the modern understanding of strict liability in cases involving consumers harmed by (arguably) defectively designed or manufactured products. The canonical case is *Greenman v. Yuba Power Products*, which involved a wonderfully monstrous power tool sold by Yuba, the "Shopsmith, a combination power tool that could be used as a saw, drill, and wood lathe." Mr Greenman was injured a year or so after his wife purchased Shopsmith for him as a Christmas present, and brought suit for breach of warranty and negligence. The trial court determine that the manufacturer had not been negligent, and that Mr. Greenman's harms were not covered by any express or implied warranty.

On appeal, the Supreme Court of California found the manufacturer strictly liable for Mr. Greenman's injuries, explaining that the question of "liability is not one governed by the law of contract warranties but by the law of strict liability in tort.." As explained by the court, "A manufacturer is strictly liable in tort when an article he places on the market, knowing that it is to be used without inspection for defects, proves to have a defect that causes injury to a human being. … The purpose of such liability is to insure that the costs of injuries resulting from defective products are borne by the manufacturers that put such products on the market rather than by the injured persons who are powerless to protect themselves." Critically, under a strict liability model parties are not free to assign risk of harm by contract – any contract or warranty attempting to do so is a legal nullity.

Strict liability is an exception to the ordinary rule of negligence – it is only used in certain cases. The traditional examples are products liability, such as was the case in *Greenman*, and so-called ultrahazardous activities, such as keeping dangerous animals as pets or the use of explosives. It is clear why we only turn to strict liability in cases like these – and why cybersecurity is a similar case –

when we look to the core policy rationale underlying strict liability: ensuring that liability for harms be assigned to parties best able to bear it. Both negligence and strict liability accept that some amount of harm naturally occurs in the world. Under a negligence model, we assume that parties bear, and are able to bear, comparable responsibility for preventing of accepting the risk of harm. Under strict liability, we assume that the parties – especially in their abilities to prevent or accept risk – are asymmetric. In terms of *preventing* risk, we are generally concerned about risks that would be unreasonably, or impossibly, costly for individuals to detect. For instance, if a consumer could not determine whether a saw blade contained manufacturing defects without engaging is destructive testing of the blade, the law may hold the blade's manufacturer strictly liable for manufacturing defects. Similarly with ultrahazardous activities, where it is unreasonable, for instance, to expect individuals to take precautions against the use of explosives in construction operations or pet tigers that may be roaming the streets – in these cases, too, we place a strict burden on the party engaging in the atypical activity. We see the same in terms of *accepting* risk. In this case, the concern relates to the parties' relative abilities to bear the costs of a risk should harm come to pass. Again, the example of an injury related to power tools is illustrative: such an injury could be physically or economically devastating to an ordinary consumer, and many consumers do not have the knowledge or wherewithal to insure against such losses. The manufacturer, on the other hand, is in a much better position to assess the possible risks, and to insure consumers against those risks.

These rationale for strict scrutiny are not without criticism or nuance. Many of the criticisms of, and concerns raised by, strict liability regimes will be considered shortly below – and the idea that strict liability acts as a form of insurance will be considered in greater depth in Part IV.

Before considering these issues, we can outline the case for applying strict liability in the cybersecurity context. We already saw that the rationale for the first steps towards strict liability – *MacPherson*'s abandonment of privity requirements – mirrored concerns similar to those we see in the cybersecurity context: the difficulty of attributing liability and recovering damages that results from the multiplicity of actors and the complexity of their interconnected relationships. So, too, do the concerns about parties' relative abilities to prevent and accept risk motivate modern principles of strict liability mirror reality of the cybersecurity setting. As discussed in Part I, every entity involved engaged in conduct online – from individuals, to small businesses, to non-profit and governmental organizations, to large non-tech firms, to large tech firms – is exposed to cybersecurity risks. Mitigating these risks is far beyond the expertise of the vast majority of these entities. And, even if it weren't beyond their competence, most defects in third-party systems are latent. Even if these third parties open their systems up for inspection, it is functionally impossible to expect even sophisticated parties to audit them for defects at reasonable costs.

This is largely descriptive of the situation that exists in the business-to-business landscape. Even among sophisticated parties, few are in a position to meaningfully understand, let alone prevent, cybersecurity risks. But this is even more dramatically the case in the consumer-to-business relationship. Here, consumers are almost entirely at the mercy of the firms they interact with online to keep data that they disclose to those firms secure. Consumers have no visibility into those firms' systems, into what data those firms retain, how they manage that data or use it, or to whom it is disclosed (intentionally or unintentionally). Once their data has been shared with a firm, consumers have literally no ability to monitor its subsequent use or handling, to take precautions to prevent harm, to detect its misuse, or to take action in response to those harms.

Indeed, the cybersecurity context arguably presents a more "textbook case" for the use of strict liability than seen in most "textbook cases." Strict liability regimes have two basic effects: they increase the price of products and services, and they encourage risk-taking by consumers. They increase the cost faced by providers of products and services because they those providers bear the risk of any liability. But these costs are almost always passed on to consumers. The net effect, discussed in more detail in Part IV, is that firms subject to strict liability act as insurers: they spread the cost of risk across the entire pool of consumers, collecting a premium for that risk through the price they charge, and they use those premiums to pay out damages as they occur on a stochastic basis. Importantly, the concern about increases prices has an important, potentially pernicious, secondary effect: more price sensitive consumers, or those who are less exposed to risk, may select themselves out of the market. This has the effect of spreading the cost of risk across smaller pool of consumers, each of whom therefore has to pay proportionally more. Taken to the extreme, this can make some products unviable in the market – as was indeed observed in the 1980s. In proposing a strict liability regime, we need to be very cautious about this concern, as it could be devastating to the market. The second concern is similarly important: if consumers are aware (implicitly or explicitly) that another party is liable for any harm that befalls them, consumers may have an incentive to opportunistically engage in riskier behavior. For instance, consumers may shirk on routine maintenance of potentially dangerous products, or fail to read manuals or otherwise educate themselves to the safe operation of potentially dangerous products, if they know that they will receive compensation despite their own negligence.

There are two well-understood problems raised by strict liability: adverse selection and moral hazard. Fortunately, neither of these concerns is substantial in the cybersecurity context. Users and purchasers of products and services throughout the cyber-domain consistently have little ability to control, monitor, or prevent against harm. At the retail level, consumers are wholly at the mercy of the firms with which they work and to which they provide data to ensure that that data is reasonably stored, used, and secured. The best that even a sophisticated consumer can do is rely on a firm's assurances and reputation. But if the past several years have demonstrated anything about security, it is that even security-conscious, sophisticated firms can by the subject of cyber-incidents. The same also holds in the business-to-business context. When one firm engages another to provide security-related services or products, it is generally because the contracting firm lacks the sophistication or resources to implement those products or services on its own. And, as discussed at the beginning of this Article, the complexity of software and of designing secure systems, means that contracting parties cannot reasonably audit or monitor the performance of most security-related products or services.

Taken together, this analysis means that neither of the common concerns about strict liability regimes apply in this context. A transition to strict liability likely *will* increase the cost of providing products or services, especially in the short run, *but not* in a way that is likely to adversely affect consumers. The risk of harm from cyber-incidents is spread relatively uniformly across the online ecosystem, which means that we are not worried about price-increases causing some portion of the market to opt-out of the market (leading to further increases in price to the remaining portion). Indeed, the opposite is more likely to occur: concerns about security today increase the cost of participating in these markets today, which may cause risk-averse users to opt out of the market (or to engage in costly and largely ineffective self-help, such as using complex password management systems or multiple e-mail addresses). Pushing the cost of these risks back to the parties best able to mitigate and bear them could actually grow the market, rather than segmenting it. And, in the long-run, placing the risk of cyber-incidents on parties that are better able to mitigate them will likely lead to an overall improvement in the systems that make up the cybersecurity ecosystem, reducing the overall risk for everyone. Similarly, the second concern about strict liability – that, in this context, it creates perverse incentives for users and contracting parties to engage in riskier behavior – is largely inapposite. Today, it is hard to imagine an environment in which participants routinely engage in riskier behavior.

The basic problem in the security ecosystem as it exists today is that the difficulty of imposing liability in negligence and contract models has effectively created a "strict fault" regime. Under this current regime – which is governed by negligence and contract law in name only – sophisticated parties pervasively externalize risk upon unsophisticated parties. This is exactly the opposite of how the law usually works, and of how we should want to see incentives structured: we generally want to impose liability in the first instance on the parties best able to prevent harm from occurring or to absorb the risk of harms that do come to pass. Doing so tends to reduce overall risk to society by maximizing incentives to efficiently reduce it and minimizing the costs are dealing with it. Under a negligence and contract model, we have seen the opposite: incentives to burden unsophisticated parties with risk rather than working to mitigate it, without any concern for the cost of the resulting harms. Strict liability is manifestly a better approach.

III.C. Limitations: Statutory Damages, and Other Practicalities, and Best Laid Plans

Transitioning to a strict liability regime would address many of the problems facing today's cybersecurity ecosystem. Indeed, the most important advantages of a strict liability regime – that it serves as a form of insurance – won't be addressed until the next Part of this Article. But strict liability is not a panacea. Before turning to discussing the relationship between strict liability and insurance, some practicalities of implementing a strict liability regime for cyber-incidents need to be considered.

The substantial limitation on a strict liability regime is that it does nothing to address the question of damages. Recall that one of the greatest obstacles to imposing civil liability on firms that have experienced data breaches, or other cyber-incidents, has been proving cognizable harm in court. Courts have consistently found that damages cannot be awarded in these because causation is too tenuous, there are too many potential intervening factors that could have caused any harm, or harm is too speculative to quantify.

There is a straightforward solution to this problem: statutorily-directed damages. "Statutorily-directed" means two things. First, courts should be instructed to err on the side of finding cognizable damages. Evidence still needs to be required to support a finding of damages, but courts can be statutorily directed to require a reduced burden of proof, shift the burden of proof, or accept that certain harms (e.g., privacy harm) are cognizable. Second, and more important, Congress can direct the establishment of a schedule of damages to be used by courts in establishing damages for various sorts of harms at trial. The Federal Trade Commission (FTC), for instance, could be directed to establish such a schedule of damages through a rule-making process, with instruction that the schedule be based on empirical data but that the agency should err on the side of finding substantial damages and that deference should be given to the agency in interpreting that data. Indeed, for reasons discussed in Part IV, it would make sense to require the agency to use a multiplier in setting damages. Once such a schedule of damages had been set, courts would use it as a floor in the civil context – a judge could still find higher actual damages or assess punitive damages where appropriate – and would otherwise fall back on the statutory direction to find cognizable damages in the event of harms not covered in the schedule.

[[[Add discussion of *who* is subject to SL regime to below paragraph. Those who collect user/3rd party data, who sell/distribute/provide systems and services that store/manage or control access to such data, and who integrate such systems are strictly liable to direct and indirect retail consumers, but can sue each other for negligence/indemnification. For instance, a systems integrator or hardware manufacturer could be strictly liable to a consumer or consumer-facing firm, even if it was a software fault that enabled the cyber-incident – *but* they could in turn sue the software developer for the defect in the software. And a consumer could sue a consumer-facing firm that collected her data and experienced a breach.]]]

Beyond the question of damages, there are other implementation details and decisions that would need to be addressed. A few specific points are discussed below, with the goal of designing a system that is broadly incentive-aligned – though it is certainly not the only approach, and the certainly are other issues that may need to be addressed. One challenge that the switch to strict liability does not address is the incentive that firms face to detect, disclose, and otherwise respond to adverse cyber-incidents. Simply stated, under any liability regime a firm will face no liability if it can keep an incident secret. As an initial matter, a federal civil cause of action should be created alongside the transition to strict liability that allows both private parties (acting alone or as a class) and the FTC to bring civil actions in federal court. The low bar to recovery created by the strict liability nature of this cause of action, along with the multiplier to be used by the FTC (or other agency) in developing a schedule of damages, creates an initial incentive for those potentially harmed by cyber-incidents to be vigilant in monitoring and taking action in response to them. Additionally, punitive damages should be expressly authorized – even encourage – for firms that do not timely detect or respond to a cyber-incident. On the other hand, firms should be affirmatively encouraged to put procedures in place for the timely detection of and response to cyber-incidents – including providing notice and reasonable compensation to harmed parties. One simple approach to creating such an incentive is to bar suits by the FTC or class actions against firms that have such procedures in place.

IV. Data-Breach and Cyber-Incident Insurance: The Shield

Part III of this Article argued for the use of strict liability in addressing harms that result from cyber incidents. Use of strict liability in this context would correct many of the challenges that parties face in establishing liability for harmful conduct discussed in Part II. In particular, the failures of existing private and public law mechanisms to assign liability for cyber-incidents creates incentives for those who would otherwise bear the cost of mitigating or the costs of harms caused by such incidents – generally the same parties who are in the best position to take precautions against them – to externalize the risk of cyber-incidents on to third parties – generally those least able to mitigate or afford to bear such risk. In effect, the current model is a no-liability model, which creates pervasive, harmful incentives. Adopting a strict liability model would go far to align public and private incentives to reduce cyber-incident risks to a more efficient level.

But there is another, more powerful, benefit to using strict liability in this setting: strict liability is, effectively, a form of insurance, and broad adoption of strict liability would foster the development of a vibrant market for data-breach and other cyber-incident insurance policies. An insurance-based approach to addressing cybersecurity concerns is substantially preferable to either the current strict-fault approach or even an effective liability-based system that focuses on individual actors. This is because cybersecurity-related risks are based in systemic problems that affect users throughout the cybersecurity ecosystem – they rarely result from individual-scale problems. Such risks are better managed on a pooled, insurance-scale basis. And, importantly, insurance-based systems have powerful regulatory characteristics that can both improve the behavior of individuals operating in the current cybersecurity ecosystem and improve the overall state of that ecosystem moving forward.

[[[To this end, this Part proposes …]]]

IV.A. Strict Liability as Insurance

The intuitive understanding of strict liability is that it is meant to place the burden of avoiding harm on the more sophisticated party in a relationship – generally the party with greater knowledge about the risks associated with the use of a given product or service. The traditional example is of a dangerous product such as a power tool, which may have some latent defect or require non-obvious training in order to use safely. Ordinary consumers reasonably have need to use such products, but are frequently ill-equipped to do so safely. Strict liability seemingly places the burden of ensuring the safety of such products on the manufacturer – the sophisticated party – to ensure that the manufacturer goes beyond the requirements of ordinary negligence to also ensure that the product is safe for consumers who may themselves be negligent. This seemingly-reasonable understanding is explained on the grounds that the sophisticated party is in a better position to mitigate such harm than its counterparties, so the burden should be placed on the sophisticated party. As Justice Traynor, the author of the *Greenman* opinion commonly heralded as establishing modern strict liability, wrote in an earlier (dissenting) opinion, the one in which he first articulated his concept of strict liability: "public policy demands that responsibility be fixed wherever it will most effectively reduce the hazards to life and health inherent in defective products that reach the market."

But this is not, in fact, how strict liability operates. Following early adoption of modern forms of strict liability, legal scholars realized – both through theoretical and empirical research – that strict liability does not induce firms (or other parties subject to strict liability) to take greater care to avoid harm than ordinary negligence. The reason for this is simple: ordinary negligence encourages firms to take precautions commensurate with the expected likelihood and magnitude of harm. In other words, under ordinary negligence, firms will invest up to $50 to avoid a 1-in-10 likelihood a $500 harm (that is, an expected $50 in harm). Counterintuitively, however, the transition to strict liability does not change this: a firm will not invest $60 to prevent an expected $50 in harm. Rather, it makes more economic sense for a firm to invest $50 in precaution, hope that the harm does not come to pass, and, if it does come to pass, write a check to the harmed party.

Strict liability, in other words, does not increase either party's incentives to take precautions against harm. Indeed, unless it is implemented with a contributory-negligence defense, it can *encourage* negligent behavior on the part of the non-liable party, since that party knows it is effectively insured against harm by the strictly-liable party. Rather than affect parties' incentives, strict liability's real effect is to shift risk of harm from one party to another.

The practical consequence of shifting risk in this way is that strictly-liable parties become insurers for their counterparties. This is most easily seen in the case of strict products liability. In the first instance, firms will invest in precautions – such as designing their products to minimize the risk of harm through ordinary use – up to that point where the investment in precautions equals the expected likelihood and magnitude of harm. Beyond investing in cost-effective precautions against foreseeable harms, firms will also set aside a portion of their revenues to cover the cost of foreseeable harms that cannot be cost-effectively mitigated. Thus, a firm will invest $50 in precaution to avoid a 1-in-10 chance of a $500 harm (or, more precisely, to minimize the expected likelihood and magnitude of harm as a function of the incremental cost of investment in precautions), but it will also set aside $50 for each unit that it sells in order to compensate the one in ten consumers whom harm is expected to befall. Critically, that $50 set aside for each unit sold does not come from the manufacturer. Instead, the manufacturer passes those costs along to the consumer, increasing the price of its products in order to meet the strict liability regime's demand that it insure consumers against harm.

In the products liability market, this is, literally, exactly how strict liability works: firms purchase third-party insurance for the users of their products and incorporate the cost of this insurance into their products' prices.

In effect, adopting a strict liability regime is equivalent to adopting a mandate that parties have insurance. Such a mandate makes sense in many contexts. In the products liability context, for instance, manufacturers have much greater ability to inspect their products and detect latent defects, or to provide basic instruction on the safe use of their products. Even more important, however, they are in a better position to understand the risks of using their products and provide (or purchase) insurance against those risks. It would be very costly to expect the relatively large number of consumers in the economy to research and purchase separate insurance policies for each product they happen to buy – indeed, in most cases more costly than the value of the product to the consumer. On the other hand, it is relatively inexpensive to require a relatively small number manufacturers to purchase third-party policies. And, on the insurer side, it is relatively costly to negotiate individual policies for individual consumers, each of whom has highly individualized characteristics – but it is relatively inexpensive to negotiate a third-party policy for a large pool of consumers.

The same analysis holds in the cybersecurity context. As was discussed in Part III.B, the difficulties of assigning and quantifying risk under the negligence regime has allowed relatively sophisticated parties to systematically externalize risk onto relatively unsophisticated parties. Under today's model, sophisticated parties underinvest in security and impost the cost of security risks on to unsophisticated parties. The first order effects of a transition to a strict liability model would be to encourage investment in precautions against cybersecurity-related risks. But given the relatively large number of relatively diverse and unsophisticated users engaging in diverse online activities that expose them hard-to-understand and hard-to-quantify risks – risks against which users are often not only ill-equipped but entirely unable to mitigate – as compared to the relatively small number of relatively sophisticated firms on the other sides of these interactions – firms that often entirely control all of the security-relevant aspects of their relationship with consumers (e.g., how and what data use stored and used, and the systems that control access to that data) – it makes very good sense to require those providing security-related products and services to insure users of those products and services. And, to be clear, "security-related products and services" includes security-related services bundled with non-security related products and services. This would include, for instance, firms that collect and store consumer data implicitly bundle systems for the secure storage and use of that data. And it would also include, for instance, the sale of products that can reasonably be expected to be used to manage a firms security-related systems, such as server software or other software that allows for storage of and access to data.

Of course, just as the risk-mitigation understanding of strict liability was explained to be "no panacea" in Part III, it also is no panacea under the insurance understanding. Indeed, and unsurprisingly once we recognize that strict liability is really an insurance regime instead of a liability regime, the same analysis offered in Part III applies here, as well. The two basic concerns about strict liability – that it will increase costs, possibly pushing some participants out of the market and thereby further increasing costs for those who stay in, and that it creates perverse incentives for parties to engage in riskier behavior – are in fact the same two basic concerns inherent in the insurance context. In the terminology of insurance, the first concern is called "adverse selection" – that the cost of insurance will cause lower-risk parties to drop out of the market, leaving only the higher-risk, higher-cost, parties behind, which in turn will further increase the cost of insurance. And the second concern, that of insurance create perverse incentives to engage in riskier conduct, is called "moral hazard." But for the same reasons discussed in Part III, these do not provide a persuasive argument against adopting strict liability, including its insurance-like characteristics, in the cybersecurity context. Risk is pervasive throughout the cybersecurity ecosystem, such that there is little concern that a meaningful portion of the ecosystem will adversely select-out of the market due to the potential cost of insurance – indeed, correcting the existing perverse incentives that sophisticated parties face to shirk on security (which, to be clear, would be corrected by the liability aspect of strict liability, not the insurance aspect), is likely to drive further participation in the market. And the insecurity of the current online ecosystem is so great, and participating in that ecosystem already so risky, that it is hard to imagine any concern about moral hazard.

IV.B. Insurance as Regulation

The discussion so far has focused on the effects of strict liability on individual actors, or in the context of individual relationships – how liability and risk is apportioned between individual users of security-related products and services and those providing those products and services. The insurance-like characteristics of strict-liability, however, offer another powerful argument for the application of strict liability in the cybersecurity context: insurance can have a broad regulatory effect on the overall market. A likely outcome of a transition to a strict-liability regime for cybersecurity is that most firms – especially relatively unsophisticated firms – would purchase third-party cyber-incident insurance policies. This alone would be the single most important step to improving the overall quality of the cybersecurity ecosystem that is possible today, because insurers have unique abilities and incentives to inform firms of their legal obligations, to develop best-practices, to audit and educate firms as to those practices, and to lobby for improvements to the overall state of the cybersecurity ecosystem.

Part I of this article made the case that, stated simply, cybersecurity is hard. Participants throughout the cybersecurity ecosystem have surprisingly little understanding of the pervasive risks and challenges associated with cybersecurity, let alone an understanding of best (or even merely good) practices. At the user-level, individuals rarely have familiarity with principles of security "hygiene," as it is referred to in the literature – concepts like how to identify and respond to risks, how to manage passwords, e-mail accounts, and other sensitive information, who to (and not to) share information with. Going up a level in the food chain, small businesses frequently lack all of this knowledge, as well, but are also tasked with bigger, more complicated challenges: how to design and secure basic IT systems, how to monitor, identify, mitigate, and respond to cyber-incidents, how to design and implement an incident response plan. For most small- and even mid-sized businesses, it is enough of a challenge (and expense) just to get a basic IT infrastructure in place. Especially outside of the tech sector most firms don't even know what issues they face, let alone how to address them. The same basic story can be told at nearly every level, and for nearly every level of sophistication, of participation in the cybersecurity ecosystem: even those implementing systems often lack information about the needs and sophistication of their customers, making it difficult to design systems that promote good security hygiene.

Insurance – and insurers – are uniquely situated to address these system and ecosystem-level concerns. The basic business of insurance is the collection of data relating to, and quantification of, risk, the evaluation of individual insured's risk profiles, and the minimization of both their insureds' exposure to and the overall market's creation of risk.

An insurer's first job is to build its actuarial tables – to collect data that will allow it to evaluate individual insured's exposure to risk in a given industry. This is a process that, in the context of cybersecurity, we will return to in Part IV.C.

Once an insurer has a sense of the factors that go into determining an individual insured's exposure to risk, it can begin underwriting new clients. This is the process by which insurers evaluate possible clients' risk profiles to determine their insurability and the premiums to be charged for insurance. In the cybersecurity context, for instance, an insurer is likely to conduct an audit of a firm's systems and procedures: what is the architecture of the firm's network, what data is stored and used, how is access controlled, what incident response plans are in place, how are employees trained and monitored, how is third-party access to the firm's systems (e.g., by contractors) assigned and monitored, and the like. This process alone offers – or would offer – most firms a more in-depth evaluation of their cybersecurity systems than they would ever otherwise receive, except possibly in the case of a serious security incident. Even more important, it would offer these firms the most in-depth education regarding security best-practices that they are likely to ever receive. Moreover, insurers have an incentive to monitor their insured's ongoing performance, providing ongoing updates and training regarding best practices and responses to newly discovered security problems

It is difficult to imagine a more effective approach to educating and evaluating the bottommost layers of the security pyramid. And this leads to a second powerful benefit of widespread adoption of cyber-incident insurance policies: effective push-back against the pervasive externalization of risks from sophisticated parties onto unsophisticated parties. There are two sources of this push-back. First, as consumers and firms are informed by insurers about their exposure to risk, they will have greater demand for more secure products. This means both that they will be willing to pay more for more secure products (which would lower their insurance premiums), and they will put greater pressure on vendors and service providers to provide more secure products and services. And second, the insurance industry itself will serve as a powerful lobby to push for better designed, more secure, products and services. The software and tech industries are powerful interests that have largely been successful in shielding themselves from liability for the quality of their wares – for good reasons and bad. There is no concerted interest group on the other side of this balance – consumers are too diffuse a group with too little an understanding of the relevant harms to which they are exposed to effectively lobby against Silicon Valley or the Business Software Alliance to demand risk be shifted back to those who have built the insecure infrastructure on which we have come to depend.

IV.C. Jumpstarting the Market

There are two approaches that a firm subject to strict liability can take to insuring against harms for which it will be held liable: it can either self-insure or purchase third-party insurance. Both approaches are commonly seen in the products liability context, and there are specific circumstances under which either approach may make sense. In the case of cybersecurity, however, it will generally make sense for all but the largest firms to turn to third-party insurance. This is simply because most firms don't have the necessary data or sophistication to construct the actuarial data needed to evaluate their customers' risk exposure, to apportion the cost of that exposure across their customer base, or to reasonably manage claims. Rather, it will generally make much more sense for firms to purchase third-party liability coverage from an insurer with expertise in cybersecurity, with data aggregated from a across a range of sources and security incidents, and with the resources necessary to manage the sort of claims seen in the cybersecurity context.

This poses a substantial problem: today there is no robust market for cyberinsurance, especially for small- and mid-size firms. Insurers have been writing cyberinsurance policies – many of which contain cybersecurity and related coverage – for large, and relatively sophisticated, firms for a number of years. But these policies are generally bespoke, written for specific firms and based upon those firms' individualized needs and characteristics. Such policies are inappropriate to the vast majority of parties potentially subject to strict liability for adverse cyber-incidents. The transition to strict liability needs to be accompanied by the creation of a retail marketplace for cybersecurity and cyberincident insurance.

[[[Unfortunately, there are a number of obstacles to the development of such a market. Limited actuarial data; correlated risks, not iid; regulatory uncertainty – unclear what firms' legal exposure to these risks are (due, e.g., to FTC efforts, legislative uncertainty).]]]

Fortunately, the transition to a strict liability regime described in Part III contains within it a mechanism for jumpstarting such a market: the schedule of statutory damages. The previous discussion of statutory damages indicated that they should be set and interpreted aggressively – that the FTC (or other agency) and courts should be instructed to err on the side of finding that damages are not only cognizable, but substantial. Indeed, it makes sense that these statutory damages should be set at a multiple of estimated actual damages. This is in part to correct for infrequency of detection. But it is also in part to create an incentive for the development of a robust insurance market.

In order to "jump start" the market for retail-scale cyber-incident insurance, damages paid by insurers would be limited to actual damages, as provable by insurers' actuarial data. The schedule of statutory damages would be taken as presumptively valid, but insurers would be able to rebut them as actual data about the costs of various types of cyber-incidents was collected. This would have two effects. First, the relatively high statutory damages would create demand for insurance products by firms exposed to cyber-incident risks. And, second, insurers would be able to charge relatively high premiums as this market develops – in order for their products to be desirable, they would only need to charge premiums incrementally below the potential costs firms face from aggressive statutory damages. As insurers became more familiar with the market and develop actuarial data, the cost of these products will then be driven down as firms compete for business.

Summary and Conclusion

Preliminary Draft

Broadband Industry Structure and Cybercrime
An Empirical Analysis

Draft 3.0[1]
April 24, 2016

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Abstract

Prior studies have shown that while ISPs are well positioned to provide residential and SME users critical protection from cybercrime, their incentives to do so are often insufficient. The presence of competition in providing broadband service is a factor we might expect to impact such incentives as shown in prior theoretical work. We test this finding using data consisting of malware attacks send by devices with botnet obtained with honeypot sensors. We conduct preliminary analysis of data collected to date. Using econometrics to analyze the frequency of infected devices found on residential ISP networks by county we find a significant and nonlinear relationship between the number if ISPs providing service in a county and the rate of infection. In counties with very small numbers of ISPs, entry of a new ISP will enhance security against botnet infections. Preliminary results suggest that in counties with larger numbers of ISPs, additional ISPs will decrease security.

[1] As data collection is still in process, there are limited results reported in this preliminary draft.

1. Introduction

Cybercrime continues to be a growing drain on the world economy. A widely cited recent report estimated the global cost of cybercrime at $475 billion (CSIS 2015). Amid this continual game of cat-and-mouse between hackers and those minding data stored and in transit, Internet service providers (ISPs) can play a pivotal role. While individual users obviously bear responsibility for maintaining basic safety through good digital hygiene and other precautions, there is much that can be done by the more concentrated and knowledgeable ICT industry. The advantages of such were noted by US FCC Chairman Tom Wheeler, when he recently called for the communications sector to "create a new paradigm of cyber readiness …" in which "…the network ecosystem must step up to assume new responsibility and market accountability for managing cyber risks," (Wheeler, 2014). ISPs in particular, as providing what might be considered a gateway to the Internet for the common users, are well positioned to help secure against most forms of cybercrime. Also, ISPs generally possess the necessary expertise, usually lacking in their residential and SME customers.

We are beginning to understand the nature of ISP incentives to invest in cybersecurity for their residential and SME customers through a building body of economic modeling literature. This is augmented by empirical evidence, including a 2010 OECD study showing that ISPs have significant discretion, and variation, in how they address botnet mitigation. The authors of that study recognized and estimated many of the factors that can explain the sizable differences found in the security performance of ISPs, emphasizing the institutional and organizational characteristics that shape ISPs' incentives (van Eeten et. al., 2010). This paper builds on such existing theoretical and empirical work to further explore the role of broadband competition on the level of security provided by ISPs. This is a particularly relevant area of inquiry for an industry where fast-paced innovation can create new entrants, such as the increasingly mobile provision of broadband.

The relationship between ISP competition and security investment has multiple dimensions. Increased competition might lower the margins for ISPs, resulting in lower security investment. Alternatively, if users are interested in greater security and can discern the relative security levels of the competing ISPs, competition might lead to increased security investment. Yet another possibility is that competition provides an opportunity to free ride on the security provided by rival ISPs, again reducing security investment. Gideon and Hogendorn (2015) show theoretically how ISP incentives change in different competitive situations. In this paper we test those theoretical results by analyzing malware data and tracing the geographic locations of the infected devices sending the malware. The data is obtained by placing honeypot sensors on servers to analyze the infection rates of the counties where residential ISP users generate the attacks. Our analysis of the ISPs where attacks originate builds on previous work where data was obtained with spam traps (van Eeten 2010). Our use of honeypots enables us to capture a sampling of infections beyond spam-generating botnets.

*Why ISP*s

In tracing the IP addresses responsible for generating spam, malware attacks captured by honeypots, and communicating with the Confiker botnet, van Eeten et. al. (2011) found that 80% were on ISP networks that serve residential and SME users. This tells us two things. First, there is significant insecurity existing in these users of ISPs. Since cybercriminals almost uniformly protect their identities by committing crimes using botnets of infected machines that are distributed throughout the world, we can consider each of these attacking IP addresses as roughly one infection that occurred on the ISPs' users' networks.[2] Second, once infected, the attacks they execute spread the infection to create more attacking devices. This lack of security in residential and SME ISP and user networks provides an army of infected machines to further advance the volume of cybercrime. ISP users are both victims and resources for cybercrime, making them a particularly productive target of mitigation and prevention efforts. Improving the security on these networks can be rewarding.

Existing research shows that ISPs vary significantly in their infection mitigation and prevention strategies and performance. In a study of the IP addresses of bot-generated spam, van Eeten et al (2010) find that most bots are concentrated on 50 ISPs worldwide. A later study that combined datasets generated by spam traps, honeypots, and sinkholes found significant variation in infection rates among the ISPs of several countries (van Eeten

[2] This is likely undercounting infections, as there are often more than one device attached to a residential or SME network, affiliated with the same IP address, and more than one may be infected. There are also some complications in the specific counting when dynamic IP addressing is used. See van Eeten et. al., 2011 for a detailed discussion of this.

et al, 2011).[3] These differences among ISP security levels suggest they face different incentives (benefits) and/or possess different technology (costs) of mitigation and prevention of infection.[4] It is generally understood that ISPs lack sufficient incentives to provide the socially optimal level of security on their networks, due largely to spillover effects (Anderson and Moore, 2006; Huang, Geng and Whinston, 2007; Gideon and Hogendorn, 2015). While some models of this market failure allow for the ISP to increase their revenue by providing greater security, based on the premise that this would attract customers (see, for example, Garcia and Horowitz, 2006), there is no evidence that customers consider the relative security of ISPs, when in fact they do have a choice of more than one ISP.

In this paper we explore the differences in security provided by ISPs with respect to ISP market structure and other demographic and technology intensity factors at the county level. The following section provides background on the role of ISPs in providing protection against malware and cybercrime, and on their incentives to do so. Section three describes the approach we use to answer the research question, and section four describes the data collected to date. Data collection is ongoing. The data, analysis and results presented herein are preliminary. In section five we present the econometric analysis of our data. We provide preliminary conclusions and discussion of next steps in section six.

[3] Note that van Eeten et al 2011 finds the variance in ISP infection rates for the US is lower than most countries when measured based on the data from the spam traps, the honeypots, and the sink hole. This may limit the generalizability of our results using infected devices on ISP networks in the US.

[4] This is based on a rather strong assumption that other non-related factors of infection rates, such as user hygiene, will be similarly distributed across the users of the different ISPs. We return to this in our data discussion and analysis.

2. Background

Potential role of ISPs

There is no obvious obligation on the part of ISPs to prevent infections and attacks on their users' networks. Certainly they are not the bad actors. Much of the focus on the ISPs is based on their expertise and structural position to provide greater security for much of the Internet ecosystem.[5] However, as commercial entities, they lack incentives to incur costs that create a diffuse benefit not easily monetized. While we would expect users to value security in their broadband connections, they often cannot distinguish the relative security provided by different ISPs, or even by ISPs versus the software on their own devices and other elements of the Internet. Accordingly, users tend not to consider security a criteria when choosing a broadband connection (Rowe & Wood 2013).

In fact there is no consensus on the role of ISPs in cybersecurity nor on any obligation implied by their expertise and connection to less knowledgeable users. The debate on the responsibility of the ISPs for cybersecurity arguably originates in the even broader debate of whether any kind of communication provider should be responsible for activity that takes place using the services they provide. This reaches back before commercial use of the Internet. The first notable incidents of such activity in the US occurred during the 1980s, and the response was telling: each time, the affected party did little to alter their system's security, and instead called upon law enforcement. Lack of specific computer-related crime

[5] However, one can argue that ISPs have less competence in providing security than the cybersecurity firms such as Norton, McAfee, Threatstream, and Trendmicro.

laws at the time limited law enforcement. By 1990 US law enforcement was better equipped to prosecute computer crime, most notably in Operation Sundevil ("The History of Doom" 1990; Sterling, 1994). This early involvement of law enforcement, rather than network operators, was also the beginning of establishing norms of juridical responsibility regarding the ISPs in the US. One might interpret such widespread sting activity of federal law enforcement as a signal that protection against cybercrime is entirely in the domain of proactive government police action, not the establishment of greater security by organizations providing the network services that enable the threats.

The role of the ISP collaborator as informant continues to develop. In 2001, the Budapest Convention on Cybercrime primarily focused on imposing global penalties on virus authors, but did promote a role for ISPs by ensuring State Parties adopt legislation compelling ISPs to 'cooperate and assist the competent authorities in the collection or recording of traffic data …. [and] keep confidential the fact of the execution of any power provided for in this article and any information relating to it," (Convention on Cybercrime, 2001). Similarly, the US established information sharing procedures between the US government and the ISPs with Presidential Decision Directive 63, further establishing a role for service providers as cooperating information providers to law enforcement, with no mention of minimal security standards or obligations (Moteff, 2015; Palfrey 2000).

By the mid 2000s, with the proliferation of self-propagating botnets, ISP obligations were proposed, sometimes even with the insinuation of liability.[6] A popular and continuing feature of these debates is the role of the informal inter-ISP cooperative institution in addressing cybercrime. Dourado (2012) argues that such institutions are more efficient than the proposed formal legal regimes, as ISPs can use peering agreements to enforce mechanisms against bad actors. Meanwhile, Bechtold and Perrig (2014) argue that with the possibilities offered by new Internet architecture, more accountability will have to be built in at every level, including for ISPs.

In a 2011 study of botnet detection and mitigation, the European Network Information Security Agency (ENISA) proposed three high-level objectives for reducing cybercrime: mitigation of existing botnets, prevention of new infections, and minimizing the profitability of botnets and cybercrime. They recommend a role for ISPs in the first of these objectives only. In their specific recommendations for ISPs, they recognize the conflict between the ISP's position to take a highly active role and the invasion of their customers' privacy this might entail, as well as their potential loss of reputation with customers if they become the bearers of bad news (in notifying users of infections). The resulting recommendation for the role of ISPs is the identification and notification of customers with malicious hosts, though with the provision of increased incentives to do so (Plohmann, Gerhards-Padilla, and Leder 2011). The resulting ISP role remains one of informant.

[6] See Lichtman and Posner 2004 as one such example in the US, arguing that ISPs fail to adequately disprove why they should not be held to the standards of indirect liability See also Harper 2005, a critical response and example of the controversy surrounding such proposals.

In an empirical study of Dutch ISPs commissioned by the Netherlands Ministry of Economic Affairs, Agriculture and Innovation, van Eeten et. al. (2011) find that ISPs improve their detection of infected machines on their networks without unduly increasing their costs by collaborating with a common platform or clearinghouse to provide the necessary intelligence to all participants, as is done in Australia. They also note such a clearinghouse can serve to provide light-handed industry self-regulation. Huang et. al. (2007) also propose collaboration among ISPs, though of a different nature. They discuss how ISPs can engage in cooperative filtering and cooperative smoothing by caching and improve their security. In addition to Australia, collective efforts are underway in other countries, including the Netherlands Anti-Botnet Working Group. Public-private initiatives are also seen, including in Germany, Japan and Korea.

Incentives

After many years of limited implementation of technologies known to provide effective cybersecurity, attention has shifted to understanding the incentives of ISPs and other entities that prevent them from using the existing technologies to provide more secure networks. Huang et al. (2007) describe a broken incentive chain, illustrating how the ISPs are positioned to make the investment in greater security but are rarely compensated for the benefit it provides to Internet content providers and end users. Others also identify similar spillovers that result in underinvestment by the ISPs (Anderson and Moore, 2006; Garcia and Horowitz 2007). The impact of the spillovers are further complicated when there is competition in the ISP market (Gideon and Hogendorn, 2015). Current business models in the broadband value chain also impact the ISP incentives to invest in greater security. Huang et al (2007) show that the subscription payment model, which leads to the practice of maintaining residue bandwidth, as dampening any incentive to participate in cooperative filtering as the ISP is already protected against traffic surges. In this paper we focus on how the presence of competition in the ISP market impacts the level of security observed on the ISPs' networks.

3. Approach

We have developed two distinct and complementary strategies for collecting residential network botnet infection data using honeypot sensors. One of these strategies uses honeypot sensors placed on servers to detect and report malware attacks generated by infected devices on residential ISP networks. We trace the attacks to their ISP and county of origin to determine the rate of infection by county in the US. All data presented and analyzed in this paper is collected using this strategy. The second strategy involves placing honeypot sensors directly on residential networks to record attempted malware attacks. This strategy is not yet implemented. A description of this strategy and the obstacles to its implementation are included below.

Honeypot sensors

A honeypot is a device programmed with software to simulate a vulnerable user and so attract intrusion attempts and malicious code. The honeypot observes the attacks, recording data such as the source and nature of the attack. Honeypots are commonly used to enhance the security of a network by providing intelligence regarding potential attacks and existing vulnerabilities. In this study we simply use the honeypots to observe attacks and compile these observations into a dataset. Our sensors run software designed by Modern Honey Network.[7] We deployed Kernel-based Virtual Machines (KVM) running Ubuntu 12.04.5 on servers physically located in Frankfurt, Singapore, or New York City. Each KVM was running a single form of honeypot software designed to make the sensor detect and record identifiable information about potential attackers, with some causing their KVM to emulate different vulnerabilities.[8]

Our sensors are configured to collect, for each attack, the source IP address, the destination IP address, the protocol used in the attack, the source port, the destination port which censor was attacked, which honeypot was running on that sensor, the time, and any generated signature data. Combining this with other data sources allows us to use the IP address to identify the ISP of the source and its geographic location. This data is then used to determine the specific county of the infected device and the number of ISPs serving the county. We combine this with other county-level demographic and technology-intensity data to analyze the effect of the ISP market structure on the frequency of infected machines engaging in attacks.[9]

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[7] See https://www.threatstream.com/blog/mhn-modern-honey-network and http://threatstream.github.io/mhn/ for more information on Modern Honey Network and its software.

[8] Data since February 13, 2016 also incorporates KVMs that were running multiple honeypots in tandem (specifically two KVMs per city) to increase data collected. The combinations of honeypots are always the same per city to ensure regularity.

[9] Our methodology of tracing the attack IP addresses back to the ISP of origin is based on the process used by van Eeten et al 2011 and 2010, described below.

We placed sensors on Digital Ocean data center servers in New York City, Singapore, and Frankfurt. Data was collected from July 24 – November 12, 2015 and February 13 – April 20, 2016.

Attack sources

As in the prior empirical studies discussed above, the attack data collected provides a sample of infected devices. Intrusion attempts and malware attacks overwhelmingly originate from bots. Like van Eeten et al, (2010 and 2011), we can consider the source IP address of each attack to represent an infection that was not prevented by that user or their ISP.[10] By tracing the IP addresses back to the ISPs and identifying their geographic market, we can evaluate the role of industry structure and other demographic and technology-intensity factors on the level of security provided for this sample.

Considerations

There are some limitations to the conclusions we can draw based on this data collection strategy. First, as indicated by the minimal overlap of IP addresses found by three different datasets generated by (1) spam traps, (2) honeypots, and (3) a known botnet sinkhole in van Eeten et al. 2011, our use of honeypots will not provide a comprehensive picture of IP addresses with infected devices. This may impact the results of our analysis of source attacks. Another potential limitation is that we analyze only those IP addresses based in the US.[11] Thus our sample may exhibit less variance than if it included other countries. [12]

[10] Data of attack sources collected by the honeypots is first cleaned to remove IP addresses that are not part of Tier 2 ISP networks, and corrected for dynamic IP addressing.

[11] We intend to expand this study to include international markets as noted below.

It is also important to remember the dynamic nature of the cybercrime industries and their activities. The cybercriminals have proven themselves to be highly innovative and adaptive. Thus there are limits to any predictions we can make about attack data generated in 2015-16 based on results of studies done only a few years prior. This is seen in the observations of ven Eeten et al 2011, where their results show a dramatic shift in the composition of cyber attacks, with the proportion of attacking IP addresses engaged in generating spam making a sudden surge to far exceed those captured by the honeypots from the fourth quarter of 2009 to the first quarter of 2010. Similarly, the attack activity observed in the current study cannot be considered predictive of future attack behavior. However, the sources of incentives for ISPs to invest in the security level they provide to their customers are less malleable, though this of course may also be responsive to changes in attack strategies, business models, and policies.

Malware Attack Detection on Residential Networks

This strategy collects data by placing honeypots designed to capture malware and other malicious intrusion attempts at multiple residential points on different ISP networks, some monopolists and some facing competition. We use this data to look at the difference in intrusion attempts across the destination ISPs, as well as the difference in the ISPs from which the attacks originated, as the attacks generally come from infected machines. Our study of intrusion attempt data by destination ISP is a new approach to understanding

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[12] See van Eeten et al 2011 for a comparison of infections by country and variation of infection among ISPs by country. While there is variance in the infection rates of ISPs in the US, it is less than for most other countries in all measures shown.

security investment incentives, enabling us to better identify the effect of ISP industry structure on protection against such intrusions. This strategy is designed to simply measure the number and nature of attack attempts that arrive on the users' networks of ISPs facing different competitive situations. Such attacks are detected and reported by honeypot sensors placed on numerous residential networks. We test this strategy by deploying laptops running Ubuntu 15.04 on residential networks.

Figure 1 illustrates honeypot placement within the relevant elements of the Internet structure.

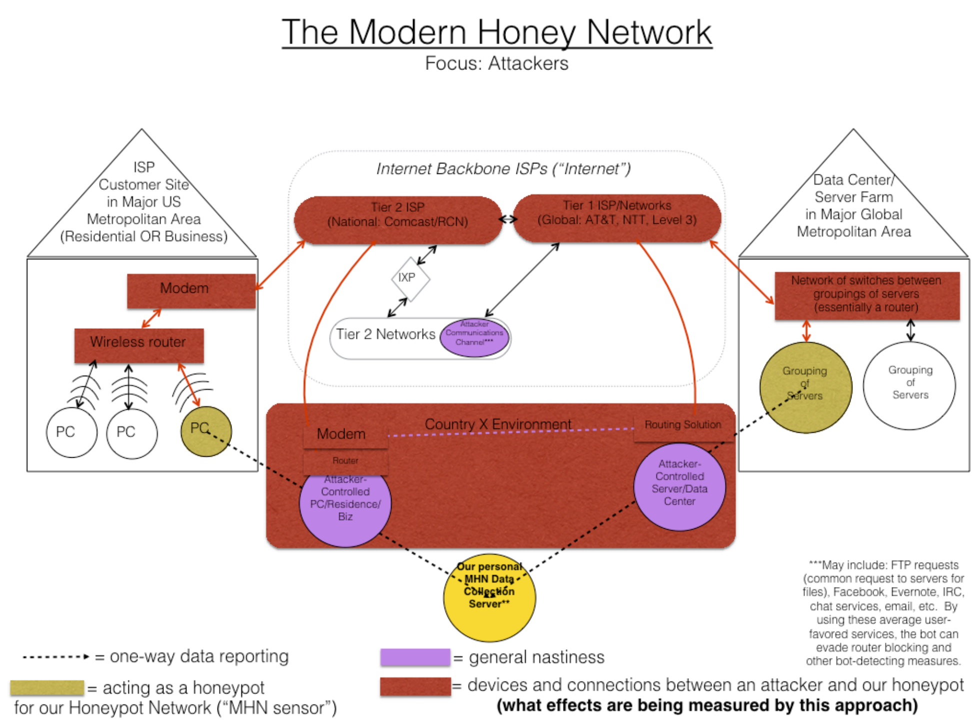

Figure 1: Honeypot Placement

As most infections currently occur through email attachments or clicking on websites, an interactive honeypot sensor that can simulate website visiting and clicking activity will be most useful. The minimal overlap of IP addresses engaged in different forms of attacks (van Eeten 2011) will not present a problem in our analysis of attacks observed on the different ISP networks as they will all be monitored with the same types of sensors. Also there is no reason to expect the networks would be subject to different attacking populations.

This strategy has proven difficult to implement. One interesting surprise in our test placement of sensors thus far is how difficult it is to get attacked on the residential networks, indicating that the level of security provided by the ISPs might be quite good. Why, then, are there so many bots? One possibility is that the number of bots in the US is quite low (as our sensors are currently limited to US networks). Indeed, van Eeten et al (2011) indicates that the US ranks fairly highly on an international comparison of three different types of infections. The persistent prevalence of infection, however, though lower than in most countries, implies that there are attacks that we were not detecting in our sensors. We are currently experimenting with different types of sensor software in order to find which will identify and capture the attacks that infect US ISP users. We are also experimenting with an alternative placement configurations of our residential sensors. The router in a residential network is often responsible for blocking potential attacks, as it will only accept what it is programmed to receive. A successful attack must 'trick' the router into thinking it is something it expects. This implies that an ISP with a larger volume and/or variety of attack attempt activity detected before going through the router is likely to have a higher probability of malware successfully gaining access to the users' premises.

Thus we are experimenting with sensors placed between the ISP and the router to detect the activity attempting to enter the residential network.[13]

A potential limitation of this strategy is really one of our implementation of it, not the strategy itself. Due to resource constraints we are restricted to local placement of our sensors. Thus our samples for the different ISPs may show less variance than they would in other countries, or in a data set with sensors placed in multiple countries. This would be the ideal data collection design, and we plan expanding this study with international sampling at a later date. Thus any effect of industry structure found may be less than we would find in other countries.

4. Data[14]

Using sensors placed on servers hosted by Digital Ocean as described above, we collected data on 13,304,556 attacks as of April 20, 2016. We refined this data to find the attacks were executed from 154,955 unique attackers, as indicated by the IP addresses collected for each attack. Using a process similar to van Eeten et al 2010 and 2011, we then used a geolocation database to find the location of the ISPs associated with each IP address, finding 13,625 (8.79%) of the attacking IP addresses are located in the US. We then eliminated any IP addresses that were not from ISPs serving residential users in the US.[15]

[13] As these tests are still in process, we do not report residential network sensor data in this draft.
[14] As data collection is still in process, there are limited results reported in this preliminary draft.
[15] For this study we analyze only ISPs in the US as we are using market structure data from the National Broadband Map created by NTIA and the FCC (found at

Table 1 describes the results of this data cleaning process. The result is a dataset of 3,777 unique attacking US residential IP addresses, identified by county. With these IP addresses located by county, we create our dependent variables measuring infection rates by county. Attacking IP addresses are located in 820 of the total 3,230 US counties listed in the National Broadband Map.[16] While this is only 25.39% of the counties, it includes 75.77% of the population and 75.3% of the households passed by any wireline broadband service. We then combine this with market and demographic data by county from the National Broadband Map and demographic and survey data used in Forman, Goldfarb and Greenstein, 2012. Table 2 provides a description of our market structure and demographic variables.

Table 1: Data Compilation

No. attacks recorded by Honeypot sensors	13,304,556
No. unique IP addresses recorded by Honeypot sensors	154,955
No. unique IP addresses in US	13,625
No. unique IP addresses in US residential ISPs	3,777

Using the collected attacking IP addresses and their locations, combined with National Broadband Map county data, we create variables to measure the extent of infected residential devices in each county. We consider three different infection rate variables: (1) number of attacking IP addresses per 100k population (attack_rate_pop), (2) number of attacking IP addresses per 100k housing units (attack_rate_hh), and (3) number of

http://www.broadbandmap.gov/analyze). Any attack source not from an ISP included in the National Broadband Map was excluded from the dataset.

[16] For information about the National Broadband Map see http://www.broadbandmap.gov/about.

attacking IP addresses per 100k housing units passed by any wireline technology (attack_rate_hhpassed).

Our primary focus is on the effect of ISP industry structure on the number of infections found. We create two variables to represent this, number of ISPs serving the county, obtained from the National Broadband Map, and a squared term for the number of ISPs to allow for a nonlinear relationship.[17] These variables are imperfect as sometimes the ISPs listed for a county do not serve the entire county. Thus a county with more than one ISP may actually be a monopoly market if there is no overlap of territory served by the ISPs.. When using number of ISPs as our market structure independent variable, we may be including some very small ISPs that serve only a select small market within the county, though all ISPs included serve a minimum of 4% of the county.

We also consider other factors that might contribute to differences in infection rates among broadband users by county. The data from Forman, Goldfarb and Greenstein 2012 is particularly helpful as it contains, in addition to the usual demographic factors, variables created by surveys that indicate the level of technological intensity of a county, which may be interpreted as indicators of the level of sophistication of broadband users of a county. Using these factors we can approximately correct for the level of protection users can provide themselves. Table 3 provides descriptive statistics of all variables for all 3,230

[17] We also attempted dummy variables indicating a monopoly market, a duopoly market, or more than three providers. This was not useful, though, as the National Broadband Map includes many wireless ISPs so the number of ISPs per county was often quite high. See Table 3.

counties. Table 4 contains descriptive statistics for these variables in the 820 counties where attacks from residential ISP IP addresses are observed.

Table 2: Variable Descriptions

Variable	Definition	Source*
attack_rate_pop	number of attacking IP addresses from residential ISPs / 100k county population	Authors and NBM
attack_rate_hh	number of attacking IP addresses from residential ISPs / 100k county housing units	Authors and NBM
attack_rate_hhpassed	number of attacking IP addresses from residential ISPs / 100k county housing units passed by anywireline technology	Authors and NBM
numISPs	number of ISPs in the county (including wireless) in 2014	Counted from NBM
surv_deeppost00	% businesses using advanced Internet in 2000	FGG
surv_pcperemp00	PCs per employee in 2000	FGG
surv_shalpost00	% businesses using basic Internet in 2000	FGG
indivhomeinternet00_cty =	% of households with Internet at home in 2000	CPS in FGG
anywline	% of population with access to any wireline broadband in 2014	NBM
dem_race_black	% of black people in the geography in 2014	NBM
dem_educ_bachorgreater	% people with bachelor's degree or higher in 2014	NBM
dem_educ_hsgrad	% people with hs diploma in 2014	NBM
dem_inc_poverty_100	% pop under 100% poverty level in 2014	NBM
median_income	Median income for geography	NBM
carnegie1_enr	Per capita number of students enrolled in local PhD-granting institutions	Downes-Greenstein (2007) in FGG
frac_in_eng_pro	Per capita number of students enrolled in engineering programs at local universities	Downes-Greenstein (2007) in FGG
npatent1980s	Total number of patents from inventors located in county, 1980-1989	US Patent Office in FGG
frprof	% of county's work force em- ployed in professional occupations in 2000	Census in FGG
dem_age_greater60	% of people >60 yrs. old in the county in 2014	NBM
netmig95	Net migration to county in 1995	Census in FGG

*
NBM = National Broadband Map
FGG = Forman, Goldfarb and Greenstein, 2012

Table 3: Summary Statistics for All Counties:

Statistic	N	Mean	St. Dev.	Min	Max
numISPs	3,230	8.228	3.023	1	22
numattacks	3,230	1.169	5.965	0	223
dem_race_black	3,230	0.081	0.150	0.000	0.910
dem_inc_poverty_100	3,230	0.177	0.082	0.000	0.660
dem_educ_hsgrad	3,230	0.769	0.091	0.340	0.960
dem_educ_bachorgreater	3,230	0.168	0.079	0.030	0.640
dem_age_greater60	3,230	0.230	0.059	0.030	0.940
anywline	3,230	0.869	0.150	0.000	1.000
surv_shalpost00	2,742	0.720	0.219	0.000	1.000
surv_deeppost00	2,742	0.089	0.133	0.000	1.000
frprof	3,131	0.352	0.066	0.160	0.674
frac_in_eng_prog	3,131	0.001	0.006	0.000	0.112
carnegie1_enr	3,131	0.007	0.065	0.000	2.615
indivhomeinternet00_cty	3,131	0.031	0.116	0.000	0.765
npatent1980s	3,131	0.137	0.652	0.000	20.417
surv_pcperemp00	2,741	0.226	0.172	0.000	1.937
netmig95	3,131	0.252	3.628	-138.933	72.891
numISPs_squared	3,230	76.839	57.932	1	484
median_income	3,230	46.176	13.493	11.185	123.058
attack_rate_pop	3,230	0.806	4.162	0.000	179.533
attack_rate_hh	3,230	1.554	5.179	0.000	141.044
attack_rate_hhpassed	3,228	1.791	6.634	0.000	154.993
attacked	3,230	0.254	0.435	0	1

Table 4: Summary Statistics for Counties with Attacking IP addresses Observed

Statistic	N	Mean	St. Dev.	Min	Max
numISPs	820	9.482	3.084	3	22
numattacks	820	4.606	11.154	1	223
dem_race_black	820	0.093	0.128	0.000	0.730
dem_inc_poverty_100	820	0.156	0.056	0.030	0.400
dem_educ_hsgrad	820	0.805	0.079	0.340	0.950
dem_educ_bachorgreater	820	0.223	0.096	0.070	0.640
dem_age_greater60	820	0.219	0.044	0.090	0.500
anywline	820	0.945	0.087	0.180	1.000
surv_shalpost00	803	0.758	0.168	0.000	1.000
surv_deeppost00	803	0.099	0.084	0.000	1.000
frprof	820	0.387	0.071	0.221	0.666
frac_in_eng_prog	820	0.002	0.007	0.000	0.112
carnegie1_enr	820	0.015	0.055	0.000	0.612
indivhomeinternet00_cty	820	0.104	0.197	0.000	0.765
npatent1980s	820	0.447	1.211	0.000	20.417
surv_pcperemp00	803	0.290	0.156	0.000	1.017
netmig95	820	0.430	6.973	-138.933	72.891
numISPs_squared	820	99.401	68.816	9	484
median_income	820	54.511	15.220	26.828	123.058
attack_rate_pop	820	3.173	7.796	0.107	179.533
attack_rate_hh	820	6.121	8.818	0.267	141.044
attack_rate_hhpassed	820	7.050	11.674	0.267	154.993

5. Analysis

Using ordinary least squares econometric analysis we perform preliminary estimation of the effect of these different factors on the observed rate of infection by county. We consider three dependent variables as described above. Table 5 provides a description of the preliminary regression analysis results. Each observation in this analysis is a county. Our analysis includes 803 counties where attacking IP addresses were observed. This excludes the 27 counties that were eliminated because they were missing data. In these cases the data missing was usually for the Forman, Goldfarb and Greenstein 2012 survey variables.

The results of the preliminary regression analysis show that industry structure is a significant factor in the level of protection provided by ISPs. The coefficients for the number of ISPs and number of ISPs squared are both significant at the 1% level for all three measures of infection rate. The significance of the squared term shows that the relationship between the number of ISPs and the number of infections is nonlinear. The signs of the coefficients of the number of ISPs and the number of ISPs squared indicates a U-shaped relationship. This suggests that when there is a small number of ISPs, an increase in the number of ISPs brings a decrease in the number of infections. As the number of ISPs increases, the decrease in number of infection diminishes, and even increases at larger number of ISPs. This implies that the introduction of competition into a monopoly or duopoly ISP market can decrease the infections, i.e. improve the level of security provided. The increase in number of infections with additional ISPs in a market already served by several ISPs may reflect the presence of smaller ISPs who may lack the resources to provide adequate security or are disreputable in some other way in more heavily served areas. As shown on Table 4, the mean number of ISPs per county is 9, with as many as 22 ISPs in a county.

Many of the other market and demographic variables are significant in all three models. The percent of population with access to any wireline broadband in 2014 is significant with a negative coefficient of large magnitude. This implies that the more population with access to wireline broadband the fewer attacking IP addresses observed in a county. This is a puzzling result as we would expect the opposite effect. The percentage of the county population that is black, the percentage of county population below the poverty level, and the percent of the population older than 60 are all significant with negative coefficients. This could be because in such counties a higher percent of the population are not using broadband and thus cannot be infected. Alternatively, there are fewer total devices or less total broadband use per population and household, reducing opportunities for infection. However, the median income is significant and negative, implying more income leads to less infection, contradicting this reasoning. This is also puzzling, and indicates there may be one or more missing explanatory variables. The education level variables are not significant.

Most of the correcting variables reflecting technological sophistication of the users in a county were not statistically significant. The percent of businesses using advanced Internet in 2000 (surv_deeppost00) is significant at the 5% level in models (1) and (2) and at the

10% level in model (3). The negative coefficient in all models indicates infections are lower in counties with a higher percentage of businesses using advanced Internet in 2000. This may reflect a higher level of user sophistication, which would lead to better digital hygiene or possibly users demanding higher levels of security from their ISPs.

Table 5: Regression Results

	Dependent variable:		
	attack_rate_pop (1)	attack_rate_hh (2)	attack_rate_hhpassed (3)
numISPs	-0.685***	-1.084***	-1.254***
	(0.157)	(0.304)	(0.355)
numISPs_squared	0.023***	0.035***	0.041***
	(0.007)	(0.013)	(0.016)
surv_deeppost00	-3.154**	-4.959**	-5.260*
	(1.232)	(2.397)	(2.798)
surv_pcperemp00	0.903	1.117	1.623
	(0.983)	(1.912)	(2.232)
surv_shalpost00	-0.209	-1.357	-1.677
	(0.748)	(1.454)	(1.698)
indivhomeinternet00_cty	-1.065*	-2.052*	-1.260
	(0.547)	(1.064)	(1.242)
anywline	-10.318***	-18.307***	-50.029***
	(1.340)	(2.607)	(3.044)
dem_race_black	-3.035***	-6.491***	-5.927***
	(0.879)	(1.710)	(1.996)
dem_educ_bachorgreater	5.106	7.404	9.715
	(3.425)	(6.661)	(7.777)
dem_educ_hsgrad	-3.882	-8.408*	-5.714
	(2.389)	(4.646)	(5.424)
dem_inc_poverty_100	-19.804***	-36.409***	-39.874***
	(3.893)	(7.572)	(8.840)
median_income	-0.097***	-0.166***	-0.171***
	(0.016)	(0.031)	(0.036)
carnegie1_enr	-2.128	-4.102	-4.899
	(2.872)	(5.585)	(6.521)
frac_in_eng_prog	-13.990	-18.330	-29.278

	(19.476)	(37.876)	(44.220)
npatent1980s	0.027	0.078	0.234
	(0.110)	(0.215)	(0.251)
frprof	2.436	6.268	5.585
	(4.205)	(8.177)	(9.547)
dem_age_greater60	-2.637	-18.706***	-22.594***
	(2.543)	(4.945)	(5.773)
netmig95	-0.010	-0.019	-0.013
	(0.017)	(0.033)	(0.039)
Constant	27.195***	53.255***	84.152***
	(2.927)	(5.692)	(6.645)
Observations	803	803	803
R2	0.245	0.217	0.381
Adjusted R2	0.227	0.199	0.366
Residual Std. Error (df = 784)	2.704	5.258	6.139
F Statistic (df = 18; 784)	14.120***	12.045***	26.770***
Note:			*p<0.1; **p<0.05; ***p<0.01

6. Conclusion

In this paper we present preliminary results based on cyberattack data gathered with honeypots on server farms. Each attacking IP address is considered to be a botnet-infected device. Tracing the IP addresses back to their originating ISPs and counties, we identify those that are part of residential networks in the US. Our preliminary analysis of data collected to date suggests that industry structure in the ISP market is a significant predictor of botnet infections on residential networks. The results suggest that when there is a small number of ISPs serving a market, the entry of an additional ISP to the market can bring a reduction in the number of residential machines infected to perform attacks with malware. In other words, a market with an adequate level of ISP competition will experience better security. This may be due to the increased incentives to provide better security when competing for users. Alternatively, it may reflect the increased probability that infections will be deflected from more ISPs providing security in different ways. This could result from the spillover of the benefits of good protection from the ISP that provides the strongest protection. At larger numbers of ISPs per county, we see this decrease in infections abate, or even reverse.

Further research is needed to better evaluate and understand the relationships found in this paper. The research discussed in this paper is an ongoing project. Data collection activity continues as we do not yet have a sufficiently representative sample. We also continue to explore alternative specifications of the econometric model. One particular concern is that the variables created to capture competition are insufficiently precise, and may be capturing county characteristics. We continue to consider ways of addressing this, including alternative measures of broadband competition, additional explanatory variables, and instrumental variables for possible endogeneity. We also plan to expand this research project on two dimensions. One expansion is the inclusion of international ISP markets in our analysis. Our collected data contains many attacking IP addresses from outside the US that can be included in the analysis with comparable market data. Another planned expansion is the implementation of the residential network honeypot sensor data collection strategy.

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The Evolution of "Competition":

Lessons for 21^{st} Century Telecommunications Policy

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Abstract Assessments of competition or the lack thereof have been central to the evolution of public policy toward the telecommunications industry for over a century. This centrality continues today. Yet, numerous foundational questions about this concept persist. In this paper, we chronicle the evolution of "competition" in economics and also examine how "competition" has been defined in the communications arena. The academic literature on competition hits an important inflection point in the mid-20^{th} century with the development of "workable competition," a term equated to "effective competition." We find that while the concept of "effective competition" is central to policy formation at the FCC, the Commission's own applications of "effective competition" are inconsistently applied. Given the centrality of this concept, and its inconsistent applications to date, we draw upon the seminal contributions to the development of the notion of "effective competition" to proffer a modern definition that we believe is suitable for application in 21^{st} century communications markets.

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> "[C]ompetition is first and foremost only a word, a word which may or may not be used effectively, in economic discourse, to communicate propositions about realities."
>
> Kenneth G. Dennis (1977, p. 325)

1 Introduction

Assessments of competition or the lack thereof have been central to the evolution of public policy in the telecommunications industry for over a century (Weiman and Levin, 1964). This centrality continues today. For instance, citing competitive concerns, the Federal Communications Commission (FCC) chose recently to alter a typical highest-bidder auction format for its impending incentive auction, by setting aside spectrum for all but the largest two mobile telephony providers (FCC, 2014a). Similarly, in a bold move, the FCC chose early in 2015 to reclassify broadband services under Title II of the Communications Act citing concerns that, absent expanded regulatory oversight, incumbent broadband providers may anticompetitively forestall both competitors and innovation (FCC, 2015e). And beyond particular policy decisions, ongoing FCC reports focus on assessments of competition in local telephony, wireless telephony, and the provision of multichannel video programming distribution.[1]

Despite this centrality, basic and profound questions exist regarding the definition and measurement of competition, as well as the appropriate institutional oversight mechanisms for competition policy in the telecommunications industry. These questions have most recently manifested in a white paper offered by the U.S. House of Representatives Committee on Energy and Commerce (2014). The paper is part of a series of white papers designed to provoke input on key questions confronting policymakers as they contemplate a major update to the Communications Act of 1934, which was last updated in 1996. First among the questions asked by the Committee is: "How should Congress define competition in the modern communications marketplace?"[2]

In response to this and other questions posed by the Committee, 84 parties offered answers, reflections, observations, and recommendations.[3] While the Committee may have hoped for a consensus set of responses, or at least general agreement, a review of the responses finds widely differing opinions. Indeed, despite the importance of this definition to competition policy in the communications industry, the responses to the Committee largely either sidestepped the question or offered inadequate replies. The side-steps largely fall into three categories. First,

[1] *See* recent installments of each report at FCC 2014c, 2015d, and 2015c respectively.

[2] Similarly, the repeated mantra of current FCC Chairman Tom Wheeler has been "competition, competition, competition," stating that the FCC's "competition policy will take the 'see-saw' approach: when competition is high, regulation can be low; when competition is low, we are willing to act in the public interest" (Wheeler, 2014). Of course, this approach to policy formation provokes the same question posed by the Committee.

[3] These collected responses are available at `http://energycommerce.house.gov/CommActUpdate`.

some simply ignored the question altogether.[4] Second, some substituted a conclusory assessment regarding the state of (the undefined) competition that exists in communications.[5] Third, others sought to divert attention from a definition, instead urging Congress to focus any attention to competition more narrowly[6] or, alternatively, broadly.[7]

For those respondents that did nominally address the Committee's question, the most common approach was to define competition by example thereby suggesting that we know competition exists because we see it. A number of respondents provided a litany of examples of what seem to be competitive indicators such as a low market share, a diminishing market share, or a proliferation of perceived competitors.[8] Three difficulties arise with this approach. First, it points toward a specific declarative regarding the presence of competition as it now exists and would exist for the foreseeable future. Yet, these same respondents also emphasized the rapid evolution of communications markets.[9] While there is a broad consensus that telecommunications markets have now become more rivalrous, the rapidly evolving nature of telecommunications markets raises the possibility of future market failure. Additionally, while the examples offered as competitive indicators are prolific, it is difficult to know whether these examples prove the presence of competition absent a definition of competition. And, finally, while some respondents provided examples that seem to indicate intuitively the presence of competition, others pointed toward the relatively concentrated nature of telecommunications markets as indicative of a lack of competition.[10]

But if the respondents largely failed to provide a sound foundation for defining competition, where might legislators and regulators turn to understand this concept? The discipline of economics provides insights, if not a complete resolution.

In this paper, we use the lens of economic analysis to bring focus to the discussion of competition in modern communications markets. We begin in Sect. 2 with a review of the evolution of the concept of "competition" over the history of economic thought. In Sect. 3, we find this academic literature hits an important

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[4] *See, e.g.*, the responses of Cox Enterprises, FlexJobs, Integra, ITTA, and NARUC.

[5] *See, e.g.*, the responses of: Broadband for America, which stated that there is a "single truth underscor[ing] the importance of any modern communications policy: Fierce competition occurs throughout the Internet eco-system..." (p. 2); CTIA, which stated "the wireless ecosystem is vibrantly competitive, requiring only continued 'light touch' regulations by the FCC" (p. 2); Free State Foundation, which called for a "new Digital Age Communications Act... that requires the FCC to take into account the existence of the increasing cross-platform, facilities-based intermodal competition that characterizes the digital environment" (p. 3); USTelecom, which stated "Rather than attempting to statutorily define competition...definition that will inevitably become outmoded in a very short time...acknowledgement that the communications marketplace has, indeed, become competitive" (pp. 3-4); American Action Forum, which stated "Broadband competition is vigorous, facilities-based and intermodal; while the relevant law is largely siloed" (p. 1).

[6] *E.g.*, in its response, Cellular One advocated for Congressional attention to interconnection, interoperability, the size of geographic wireless licenses and set-asides.

[7] *E.g.*, in its response, AT&T suggested that the focus should not be on "multiple discrete markets for particular inputs" but rather on "the ecosystem as a whole."

[8] *See, e.g.*, the responses of Alton Drew, Sprint, and the American Enterprise Institute's Center for Internet, Communications, and Technology Policy.

[9] *See, e.g.*, the responses of Alton Drew and the American Enterprise Institute's Center for Internet, Communications, and Technology Policy.

[10] *See, e.g.*, the response of Cellular One (p. 1) and the reponse from the Competitive Carriers Association (p. 19).

inflection point in the mid-20^{th} century with the development of the concept of "workable competition." This academic literature spawned a corollary term, "effective competition," in the policy arena. In Sect. 4, we review the definition and use of the term effective competition in two important telecommunications sectors overseen by the Federal Communications Commission: cable television and mobile telephony. We find that the various policy applications rely on substantially different definitions of effective competition. In Sect. 5, we return to the basic question posed by the Committee: how to define competition in the modern communications marketplace. Drawing upon the core elements of the academic concept of effective competition, we offer a straightforward and robust definition for application to 21^{st} century communications markets. Like virtually every economic concept that finds its way into the policy arena, our proffered definition would be subject to pressures from interests that would seek to advance their cause for more, or less, governmental intervention into telecommunications markets. Nonetheless, this definition rooted in the discipline of economics holds the promise to smartly guide policy in the rapidly evolving communications markets of the 21^{st} century.

2 The Evolution of "Competition" in Economic Thought

At its most primal level competition manifests itself in rivalry. In business, these rivalrous actions are intended to secure the patronage of consumers. Most often, competition provokes firms to take actions that are beneficial to consumers. Competition is routinely attributed to be a cause of improved firm-level efficiency, lower prices, increased quality, accelerated innovation and more rapid development of new services. For these reasons, policymakers in the United States have championed the cause of preserving and promoting competition for at least 125 years.[11] Yet while generally finding agreement on the desirability of competition, the more basic question asked by the House Committee white paper lingers: how should policymakers define competition? The importance of this question cannot be overstated. Without a clear and shared understanding of what marketplace characteristics and activities constitute competition, policy interventions to promote competition are doomed. In the absence of a common definition, well-meaning but misguided policy interventions may inadvertently harm competition through actions intended to promote competition; or alternatively, when competition is inadequate, policymakers may fail to intervene under a mistaken illusion that competition levels are already adequate to protect consumers.

The subject of competition has been central in economics since the writings of the mercantilists of the 17^{th} century (Dennis, 1977, p. xii). In this period, competition was seen as occurring between nations in the context of international trade. The more atomistic focus on competition between firms emerged with the writings of the physiocrats and ultimately gained prominence through the work of Adam Smith. It was Smith who provided a now central tenant of capitalism that competition among self-interested actors commonly promotes the aggregate economic welfare of society at large.[12] Additionally, Smith provides context by

[11] *See, e.g.*, Sherman Antitrust Act of 1890, 15 U.S.C. §§1 - 7.

[12] *See, e.g.*, Smith (1937/1776, p. 423), stating, "... where the competition is free, the rivalship of competitors, who are all endeavouring to justle [sic] one another out of employment, obliges every man to endeavour to execute his work with a certain degree of exactness." He goes on to

contrasting it with monopoly (Dennis, 1977, p. 96). And he notes as well that competition "disciplines" and "regulates" firm behavior (Dennis, 1977, p. 100). For all the value of Smith's linking competition to the social outcomes, his concept of competition "is solely equilibrating in tendency and thereby a principle of order and stability rather than change" (Dennis, 1977, p. 101). It was not until the 20^{th} century that Schumpeter (1942) proffered a vision of competition as a fundamental source of disequilibrium (and growth) in markets.

Importantly, beginning with Smith, the word and concept of competition has often been conjoined with an adjective. Smith chose to emphasize the notion of "free competition." Smith's use of the word "free" emphasized the notion that the competition he envisioned was one in which individuals and firms could freely enter to compete for consumers' patronage. Against a medieval backdrop in which entry into professions and particular lines of commerce was heavily regulated, the adjective "free" brought two special purposes. First, it provided a reinforcing notion of individual liberty that was a common theme throughout Smith's writings. Second, it provided a marker for economists for the next two centuries that would emphasize the important role that economically "free" entry can have for the ability of markets to promote efficient resource allocation.[13]

In the years after Smith's treatise, economists have honed, refined, and parsed the notion of competition. Prominent economists of the 19^{th} century began to refer to "the law of competition" referring to the general propensity of competition to drive prices to an equilibrium level.[14] Later still, economists came to qualify the word competition with "perfect." Today, the model of "perfect competition" provides a standard introduction for students of economics into the equilibrium tendencies of markets characterized by perfectly free entry, atomistic firms selling a homogeneous product or service and perfectly informed buyers and sellers.[15] As a theoretical model it provides a powerful congruence of competition with the economic efficiencies anticipated by Smith some 240 years ago.

By the mid-20^{th} century, however, it was widely recognized that the model of perfect competition bore little resemblance to modern markets. Indeed, many if not most modern markets have characteristics that strain the standard characterization of perfect competition. Firms in advanced capitalistic societies are often large in both absolute and relative terms, sell mildly-to-highly differentiated goods, and operate in markets that are subject to at least modest barriers to entry. Ironically,

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state, "But the annual revenue of every society is always precisely equal to the exchangeable value of the whole annual produce of its industry, or rather is precisely the same thing with that exchangeable value. As every individual, therefore, endeavors as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labours to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."

[13] Economically "free" entry does not, of course, literally mean that the cost for firms to enter markets is zero but rather that barriers to entry are minimal.

[14] *E.g.*, Ricardo (1811/1887), George (1879/1920, §2¶10), Mill (1848).

[15] *E.g.*, Katz and Rosen (1998, pp. 327-331).

a core element of competition (*viz.*, rivalry) is absent from the perfectly competitive model as firms in this market model do not compete with each other in the sense of reacting to a rival's actions, but instead simply respond to anonymous market forces.

This disconnect compelled fresh thinking from the economics community. 20^{th}-century economists began serious efforts to develop models of imperfect competition that may more accurately resemble the structural aspects of modern markets.[16] In imperfectly competitive market models, firms compete with each other in the sense that they account for and react to rivals' behaviors. Efforts to model imperfectly competitive models, however, have proven not to be the silver bullet that economists had sought. An early attempt to construct a general model of imperfect competition was criticized for its overreaching generality and the tendency to envision all competition as "monopolistic" (Stigler, 1956). Game theoretic models of competition, which have the virtue of explicitly modelling rivals' strategic reactions to each other, provided specific insights under particular assumptions. Yet the equilibrium outcomes of these models vary from very desirable economic outcomes (i.e., high output and low prices) to less "competitive" (lower output and higher prices) outcomes. Consequently, no general theory of imperfect competition has arisen that captures, or anticipates, the general economic behavior of firms in modern markets.[17]

3 Workable (Effective) Competition

The 20^{th}-century incongruity between the sterile (and potentially misleading) model of perfect competition and the structure of many modern markets naturally triggered substantive debate about both the concept of competition and the appropriate policy toward competition. In the 1940s, this discourse found a new and promising pathway. It was then that John Maurice Clark (1940), a prominent early 20^{th}-century economist, made an impassioned argument for a new concept of competition. He began by noting that models of imperfect competition, while "current," were in "an unformulated state" for applications of economic policy. He further noted that scrutiny of the alternative model of perfect competition had led economists to realize that "'perfect competition' does not and cannot exist and has presumably never existed for reasons quite apart from any inescapable tendency toward collusion, such as Adam Smith noted in his familiar remark on the gettings-together of members of a trade" (p. 241).

To advance a better platform, he defined competition as follows:

> **Competition** is rivalry in selling goods, in which each selling unit normally seeks maximum net revenue, under conditions such that the price or prices each seller can charge are effectively limited by the free option of the buyer to buy from a rival seller or sellers of what we think of as "the same" product, necessitating an effort by each seller to equal or exceed the attractiveness

[16] This research might be said to originate with Chamberlin (1933), who developed the model of monopolistic competition.

[17] This is, of course, not to say that significant progress has not been made in the development of specific market models, with particular features, that may be accurately used to better understand economic outcomes in appropriately identified markets.

> of the others' offerings to a sufficient number of [buyers] to accomplish the end in view (p. 243, *emphasis added*).

This definition provides the core of Clark's theory of "workable competition," a term Clark and others came to use interchangeably with "effective competition" (Clark, 1961). Clark emphasizes three key features of competition: (1) rivalry among sellers, (2) the "free option" of buyers to buy from alternative vendors, and (3) efforts by sellers to equal or exceed the attractiveness of others' offerings.

Clark's definition provides guidance for both identifying firms that are subject to workable competition and offering policy guidance. Workable competition admits the prospect that industries may, "despite large-scale production, have the characteristics of fairly healthy and workable imperfect competition, rather than those of slightly-qualified monopoly" (Clark, 1940, p. 256). On the policy front, Clark concludes that where markets deviate from structural conditions of perfect competition but are, nonetheless, workably competitive, "one may hope that government need not assume the burden of doing something about every departure from the model of perfect competition" (p. 256).

Once introduced, the concept of workable competition gained immediate traction in both the academic and political communities.[18] Joe Bain, attributed to be the father of modern industrial organization economics, scrutinized Clark's vision of workable competition, finding "much of merit" in the concept. As he observed, Clark's notion of workable competition "include[ed] a rather effective answer to those who would hold that all oligopoly tends to approximate pure monopoly behavior, or that reasonably satisfactory results are possible only if all oligopolists price independently on a price-equals-marginal-cost basis" (1950, p. 36).

Bain noted that the determination of whether a market was workably competitive would require an empirical assessment of performance along several dimensions. He further correctly observed that a successful application performing an assessment of the workability of competition requires that the empirical results of the analysis must be judged against some "ideals or goals of performance" as well as provide some clear sense of the acceptable degree of deviation from these ideals (1950, p. 37).

The original definition of workable competition fashioned by Clark is both straightforward and, with Bain's caveats duly noted, seemingly a quite "workable" tool for economists as they consider the merits of turning up or down the regulation of an industry. Following Clark's original exposition of workable competition, however, economic analyses proceeded by both continuing to alter the definition of what constituted a workably competitive market and by generating an ever-growing list of criteria that were seen as necessary to render a confident conclusion that a market was, in fact, workably competitive. These developments ultimately caused a muddling of the clean concept. By 1957, one prominent economist wryly noted that "[t]here are as many definitions of 'effective' or 'workable' competition as there are effective or working economists" (Mason, 1957, p. 381). The list of criteria too became unwieldy. One study went so far as to argue that "a market is effectively competitive *if and only if* it is free of 25 flaws" (Sosnick, 1968, p. 827, *emphasis added*).[19] Future Nobel laureate George Stigler added the criticism that the factors

[18] *See, e.g.*, Wilcox (1940).

[19] These flaws included unsatisfactory products, underuse or overuse, inefficient exchange, inefficient production, bad externalities, spoliation, exploitation, unfair tactics, wasteful ad-

identified that would be seen to be congruent with effective competition were "simply parts of the theory of perfect competition restated in homely language" (1956, p. 505). The multiple criteria for labeling a market "workably competitive" had not created greater clarity, but instead clutter and ambiguity. And the ever growing set of criteria also made the labelling of a market as "effectively competitive" more stringent than labelling it "perfectly competitive." Stigler's cutting synthesis concluded, "[t]o determine whether an industry is workably competitive, therefore, simply have a good graduate student write his dissertation on the industry and render a verdict. It is crucial to this test, of course, that no second graduate student be allowed to study the industry" (p. 505). Another poignant critique concluded that the erosion of the concept from its original form was not due to failures of classical economic thought, but rather failures of those "who fell into the bad habit of equating competition with pure competition, of confusing theoretical benchmarks with policy norms, of expecting highly monopolistic behavior in most markets where competitors are few" (Peterson, 1957, pp. 76-77).

While theoretically adrift, the increasingly ill-defined concept of workable competition also ran a risk of providing a misleading policy tool. As pointed out by Stigler (1956), "[b]ecause [the concept of workable competition] does not focus upon the alternatives open to the society in a given situation, it is misleading: sometimes nothing can be done with an unworkable industry; sometimes a workable situation can be improved" (p. 505). This important insight points toward the need, when considering policy directed toward any industry, to consider not only observable behaviors of firms within a market but also the costs and effectiveness of governmental policies designed to remedy perceived market shortcomings. Fortunately, as Jesse Markham observed, a definitional refinement helps circumvent the policy trap identified by Stigler:

> A possible alternative approach to the concept of workable competition may be one which shifts the emphasis from a set of specific structural characteristics to an appraisal of a particular industry's over-all performance against the background of possible remedial action. Definitions of workable competition shaped along these lines might accept as a first approximation some such principle as the following: *An industry may be judged to be workably competitive when, after the structural characteristics of its market and the dynamic forces that shaped them have been thoroughly examined, there is no clearly indicated change that can be effected through public policy measures that would result in greater social gains than social losses* (Markham, 1950, p. 361, *emphasis added*).

4 Effective Competition in Policy Practice

Following the introduction of effective competition to the academic literature, the concept was integrated into policy usage rather quickly. Its first appearances in the policy arena were limited to federal tax and procurement policy applications. As

vertising, irrationality, undue profits or losses, inadequate research, predation, pre-emption, tying arrangements, resale price maintenance, refusals to deal, undesirable discrimination, misallocation of risk, undesirable mergers, undesirable entry, misinformation, inefficient rules of trading, and misregulation.

early as 1944, the term "effective competition" appeared in an IRS Bulletin referencing an exemption from stringent wartime contract policies if competitive conditions were likely to result in effective competition for the contract or contract prices (U.S. Treasury Department, 1944, pp. 807, 961, 1048). Similar early references to effective competition appear in procurement clauses related to telecommunications and the military.[20] Missing from these early policy directives was any definition of "effective competition." When certain sections did incorporate definitions much later, they tended to focus on the presence of two or more rivals.[21]

In the 1970s, "effective competition" found its way into freight railroad policy. In the Railroad Revitalization and Regulatory Reform Act of 1976, Congress directed that no rate for rail service could be judged by the Interstate Commerce Commission to be unreasonable unless the carrier in question was first determined to hold "market dominance," which it defined to be the "absence of effective competition" from either other rail carriers or other modes of transportation.[22] It did not, however, define "effective competition."

Apart from procurement applications, it appears that the first meaningful discussions in the communications arena of competition and "effective competition" in particular began in the 1980s. In a 1985 Office of Plans and Policies FCC working paper, John Haring wrote:

> Competition is a process of discovery and adaptation, not a particular distribution of market shares. Any configuration of market shares may be consistent with effective competition or noncompetitive performance... Whether competition is 'effective' depends primarily on the degree of resource mobility in the economy. It has little to do with the distribution of market shares prevailing at any point in time, particularly when shares are determined by regulation rather than competition (1985, p. 2, *emphasis in original*).

In 1993, the FCC moved forward in the context of a proceeding involving the entry of foreign telecommunications carriers into the U.S., to define effective competition: "Effective competition means competition among service providers in a market that benefits consumers by expanding service offerings, promoting development of innovative technology, and lowering prices" (FCC, 1995b, ¶1) While establishing a

[20] *See, e.g.*, the Satellite Communications Act of 1962, Public Law No. 87-624, 76 Stat. 419, codified at 47 U.S.C. ch. 6 §701 et seq, which directed the FCC to "insure effective competition, including the use of competitive bidding where appropriate, in the procurement by the corporation and communications common carriers of apparatus, equipment, and services required for the establishment and operation of the communications satellite system and satellite terminal stations..." *See also* An Act of July 5, 1968 to amend section 2306 of title 10, United States Code, to authorize certain contracts for services and related supplies to extend beyond one year, Public Law 90-378, 82 Stat. 289, which permitted the armed forces to enter multi-year contracts so long as, among other requirements, "the use of such a contract will promote the best interests of the United States by encouraging effective competition and promoting economies in operation."

[21] *See, e.g.*, 48 C.F.R. §34.001 (1986), which defines effective competition within the Federal Acquisition Regulations System for major acquisitions as, "a market condition that exists when two or more contractors, acting independently, actively contend for the Government's business in a manner which ensures that the Government will be offered the lowest cost or price alternative or best technical design meeting its minimum needs." The definition was first added into this section of code in 1986.

[22] Railroad Revitalization and Regulatory Reform Act of 1976, Public Law 94-210, 90 Stat. 31, 45 U.S.C. §801.

definition that appeared congruent with the foundational definition first offered by Clark, the FCC has vacillated in other policy areas in which the definition of effective competition is central to policy. It is to those areas that we now turn.

4.1 Effective Competition in Cable TV

The concept of effective competition was present at the FCC,[23] but it was not until the Cable Communications Policy Act of 1984 compelled the FCC to define the term for the purposes of cable regulation that the FCC took concrete steps toward employing the concept as an assessment benchmark in its work regulating the telecommunications industry.[24] The FCC, operating on a strict Congressionally-dictated timetable for adopting a standard, initially settled on a finding of effective competition if at least three non-duplicated over-the-air broadcast signals were receivable within the cable system's market area. This standard was implemented as an exemption criteria from rate regulation, and ultimately resulted in rate deregulation for 96 percent of the cable industry (House of Representatives, 1992, p. 31), and remained in effect (with minor revisions and clarifications[25]) until 1991. The FCC had monitored the relevance of its definition, and staff analysis of 1988 viewership data found lack of support for the three-signal standard as a true finding of effective competition. Consequently, the FCC started a process to reexamine the effective competition standard to reflect the changed circumstances of the video marketplace. This time, the FCC dedicated seventeen months to exploring various criteria for effective competition, and settled on a two-pronged definition for the existence of effective competition. One of two alternatives must be met: first, that at least six unduplicated Grade B broadcast signals[26] be available in the relevant market, and cable system penetration in the market be less than fifty percent; or second, that at least one independently owned multichannel video service be available to at least fifty percent of viewers in the relevant market and actually subscribed to by at least ten percent of the potential viewers in the market (FCC, 1991).

This stricter definition, enacted in June 1991, significantly increased the number of cable systems subject to regulation. At the same time, Congress had already begun an investigation of what it viewed to be price gouging in the wake of substantial deregulation[27] and disempowered the FCC by enacting legislation that

[23] *See, e.g.*, the 1962 Satellite Communications Act, cited in *supra* note 20, which had instructed the FCC to "insure effective competition."

[24] Cable Communications Policy Act of 1984, Public Law 98-549, 98 Stat. 2779, codified at 47 U.S.C. §§521 et seq. This Act deregulated the cable industry, with much contingent on the presence of effective competition–the definition and determination for which Congress gave authority and mandated the FCC to create.

[25] *E.g.*, the FCC made revisions in 1988 per direction of U.S. Court of Appeals–after a case brought against the FCC by the ACLU–to require one hundred percent of the community receive three Grade B signals, although they not necessarily be the same three signals throughout the whole community, and also to use community-wide rather than county-wide data to determine whether a signal qualifies as "significantly viewed." *See* FCC (1988).

[26] A "Grade B" broadcast signal was defined as the field strength of a television broadcast station computed in accordance with regulations promulgated by the Commission pursuant to 47 USC §522 (11).

[27] The prevailing argument made by the cable providers at this time in defense of this accusation had two parts: first, that prices had been artificially low during the period of

would regulate rates on a broader scale. With the passage of the Cable Television Consumer Protection and Competition Act of 1992, the criteria for effective competition changed again.[28] Effective competition would be found to exist in the presence of any of three conditions: first, when fewer than thirty percent of the households in the system's franchise area subscribe to the operator's service; second, if the franchise area is served by at least two multichannel video programming distributors, each of which offers comparable programming to at least fifty percent of the franchise area's households and also if more than fifteen percent of the franchise area's households subscribe to service offered by the distributor other than the largest one in the area; or third, when the area's franchising authority operates a multichannel video programming service available to at least fifty percent of the households in the area. The FCC was required to implement these controversial changes and also define by rule certain Congressionally-undefined aspects of the law's standard for effective competition. As a procedural mechanism at the time, the FCC officially adopted the presumption of no effective competition during the implementation of the 1992 Cable Act (FCC, 1993).

Just four years later, Congress passed the Telecommunications Act of 1996, with the stated goal of increasing competition and reducing regulation. This act again altered the definition of effective competition in the cable industry, this time, broadening the scope to include competition from a local exchange carrier's facilities offering video programming services comparable to the offerings of cable operators.[29] In line with the act's stated goal of promoting competition and reducing regulation, the definition also eliminated many of the situations in which a determination of effective competition would be necessary to exempt a service provider from rate regulation.

After the act was implemented by the FCC (1996), the percentage of cable service providers found to be subject to effective competition rose, albeit slowly initially, but then more rapidly.[30] In particular, as the new technology of direct broadcast satellite (DBS) developed and DBS coverage became nearly ubiquitous, DBS came to be seen as a ready driver of effective competition among other multichannel programming video providers (MVPDs). As competition was increasingly seen as effective, the regulatory presumption that cable companies did not face effective competition absent a rigorous demonstration was seen as burdensome regulation.

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regulation prior to the 1984 Act, and second, that in the period of deregulation, the industry offerings had significantly improved and that merited a price increase.

[28] Cable Television Consumer Protection and Competition Act of 1992, Public Law 102-385, 106 Stat. 1460, 1465, codified as amended at 47 U.S.C. §§521-555.

[29] The act provided, in addition to the previous three criteria–low penetration, competing providers, or the presence of a municipal provider–of effective competition, a definition for "local exchange carrier effective competition" if a local exchange carrier or its affiliate or any MVPD using the facilities of such carrier or its affiliate offers video programming services directly to subscribers by any means other than direct-to-home satellite service in the franchise area of an unaffiliated cable operator which is providing cable service in that franchise area, but only if the video programming services so offered in that area are comparable to the video programming services provided by the unaffiliated cable operator in that area. *See* Telecommunications Act of 1996, Public Law 104-104, 110 Stat. 56, 115, §301(b)(3).

[30] In 1997, for example, the FCC issued decisions determining the presence of effective competition in forty-five communities with approximately 300,000 subscribers. The majority of successful effective competition petitions in 1997 were based on the local exchange carrier test for effective competition. *See* FCC (1998a).

Against this backdrop, the STELA Reauthorization Act of 2014[31] gave the FCC a mandate to reevaluate the usage of the effective competition standard. Specifically, under mandate of Congressional order to “establish a streamlined process for filing of an effective competition petition pursuant to this section for small cable operators, particularly those who serve primarily rural areas,” the FCC revisited the presumption determining the presence or absence of effective competition in the cable industry (FCC, 2015b). As the FCC had noted in its annual competition reports, fewer and fewer petitions for determination had been denied in the years since 1993, and in only half a percent of the communities evaluated since 2012 had there been insufficient evidence for a finding of effective competition (FCC, 2015a). With the added factor that DBS service provided nearly universal coverage in the U. S. (FCC, 2015c, ¶¶26-28) and was generally found to meet the competing provider test for effective competition (FCC, 2015b, ¶9), in June 2015 the FCC moved to alleviate the burden of petitioning for small (and large) cable operators by adopting a rebuttable presumption of competing provider effective competition (FCC, 2015b, ¶¶13-16).

In sum, both the definition and policy determination of effective competition in the provision of cable TV have vacillated over the years. Over the years, the FCC has alternatively defined “effective competition” to be a number of competitors greater than or equal to three, six, or two. At times, the FCC has focused solely on the number of competitors, while at other time it has incorporated an additional focus on market shares; measured, at times, using capacity or customers, and, alternatively at different times focusing on the market share of the largest–or smallest–provider in the marketplace. In short, the only consistency over the years has been the inconsistency with which policymakers have defined effective competition in the MVPD marketplace.

4.2 Effective Competition in Mobile Wireless

The FCC began a formal annual review of the state of “competitive market conditions with respect to commercial mobile services” after Congress passed legislation requiring it in 1993.[32] Unlike the case of cable TV, however, Congress did not dictate the definition or terms of effective competition for mobile telephony. The law simply required that the FCC include “an analysis of whether or not there is effective competition,” as well as “identification of the number of competitors in various commercial mobile services” and “whether any of such competitors have a dominant share of the market for such services.” In the wake of such flexibility, the FCC’s approach to the annual reporting requirement changed substantially over the years since 1993.

Initially, the FCC did not explicitly comply with all parts of the law outlining the contents of the annual report; in particular, the FCC provided a description of the industry’s competitive metrics and trends without making a finding of effective competition or lack thereof in the first seven reports. The term “effective competition” does not even appear in many of the reports, except for citations to

[31] STELA Reauthorization Act of 2014, Public Law 113-200, §111, 128 Stat. 2059, 47 U.S.C. §543(o)(1).

[32] The Omnibus Budget Reconciliation Act of 1993, Public Law 103-66, Title VI, §6002(b), amending the Communications Act of 1934 and codified at 47 U.S.C. §332(c).

the law motivating the report.[33] Surprisingly, the FCC's neither defining effective competition nor attesting to its presence or absence did not prove particularly controversial despite being a blatant contravention of a major component of its reporting requirement. This was perhaps based in the presence of phrases such as "less than fully competitive" (FCC, 1995a, ¶4), and "undergoing major changes that have resulted in growing competition" (FCC, 1995a, ¶2), which hinted at the absence of effective competition without requiring a conclusion. Later reports similarly hinted at progression toward an effectively competitive industry, which allowed the FCC to broach the topic of effective competition without specifically drawing the conclusion that the industry had yet reached a standard of effective competition.[34] Over time, both the extent of data upon which the reports were based and the analyses of those data expanded considerably.[35]

By the release of the *Eighth Report* in 2003, the FCC's perception of competitive growth in the mobile wireless industry led to a conclusion that the industry could be characterized by effective competition. Improvement in the quality and granularity of the underlying data was also revealed in the *Eighth Report* (FCC, 2003).[36] Still, the *Eighth Report*'s finding of effective competition was not predicated on a specific definition or set of criteria for effective competition. The *Eighth Report* did, however, manage to set a precedent, and each of the following six reports continued to conclude that effective competition was present in the mobile wireless industry, despite the fact that none referenced a definition for the term or stated the criteria for such.

The FCC's changed methodology and approach to assessing competition did not go unnoticed. Internally, it was met with criticism from Commissioner Michael J. Copps. Commissioner Copps argued for the need to "establish a definition of 'effective competition' and a standard for determining when such competition exists" stating that "merely listing possible relevant areas of inquiry is far different from having a rigorous method of determining whether current market characteristics mean that there is adequate competition" and that "[w]ithout more rigor, without an articulated 'effective competition' standard, the Report is of limited use in providing an analytically solid foundation for Commission or Congressional action"

[33] *See, e.g.*, FCC 1995a, 1997, 1998b, 1999.

[34] *See, e.g.*, a statement in the *Fourth Report*, "While there is still considerable room for further competitive development, the effects of the progress to date are clear" (FCC 1999, p. 10207).

[35] The *First Report* (FCC, 1995a) was composed almost entirely in a discussion of various mobile services and how they complemented each other, with some generalized price ranges for those products and broad subscription statistics, although it did reference goals for how the reporting would improve by the time of the *Second Report*. By the time of the *Fifth Report* (FCC, 2000), the length of the report had more than quadrupled, and included a much more broad selection of sector descriptors. Regarding advancements in data, prior to the *Seventh Report*, the Commission based its analysis solely on publicly available data sources, but incorporated the "Numbering Resource Utilization / Forecast" data in the *Seventh Report* (FCC, 2002), as well as conducting a public forum in February 2002 to collect further data.

[36] FCC Chairman issued a statement as part of the report stating, "This is the most comprehensive wireless competition report that the Commission has ever produced and I applaud the efforts of the Wireless Bureau to update, verify, and diversify our data to better capture the state of the marketplace" (FCC, 2003, p. 14783).

(FCC, 2003, p. 14784). Copps reiterated his views upon the release of the following four competition reports.[37]

While Copps was alone in his views within the FCC, outside the Commission, others supported the development of an effective competition standard. Notably, a 2006 report of the US Government Accountability Office (GAO) concluded that the FCC needed to "develop a meaningful and workable definition of effective competition" (GAO, 2006, p. 43), which it characterized as a proxy of true consumer choice.[38] Upon review, the managing director of the FCC, Anthony Dale, commented that developing such a definition would be "administratively impracticable" because "there is no universally accepted, bright-line definition of 'effective competition'" and questioned the recommendation to define and "measure effective competition on a granular basis" on the grounds that it was inconsistent with the deregulatory goals of the 1996 Telecommunications Act. The GAO responded that: (1) the FCC was in the best position of any entity to accomplish this task, despite its complexities; (2) defining effective competition was "a relevant and important task for the requisite federal regulatory body;" and, (3) the "FCC would be significantly hindered in its ability to fulfill its regulatory responsibilities and statutory goals of promoting competition if it cannot define competition, does not have measurable goals, and does not collect and analyze reliable data on the state of competition for dedicated access" (GAO, 2006, p. 46).

In January 2009, Commissioner Copps stepped in as Acting Chairman of the FCC a mere six days following the release of the *Thirteenth Report.* During his brief tenure in this role, the wireless bureau approached the task of articulating the components of an effectively competitive industry. With a *Public Notice* in May 2009, preparations for the *Fourteenth Report* were launched, and along with the usual requests for data and anecdotes regarding industry developments, the FCC finally requested feedback on which "specific criteria should be used to determine whether there is 'effective competition' among [mobile wireless] providers" (FCC, 2009b, p. 5619). The *Public Notice* referenced a variety of interpretations of what could constitute effective competition, and asked whether it "should continue to consider a range of indicators in determining whether effective competition is prevalent in [the mobile wireless] marketplace or define effective competition in a more specific manner" (p. 5620). The *Public Notice* also mentioned some of the definitions explored within public policy practice and economics literature and inquired whether the definition of an effectively "competitive market [as] one that

[37] *E.g.*, Copps remarked: "... the Report still contains aruments and omissions that trouble me. The central question of the legislation that requires this Report is whether the market is characterized by 'effective competition.' Yet again this year, the Report does not provide a useful definition of this term" (FCC, 2004, p. 20720). "Congress tasked us with doing 'an analysis of whether or not there is effective competition' in commercial mobile services. Yet still we fail to define 'effective competition'–and this limits the ability of the Commission and the Congress to rely on our results" (FCC, 2005, p. 16014). "The need for a clearly-stated, objectively-measurable definition of 'effective competition' gets more compelling every year...Our conclusion that competition remains effective [ ] would be more credible if we had defined that term ahead of time and **then** assessed whether current competition data meets our definition" (FCC, 2006, p. 11070, *emphasis in original*). *See also* his comments in the *Twelfth Report* (FCC, 2008).

[38] This was in marked contrast to earlier reports which focused more on the weaknesses of the data underlying previous reports. *See, e.g.*, GAO (2003).

requires no intervention to improve its performance" should be considered "in conjunction with the metrics and factors currently analyzed" (p. 5621).

However, few of the comments addressed this topic. Most of the fourteen commenters ignored the opportunity to shape a definition for effective competition and simply addressed other aspects of the *Public Notice*, focusing on concerns regarding consolidation in the industry or perceived impediments to competition stemming from roaming and exclusive handset agreements.[39] Others dismissed the importance of defining effective competition and stated that the FCC should continue to approach the topic as it had in the *Eighth* through *Thirteenth Reports*, or expressed that the FCC was incapable of generating a useful definition.[40]

Soon after the comment and reply-comment period for the Public Notice had closed, the newly confirmed Chairman of the FCC, Julius Genachowski, announced a goal of "upgrading [the] competition reports across the board to provide important information to all stakeholders and to create solid, fact-based foundation for predictable policy" (FCC, 2010, p. 11700), which appeared congruent to developing a definition of effective competition. When the *Fourteenth Report* was released, however, rather than elaborate on criteria for effective competition, the FCC simply reversed its position on the feasibility of finding the presence or absence of effective competition in the industry stating, "[t]he mobile wireless ecosystem is sufficiently complex such that no single definition of effective competition adequately encompasses both general indicators of competition and challenges inherent in the mobile wireless industry, such as spectrum availability, network interconnection issues, and network access issues" (FCC, 2010, p. 11435). The FCC further justified its stance by referencing the lack of consensus on the definition of effective competition among economists and competition policy authorities as the driving reason they failed to make a finding for or against effective competition. Chairman Genachowski posited that an "overly-simplistic yes-or-no conclusion about the overall level of competition in this complex and dynamic ecosystem" would be at odds with the FCC's role "as a fact-based and data-driven agency" (FCC, 2010, p. 11701).

Similar to the first seven reports, although accompanied by a much more granular description of the industry, the FCC's *Fourteenth Report* assessed mobile telephony market conditions without providing a conclusory assessment regarding the presence of effective competition. Unlike in those first seven reports, however, there was no clear underlying implication that effective competition did not exist. Rather, what conclusions should be drawn from the report were simply left to the reader. There was not even consensus among the various commissioners on how to interpret the report. Commissioner Meredith Baker applauded the thoroughness of the report, but stated, "we should have made an affirmative finding of a competitive market based on the year-over-year trends set forth in the Report and the significant consumer opportunities and investment provided by the wireless industry" and "[the Report's] data demonstrate a vibrant competitive environment across the mobile wireless sector" (FCC, 2010, p. 11708). Commissioner Robert McDowell

[39] *See, e.g.*, comments from Cellular South, Cricket, the Rural Telecommunications Group, MetroPCS, and Brighthouse Networks, among others of FCC (2009a).

[40] In its response, AT&T went so far as to argue that the task was unnecessary because it was obvious that "any rational definition" would clearly indicate effective competition in the wireless industry and serve as an efficient fulfillment of the FCC's statutory duty. Thus, AT&T characterized the existence of the inquiry as a "distraction of academic debates on the proper definitional phrasing" (FCC, 2009a, AT&T, p. 5).

argued that there was not "new or particularly revealing information that would prevent us from opining as to 'whether or not there is effective competition'" and "[i]f nothing else, the report shows that the wireless sector is dynamic, ever-improving, and responsive to consumer demand" (FCC, 2010, p. 11704). Given Commissioner Copps' repeated calls for the FCC to establish a definition for "effective competition," surprisingly, he was only complimentary of the new report's format, calling it, "the kind of comprehensive and granular analysis that [he had] been looking for." Copps then went on to emphasize a growth in the Herfindahl-Hirschman Index value within the mobile telephony market, which he thought heralded the "dramatic[] ero[sion]" and "serious[] endanger[ment]" of competition "by continuing consolidation and concentration in the wireless markets" (FCC, 2010, p. 11702). Commissioner Mignon Clyburn also applauded the report and expressed her fears about rural consumers without "meaningful choices among providers" (FCC, 2010, p. 11707).

The new unwillingness of the FCC to conclude that the mobile wireless market was effectively competitive was seen by many as a change in the FCC's opinion of the competitive levels in the market, and correspondingly, a harbinger of impending greater regulation of the wireless industry. Unsurprisingly, this report was met with public outcry, in particular from those companies that never expected the FCC might change its stance so dramatically and so quickly.[41] Despite this public outcry, the *Fourteenth Report* set a new course for the following four reports. Through the publication of the *Eighteenth Report*, the FCC continued to analyze a collection of competitive attributes of the mobile wireless industry without defining effective competition or making a finding that the market is or is not effectively competitive.[42]

Our review of the FCC's approach to "effective competition" in mobile telephone markets indicates that without a clear definition to guide its analysis of competition, the FCC has expended substantial effort on mobile competition reports that are ultimately just as haphazard in their approach as the arbitrary rules surrounding effective competition in the cable industry. This approach could have been improved at any point in the last twenty-two years by establishing a definition of effective competition. It is to that effort that we now turn.

[41] *E.g.*, AT&T had previously posited that any "rational definition" would surely indicate the presence of effective competition (FCC, 2009a, AT&T, p. 5). The change in the FCC's position also garnered substantive academic criticism; *e.g.*, Faulhaber, et al. (2012).

[42] FCC Commissioner Robert McDowell continued to criticize this decision not to make a finding for/against effective competition until his retirement, and was also joined by Commissioner Ajit Pai, noting, "For what it's worth, the answer is pretty obvious to me: Yes, there is effective competition" (FCC, 2013, p. 4174). Commissioner Ajit Pai and Commissioner Michael O'Rielly were particularly critical of the FCC's stance at the release of the Eighteenth Report, with O'Rielly stating "[it] amazes me that with more than 90 percent of Americans having a choice of four or more wireless providers that we are incapable of concluding, as directed by Congress, whether this industry is competitive" (FCC, 2015g), and Pai casting aspersions on the reasons for the FCC's failure to make a finding of effective competition, "The bottom line: this FCC will *never* find that there is effective competition in the wireless market, regardless of what the facts show. That's because doing so would undermine the agency's goal of expanding its authority to manipulate the wireless market–a goal it can't accomplish if it deems that market healthy" (FCC, 2015f, *emphasis in original*).

5 "Competition" for 21^{st} Century Communications Markets

Collectively the last two sections indicate that: (1) after a promising start the definition of workable (effective) competition became excessively burdened and muddied in the academic realm; and, (2) despite the absence of an agreed upon definition of the term, "effective competition" was nonetheless adopted by policymakers who have based critical decisions regarding the level of regulation or deregulation of various industries on determinations of whether the market at hand was, indeed, effectively competitive. As we have seen, however, the lack of definition permits inconsistent and vacillating interpretations in the policy realm, with little or no reliance on the economic underpinnings associated with the concept. Consequently, a rigorous definition of "competition" that is capable of smartly guiding economic policy for the 21^{st} century does not readily spring from a continuation or simple modification of "effective competition" as historically used by the FCC.

This does not, however, mean that a sound definition is not possible. Nor does it mean that a definition must be constructed *de novo*. Rather we offer a definition rooted in the lineage of economic thought on competition. Three pillars form the foundation. First, we begin by emphasizing the basic definition offered by J. M. Clark (1940), who argued that the notion that workable or effective competition has three core elements: (1) rivalry among sellers; (2) the free option of buyers to buy from alternative vendors; and, (3) efforts by sellers to equal or exceed the attractiveness of others' offerings. Second, as elaborated by Bain and Qualls (1987), "workable ... competition in markets is revealed by, and is the result of, whatever gives rise to satisfactory or workable performance–performance that enhances economic welfare to a reasonable degree" (p. 10).[43] Finally, to the extent that effective competition serves as a trigger for policy intervention in markets, Markham's insight becomes a requisite element of any sound policy application of effective competition. In particular, in the absence of a "clearly indicated change that can be effected through public policy measures that would result in greater social gains than social losses" (Markham, 1950, p. 361), the market may be considered effectively competitive.[44] Taking these considerations together, a market can be said to be **effectively competitive** when:

1. Firms exhibit overt rivalry in their quest for consumer patronage;
2. Consumers have choices among vendors, readily demonstrate their ability to change vendors, and vendors (either incumbent or *de novo*) have the ability and propensity to expand output to satisfy consumer demands;
3. Rivalry among vendors manifests itself in desirable economic performance metrics, including price, output, quality, investment, and innovation; and
4. No clearly indicated and cost-effective policy change can improve upon prevailing economic performance in the market at issue.

[43] As a practical matter, this feature of effective competition embodies the prospect that Schumpeterian-style competition for a market (as opposed to the more traditionally-conceived competition within a market) is sufficiently powerful that the market generates desirable performance characteristics despite high levels of market concentration.

[44] This early call for an assessment of the policy effectiveness of market interventions is more recently repeated by the Department of Justice when it noted that "[t]he operative question in competition policy is whether there are policy levers that can be used to produce superior outcomes, not whether the market resembles the textbook model of perfect competition" (2010, p. 11).

Although rooted in the initial definition of workable competition, this modern definition is manageable, avoiding the encumbrances that hindered its early progress in the academic arena.[45] It also offers a consistent foundation for policy analysis, creating the possibility that assessments of market competition will not vacillate depending on the ideological mood of Congress, regulators, or the public.[46] It has the advantage of being grounded in measureable indicators about which consumers are likely to care deeply: do they face choices of vendors, can they readily change vendors, do firms actively vie for their patronage, and are they benefiting from marketplace rivalry? Additionally, while laying a foundation for the assessment of competition in 21^{st} century markets, the definition has sufficient similarities with current analysis that adopting it as a standard would not require significant departures from current practices and policies. For instance, the modern effective competition standard would require very few changes in data collection and analysis commonly conducted by the FCC.[47]

While offering advantages for communications markets, the reliance on a definition of "effective competition" will surely raise both anticipated and unanticipated challenges. An anticipated challenge of the modern definition is that it, like its early predecessor, provokes assessments of performance without providing a clear, bright-line determination of performance standards that would be sufficient for rendering a market effectively competitive. Nonetheless, benchmark analysis is certainly possible and in many cases may provide clear judgments. Another anticipated challenge that the modern definition will face is that, although it provides a direction for analysis, the likelihood remains that advocates will seek to hijack its application for their own ends. This challenge, however, is not new. Indeed, self-serving advocates are likely to find manipulation of policy toward their narrow self-interests to be more difficult with the definition in place. And, as noted above, by establishing the modern definition, policy swings solely based on ideological shifts in Congress, the FCC, or the public are less likely.

6 Conclusion

Economic concepts own a special place in the social sciences. Like concepts employed in other social sciences, economic concepts provide its scientists with the tools they need to better understand the workings of the target of their inquiry. Economic concepts, however, also routinely serve to inform and drive policy. This is especially true of the concept of competition. Despite the centrality of the concept of competition to communications policy, however, numerous, foundational questions about the concept persist. Accordingly, in this paper, we have chronicled the evolution of "competition" in economics and also how "competition" has taken shape in the communications arena. We have found that the concept of "effective

[45] *See* the discussion in Sect. 3.

[46] For evidence of such vacillation in regulatory and deregulatory measures over the past half-century, *see* Mayo (2013).

[47] Indeed, to the extent that the modern definition focuses policymakers more toward performance-based analysis of communications markets, it is completely consistent with the FCC's own observation that "market performance metrics provide more direct evidence of competitive outcomes and the strength of competitive rivalry than market structure factors, such as concentration measures" (FCC, 2010, ¶10).

competition” is central to policy formation at the FCC. Yet, we also have found that the FCC’s own applications of “effective competition” are inconsistently applied. Given the importance of this concept, and its inconsistent applications to date, we draw upon the seminal contributions to the notion of effective competition to proffer a modern definition that we believe is suitable for application in 21^{st} century markets.

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Empirical Analysis of the Broadband Coverage in Europe: Infrastructure Sharing vs. Facilities-Based Competition

Christopher S. Yoo

ABSTRACT

For two decades, policymakers have debated whether infrastructure sharing or facilities-based competition represented the better approach to promoting investment in broadband networks. Prior empirical analyses have based their conclusions on subscription data. The existence of significant barriers to adoption unrelated to availability underscores the extent to which subscription data represent an imperfect measure of investment. Data on broadband coverage would represent a more accurate indicator of investment than broadband subscriptions. Fortunately, the European Union began collecting such data in 2011, reporting data separately for both national and rural coverage. This study represents the first in-depth empirical analysis of this data. Regression analysis indicates that that measures of infrastructure sharing are significantly negatively correlated and measures of facilities-based competition are significantly positively correlated with 25 Mbps deployment. A similar regression on 100 Mbps deployment yields similar results, albeit with less statistical significance. Alternative specifications that guard against potential multicollinearity and robustness checks on direct measures of investment corroborate these findings. An analysis of component broadband technologies reveals that DOCSIS 3 plays a more important role than fiber-to-the-home in supporting NGN coverage.

Trends in Cable Network Economics

Implications for Public Policy

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Trends in Cable Network Economics

Implications for Public Policy

Abstract

Introduction

Over the past 50 years the network economics of cable television networks engendered a profound impact upon the diversity of information available to modern society in the form of video and broadband content. Cost-effective one-way transport of analog and digital technology has increased the diversity of television channels to several hundred from a handful. Cost effective two-way transport of Internet access services over cable in substantial part established societal reliance upon always-on access to Internet content at broadband speeds. In response policy makers have enacted many laws and regulations over this time designed to promote and preserve open access to information either specifically or generally targeted to the flow of content over cable networks, with the Federal Communications Commission (FCC) Open Internet decision in 2015 the latest prominent example.[1]

Incremental technological innovation over time has been the key driver establishing favorable network economics to push this evolution of expanding services and information carried on cable networks. As the cable industry now sits upon the cusp of deploying yet another new generation of transport technologies and the new Open Internet rules start to take shape, it is an opportune setting to examine how well the network economic equations enabled by new IP transport technologies are likely to align with the principles and objectives of the FCC's Open Internet framework.

To answer this research question, this paper reviews how the economics associated with the allocation of cable capacity for video and data services has evolved over the past 20 years, and where it is likely to go in the next 5 years. This paper argues that significant past and

[1] In the Matter of Protecting and Promoting the Open Internet, Report and Order, FCC 15-24 (2015). [hereinafter "2015 Open Internet Order"]

ongoing changes in the economic framework for allocation of network resources over cable networks have been, and will continue to be, caused by significant new technological innovations in digital television and Internet Protocol based ("IP-based") transport. To accomplish this, we develop an economic framework to illustrate how the efficient allocation of network capacity for analog cable service can be described, and the changes introduced to the framework with the migration to digital television technology. Next, the paper provides a brief explanation of how the new IP transport technologies of Data Over Cable Service Interface Specification (DOCSIS) version 3.1 and network management technologies of software defined networking (SDN) and network virtual function (NFV) are likely to be used over cable networks. These new technologies will likely spark another significant change in the economic calculus or network economics associated with the efficient allocation of capacity over cable networks.

Based upon these anticipated changes, the paper next examines the potential policy implications with a particular focus upon the 2015 Open Internet order. The allocation framework helps to identify policy issues posed by the use of new IP transport capabilities. A preliminary finding is that as video becomes the dominant application carried by the Internet, the Open Internet framework will likely need to address the network access issues specific to IP video including the wholesale migration of video to IP, definition of services using QoS and reasonable approaches for managing public Internet congestion. such as the principles and rules addressing no paid prioritization and specialized services. The analysis also shows how the economics of new channel deployment over cable will become easier in the IP environment, but more complex with regard to the network operations associated with quality.

Literature Review

The amount of network capacity over cable television networks has been an ongoing point of public attention since their initial deployments in the 1950s due to its important role in the overall telecommunications infrastructure. Consumers look to the number of television channels carried for television service or the overall speed of broadband service as important inputs into their deliberations in selecting their TV and Internet services. Policy makers have considered the associated channel capacity of cable networks in considering public policy issues associated with broadcast retransmission, vertical integration, open access, and Open Internet proceedings to name but a few.

Starting in 1989 the cable industry deployed hybrid-fiber coax (HFC) networks that have benefitted from the large information carrying capacity of fiber optic and coaxial cable.[2] HFC networks allow cable operators to incrementally invest in new networking technologies that have significantly increased network capacity since this time.

To increase capacity cable operators generally have extended the fiber optic portion of the network closer to the home. This has occurred in incremental fashion over time, starting with a pair of fibers approaching to within a mile of several thousands households (e.g., a fiber node size of 5000) to reaching within 1000 feet of homes creating node sizes of 100 – 250 homes.

This progression of network "upgrades" extending fiber deeper into the network probably has been the largest driver of additional capacity over time. A significant body of knowledge on the incremental technological advances allowing this growth in cable network capacity can be found in the archives of the cable industry association over the past 30 years, though readers should note that these papers are often authored by cable industry vendors without peer review.[3] Likewise, due to the heavily regulated environment from which cable has emerged, many technical reports and studies have been produced on cable capacity that support of the public policy positions of interested parties.[4]

The topic of how the economic equation for deciding how the bandwidth has been or should be allocated over cable networks, both for new video channels within the video service as well as between different services carried over the network, has not been addressed in any great detail. While there is a presumption that the revenues associated with new channels and services need to outweigh existing revenue streams or network costs, there have been few, if any, allocation models published describing this economic calculus with any great detail.

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[2] See J. A. Chiddix and W. S. Ciciora, "Introduction of optical fiber transmission technology into existing cable television networks and its impact on the consumer electronics interface," in *IEEE Transactions on Consumer Electronics*, vol. 35, no. 2, pp. 51-62, May 1989.

[3] The technical papers from the National Cable and Telecommunications Association (NCTA) can be found at http://www.nctatechnicalpapers.com/.

[4] See, for example, Steven J. Crowley, "Capacity Trends in Direct Broadcast Satellite and Cable Television Services" prepared by the National Association of Broadcasters, et al, October 8, 2013.

Economic Framework for Cable Network Allocation

As technology has evolved over time, what have been the incentives for cable operators in making decisions to carry new additional television channels or to add new services? Technological innovation and progress clearly have expanded cable network capacity. Yet as we will see, while this growth in capacity may have reduced the opportunity cost of adding additional content, it has not simplified the economic calculus for making this decision. If anything, the growing convergence in the digital transport of services serves to reduce the transparency and ability to precisely predict the impact, or opportunity cost of each additional video channel or new service carried by the network.

This section of the paper reviews how the economic framework for adding cable channels has evolved over the past 20 years, starting with analog television channels in the late 1990s.

Good Old Days: Analog Television Economics

A little over 20 years ago, most cable operators were still only offering their customers cable television service based on analog technology. The decision facing these cable operators to introduce a single, analog television channel could then be illustrated using a relatively straightforward economic framework that compared the cost of the network to the anticipated revenues of each channel.

In an effort to develop a framework reflecting this situation, we assume each channel occupies a fixed 6 MHz of spectrum. Thus, the number of channel slots can be estimated to be the overall downstream capacity divided by 6 MHz.[5] If we assume the network is used only for analog television services, then the total fixed and operating costs of the network is fully allocated to the television service. Dividing the total annualized network cost (by annualizing all fixed costs and then summing with all the operating costs) by the total number of channels supported by the network capacity gives the average total cost per channel. This figure represents a rough benchmark that the revenues of each channel need to exceed to justify the cost of network capacity to support each channel.

On the revenue side, each channel generates subscription revenues from the customers of the cable operators and advertising revenues from advertisers. The net total from these two revenue streams should offset the cost of network transport. Each channel, of course, generates different subscription and advertising revenues based upon the popularity and genre of its programming. Due to this variation it is possible to rank the different cable channels according to the generated amount of net revenue.

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[5] For example, a low-split 550 MHz cable system typically used the frequencies between 54 – 550 MHz for downstream transmissions, for a total of 82 channels.

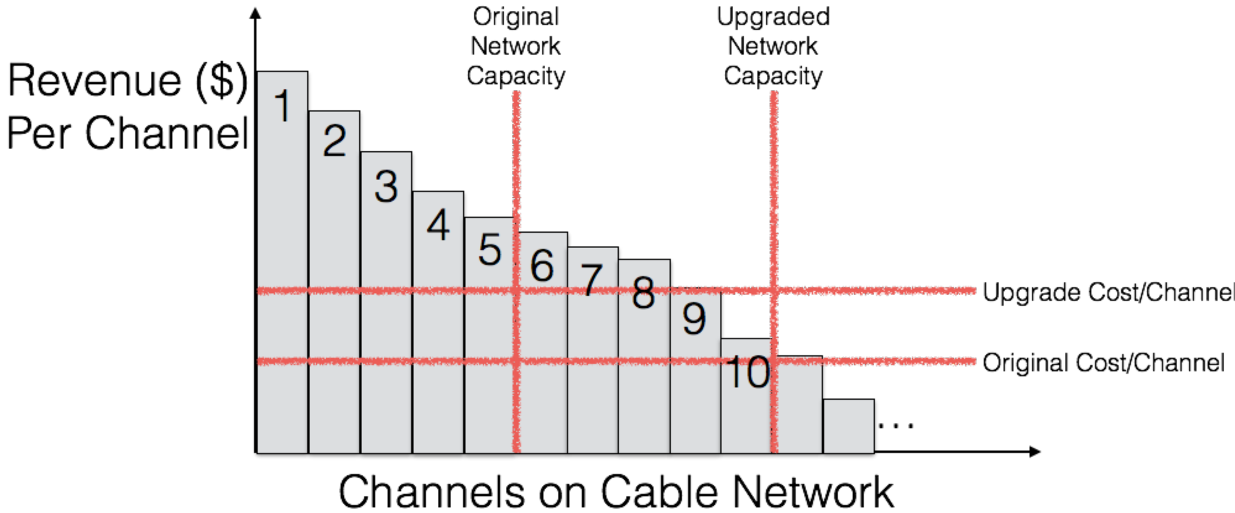

Figure 1: Allocation Framework for Analog Video

Figure 1 provides an illustration of this rank-ordering framework. In this hypothetical scenario, the net revenues of channels carried by the cable network are illustrated, with Channel 1 generating the most revenues, followed by Channel 2, *etc*. The total cost per channel of the network establishes a cost benchmark that the net revenues of all carried channels should exceed. In this case, the original network capacity is 5 channels and the network carries the set of 5 channels that exceed the average cost per channel benchmark and offer the most revenues per channel. Note that some channels may provide revenues that exceed the cost benchmark but are not part of the video service due to a lack of network capacity. How does the operator decide to expand capacity to carry more channels? Adding cable network capacity is usually "lumpy" in that cable operators cannot sequentially add a single channel as needed but instead must increase capacity through network "upgrades" that add 30 or more 6 MHz channels to the overall capacity (e.g., adding 200 MHz of network capacity that moves a 550 MHz network to 750 MHz). The network upgrade cost establishes a new cost benchmark that identifies the channels to be added to the video service.[6]

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[6] Note the assumption in Figure 1 that the network cost per channel benchmark increases with the upgrade. This may not occur in all cases. Generally speaking with cable networks, as the network capacity increases closer to the home, the cost benchmark also will increase.

Complexity Introduced: Digital Television

The transition from analog television to digital television over cable networks, as well as the ability to compress digital video streams to reduce the overall bit rate, has been well covered in numerous scholarly works over the past 20 years and will not be covered here. What is important for this analysis is to list the technical characteristics of digital television and encoding which have caused major changes in the network economics of cable networks:

1. Can support improved picture quality through the introduction of standard definition television (SDTV) and high definition television (HDTV) resolution formats.
2. Allows for a much higher number of video channels to be carried for every 6 MHz of bandwidth. Depending upon the content of each video channel, a single 6 MHz channel over cable can carry 8 – 15 SDTV or 3 – 5 HDTV programs.[7]
3. Takes advantage of new standards for encoding through the Motion Picture Experts Group (MPEG) that have been realizing a reduction of about 50% in video bit rate with every new generation of the standard (while maintaining picture quality).

What is the allocation framework given these new characteristics of video transport? During the time frame of 2000 – 2015, a major impact of digital video technology was the need to support different video formats due to the wide variation in the type of television receivers found in consumer households.

1. Legacy analog format to support the base of analog television receivers used by their customers.
2. SDTV format for the most affordable digital TV sets during the early years of this time period.
3. HDTV format for the increasing number of HDTV sets that emerged over this time period as the cost of these sets plummeted.

In the late 1990s high-speed data service emerged as a core service element for the cable "triple play" of telephone, video and broadband services. Broadband service required a separate channel allocation that has been growing steadily over time since its inception.[8]

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[7] The payload of a typical 6 MHz channel over cable using 256 QAM (Quadrature Amplitude Modulation) is roughly 38 Mbps. Thus, 10 SDTV channels could be carried at an average of 3.8 Mbps each, or 4 HDTV channels at 9.5 Mbps apiece.

[8] Most cable operators began offering telephone service during this time that required a small amount of high-speed data bandwidth. A few operators used "circuit-switched" telephone service that required separate, dedicated bandwidth to operate, but this approach was quickly scrapped in favor of the voice over IP (VoIP) approach employed today.

We can apply the same rank-ordering framework described above for the analog scenario in Figure 1, though we require some modifications due to the different transport characteristics of digital television. The network now is used for analog and digital television services, along with telephone and broadband service. The common fixed and operating costs of the network must therefore be shared across all these services. Dividing the total annualized network common cost allocated to each service, plus any service-specific fixed and operating costs, by the total number of channels supported by the network for the service gives the average total cost per channel.

For video services the same cost benchmark based upon the annualized cost per 6 MHz channel can be applied, though it has to be recognized that multiple video programs can be carried per 6 MHz channel. The overall impact of this is that the network cost per program, as opposed to the network cost per channel, now falls considerably depending upon the number of SDTV and HDTV programs carried per 6 MHz channel. On the revenue side each channel again generates subscription revenues from the customers of cable operators and advertising revenues from advertisers, but these revenues streams are separated based upon the technical format used by the customer (advertising is usually the same across each format). So now the net total from these revenue streams should offset the cost of network transport for all video formats.

For broadband services the network cost per channel benchmark used for video can be applied to reflect the opportunity cost for using some network capacity to carry broadband service. As long as the revenues generated by broadband service exceed the network cost per channel multiplied by the number of channels dedicated to carry broadband, then the use of the capacity is efficient as compared to using the capacity for additional video services.

Figure 2 provides an illustration of the new allocation framework as applied with the delivery of digital television over cable. In this hypothetical scenario, the network uses 70 channels to carry analog video, 15 channels to carry 150 SDTV programs, and 25 channels to carry 75 HDTV programs. This is a typical cable band plan for a 750 MHz HFC network circa 2005 – 2010. The problem here for the cable operator is that the revenue calculation has become much more complex. Each major cable channel might be carried in three separate formats since the operator risks losing customers by not carrying each format. While the revenues per channel can be rank-ordered within each format category, and then summed across the three categories, the operator may have contractual constraints in being able to keep one format while eliminating another. Also note that the lower network cost per program benchmark can afford the cable operator additional opportunity to add new digital programs assuming there is enough network capacity.

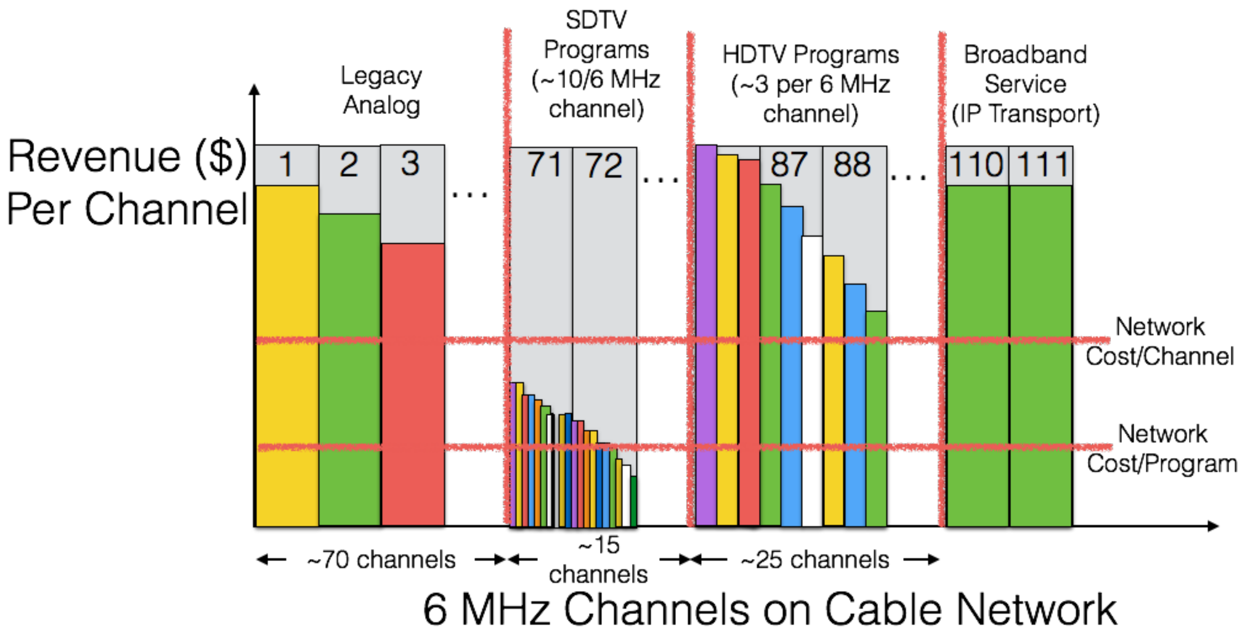

Figure 2: Allocation Framework for Analog and Digital Video

Two interesting trends emerged during this time frame that further changed the network economics and shifted the overall band plan away from analog to more HDTV:

1. Low-cost digital devices allowed operators to deploy cheap digital-to-analog (DTA) adapters eliminating the need to carry the analog television format.
2. Emergence of low-cost HDTV receivers reduced the size and demand for the SDTV platform as well.

As television viewing fully migrates to HDTV over time, it would appear initially that the economic equation for video channel selection should return to a simpler state after the transition from analog television and lower use of SDTV. The problem with this view, however, is that the next format for television known as "4K" is already emerging, and the transition to IP transport from the MPEG-based QAM is occurring as well. Moreover, the amount of network capacity now required for broadband services is increasing sharply. As discussed next, the transition to IP promises to simplify some aspects of video carriage, and introduce further complexities given the flexibility afforded by IP transport.

Finally, over the past 5 years observe that the allocation for broadband service as shown in Figure 2 has expanded from 2 channels (6 MHz apiece) to 4 – 8 channels. The use of DOCSIS 3.0 channel bonding technology permits cable operators to combine up to 24 separate 6 MHz channels together to offer higher speed broadband services above 100

Mbps.[9] To make economic sense, the revenues of existing and new broadband services need to exceed the network cost per channel benchmark adjusted to reflect the additional cost of channel bonding. Note that the revenue calculation may become more complex given the flexibility of the IP platform to offer multiple sources of revenue based upon existing and new speed tiers for broadband services, advertising revenues associated with broadband services and IP transport services for businesses.

Integrated Flexibility: IP Transport

Today the migration to IP technology is fully affecting the entire video ecosystem. Video service providers are now looking to use IP transport because the IP-based networking equipment is the lowest cost and the proliferation of IP-based consumer devices makes it easier for service providers to provide video content to any device at any location and time.[10] A full description of the transition to IP for the cable architecture is beyond the scope of this paper. Instead, we will focus upon the emergence and impact of two significant emerging IP transport innovations, namely DOCSIS 3.1 and SDN/NFV network management technology. Because how these innovations will be used over cable is less well understood at this point in time, we will first explain how these technologies are being developed, and proposals for how they will be used over cable in the next 5 years.

DOCSIS 3.1: The End of 6 MHz Channelization Legacy

The latest version of the DOCSIS specification is DOCSIS 3.1.[11] Wide-scale deployment of this new technology is likely to commence in 2017.[12] DOCSIS 3.1 contains several interface changes that hold significant implications for the amount of channel capacity available for IP transport over cable networks. The key changes relevant to this study are listed below:

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[9] For example, combining 4 256-QAM channels (38 Mbps apiece) allows cable operators to offer broadband service at speeds above 100 Mbps. See Om Malik, "Finally, 100 Mbps Everywhere (If You Have Comcast)," April 14, 2011, https://gigaom.com/2011/04/14/finally-100-mbps-everywhere-if-you-have-comcast/.

[10] The migration is underway even though the transport efficiency of IP video (less than 85%) is actually much less than MPEG-2 transport (97%) over DOCSIS. See "Streaming over HFC: MPEG-2 or IP or Both?" accessed April 22, 2016, http://www.nctatechnicalpapers.com/Paper/2000/2000-streaming-over-hfc-mpeg-2-or-ip-or-both-/download.

[11] The suite of three DOCSIS 3.1 specifications is located at www/cableabs.com. Previous DOCSIS specification versions include 1.0, 1.1, 2.0, and 3.0. DOCSIS 3.1 equipment will be backward compatible with the previous DOCSIS 3.0 version equipment.

[12] See "In D3.1 First, Comcast Goes Gig in Atlanta," *Light Reading*, 3/15/2016, accessed April 7, 2016, http://www.lightreading.com/cable/docsis/in-d31-first-comcast-goes-gig-in-atlanta/d/d-id/721876.

1. *New Modulation*. DOCSIS 3.1 uses Orthogonal Frequency Division Multiplexing (OFDM) in the downstream and Orthogonal Frequency Division Multiplexing Access (OFDMA) in the upstream. This new multiplexing approach employs separate discrete subcarriers that are only 25 or 50 KHz wide but do not require guard bands between each other or the use of 6 MHz channels. The guard bands required between OFDM subcarriers are very small as compared to legacy technology.
2. *Larger Channel Size and More Spectrum*. In fact DOCSIS 3.1 affords operators considerable flexibility to define channel size between 24 – 192 MHz in the downstream and 6.4 – 96 MHz in the upstream. The larger channel size increases multiplexing efficiency, and sharply reduces the use of spectrum as guard bands between channels.[13] The specification also increases the amount of upstream spectrum to the range of 5 – 204 MHz and downstream range of 258 – 1218 MHz (optional up to 1794 MHz).
3. *Higher Order Modulation*. The highest order modulation formats supported by DOCSIS 3.0 were 64-QAM and 256-QAM for upstream and downstream, respectively, with each delivering a payload throughput of roughly 27 Mbps and 38 Mbps over a 6 MHz channel. DOCSIS 3.1 adds up to 4096-QAM (optional up to 16384-QAM) for the downstream, and up to 1024-QAM (optional up to 4096-QAM) in the upstream. To compare, the payload throughput of 4096 QAM over 6 MHz is about 54 Mbps. DOCSIS 3.1 also adopts more powerful error coding techniques that allow more use of higher order modulation formats.
4. *Modulation Flexibility*. A key benefit of OFDM/A is that all of the subcarriers can have a different modulation order.[14] In the past, the poorest part of the worst 6 MHz channel for the high-speed data service would dictate the modulation order employed for the full service. Modulation order decreases with an increasing noise environment encountered, so the ability to work around the noisy portions of spectrum with less efficient, but more robust, subcarriers allows for substantial boost in overall network speed of up to 40%.[15]

[13] See, for example, http://www.incognito.com/blog/a-technical-guide-to-docsis-3-1-and-beyond-part-2-technical-advantages/ estimating a savings of 6% in spectrum (1.44 MHz) per 24 MHz of OFDM space through less us of spectrum for guard bands.
[14] Wikipedia defines the modulation order as the number of different symbols that can be transmitted during a fixed period using a digital communication scheme. Using this definition, a higher order modulation scheme can transmit more symbols per fixed period of time, meaning more information is transported over the communication channel.
[15] See, for example, http://www.incognito.com/blog/a-technical-guide-to-docsis-3-1-and-beyond-part-2-technical-advantages/ estimating a 35.8% improvement in network efficiency due to variable modulation profiles.

5. *Hierachical Quality of Service (HQoS)*. Historically quality of service (QoS) over DOCSIS has been defined and managed as individual service flows over the HFC network.[16] HQoS enables cable operators to aggregate together groups of service flows to better manage and control QoS policies at the aggregate level. This permits, for example, the network operator to assure fairness for each of the different aggregated service flows (i.e., each aggregated service flow receives a percentage of overall traffic). A key use case for HQoS is the ability to manage the per subscriber aggregate QoS traffic.[17] With the migration to all IP, subscribers will have several different flows to support their different applications (e.g., different video, voice and video conferencing applications), each of which might have QoS associated with the service flow. HQoS permits the operator to better manage the allocation of network resources in the event of contention.[18]

The upshot of migration to DOCSIS 3.1 is that cable operators will have much more IP capacity on their networks to support the migration of video services to IP transport. IP-based video services over cable will still employ the same MPEG encoding, but will use different transport protocols developed to stream video programs over the Internet. Most major cable operators are choosing to deploy DOCSIS 3.1 in deep fiber configurations. This very likely could be the last incremental, major upgrade to HFC plant before fiber is extended all the way to the home.[19]

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[16] Wikipedia defines quality of service as "the overall performance of a telephony or computer network, particularly the performance seen by the users of the network." For a useful discussion of the definition of QoS and its use on the Internet, see K. C. Claffy and David D. Clark, "Adding Enhanced Services to the Internet: Lessons from History," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, September 7, 2015), http://papers.ssrn.com/abstract=2587262.

[17]See "Hierarchical QoS, The Next Step In Enhancing DOCSIS QoS Architecture - NCTA Technical Papers," accessed April 22, 2016, http://www.nctatechnicalpapers.com/Paper/2013/2013-hierarchical-qos-the-next-step-in-enhancing-docsis-qos-architecture.

[18] *Ibid*, p. 4. For example, a household might subscribe to a 20 Mbps broadband service and a separate video service with a maximum traffic rate of 9 Mbps that has higher priority. The aggregate QoS settings for the home might limit the combined traffic rate of both flows to 20 Mbps, which means the whole 20 Mbps would be available for the broadband service when the video service is not in use, but this could fall to 11 Mbps when the video service is fully active. Without an aggregate QoS limit, both services would run separately and could consume bandwidth up to 29 Mbps, which could be an inefficient use of network resources.

[19] While still early in terms of planning, some cable operators are stating that they prefer upgrading to fiber-to-the-home networks instead of deploying DOCSIS 3.1. See "Why D3.1 Isn't on Every Cableco Agenda," *Light Reading*, 3/3/2016, accessed April 7, 2016,

Coming back to how DOCSIS 3.1 might change the economic equation for allocation of cable bandwidth to different services, the following observations are important:

- The concept of a 6 MHz channel no longer applies. Very large swaths of cable spectrum (up to 192 MHz apiece) can be provisioned to deliver IP bandwidth.
- The cost benchmark for cable capacity therefore transitions from a "cost per channel or program" metric to a "cost per Mbps" measure for the *application* being carried over the network.
- The cost of IP transport is highly sensitive to the latency requirements of the application. Thus, a QoS regime will likely be necessary to prioritize the traffic needs of real-time applications. This means the cost per Mbps metric needs to reflect the anticipated level of priority required by the application.

Before applying these insights into a new economic framework for cable allocation, we also look at another important development in IP transport – the trend to software-centric networking – that will heavily influence the new model.

Network Management Using SDN and NFV

An in depth explanation of software defined networking (SDN) and network function virtualization (NFV) architecture and technology is beyond the scope of this paper.[20] The focus here is to describe how these new technologies might be applied over cable, and the implications for the economics of capacity allocation.[21]

Briefly, SDN is network management technology that moves the control of network resources (e.g., routers and switches) through a standardized interface to a new element called a "controller" providing centralized control. The abstraction of the SDN control layer between the application and network resource layers is achieved through standardized

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http://www.lightreading.com/cable/docsis/why-d31-isnt-on-every-cableco-agenda/d/d-id/721514.

[20] See, generally, ITU, "Framework of software-defined networking", ITU Recommendation Y.3300, June 2014, <http://www.itu.int/rec/T-REC-Y.3300-201406-I/en>, and ETSI, "Network Functions Virtualisation (NFV): Architectural Framework", ETSI GS NFV 002, October 2013, <http://www.etsi.org/deliver/etsi_gs/nfv/001_099/002/01.01.01_60/gs_nfv002v010101p.pdf>.

[21] Some of the information in this section was derived from research conducted during the Fall 2015 semester by Gauri Kanitkar, a master's student in the Interdisciplinary Telecom Program at CU Boulder.

interfaces or application programming interfaces (APIs).[22] Some key benefits anticipated by using SDN include:

- *Lower cost equipment*. Networking equipment will be lower cost due to simpler devices without the need for control logic. SDN utilizes so-called “white box switches” that are commodity devices customized for SDN applications and not related to any costly proprietary brand or functionality. For cable, this benefit is available for use of SDN technology in the backbone and middle mile portions of their networks, but less so in the local access network where DOCSIS equipment is customized for the HFC network configuration that is a smaller, less commoditized market.

- *Ease of provisioning new services and maintenance*. New service provisioning and maintenance of network devices becomes fast and inexpensive using only downloadable and deployable software. Maintenance costs of networks are comparably less as software can be updated with minimal downtime of a network.

NFV technology decouples software from hardware, meaning that network elements no longer have to be an integrated hardware and software entity. Detachment of the software from hardware allows for hardware resources to be shared by multiple software entities, which permits better scaling and utilization of network resources overall. Using NFV, network functions are migrated from proprietary hardware to a virtual platform without performing all network functions on the hardware device. These network functions can be networking devices such as firewalls, routers and switches or networking applications like content delivery networks (CDNs) and voice over IP (VoIP). Some key benefits anticipated by using NFV include:

- *Lower cost*. NFV fundamentally changes the way networks are built by incorporating virtualization to improve capital efficiencies. Network operators can use low-cost, general-purpose servers and storage devices to provide multiple network functions using software virtualization techniques. For cable, this benefit is available for use of NFV technology mainly in the network cloud through the efficient provision of new and existing cloud services on a virtual platform. NFV helps to lower capital expenses by reducing the need for dedicated, proprietary hardware implementations;

[22] These standardized APIs removes the need for network administrators to have to learn the syntaxes for all the propriety devices. Instead, s/he can configure these devices using commonly defined API calls. Because these APIs are implemented in software, the growing usage of SDN applications is associated with the trend to “software-centric” networking.

it also helps in lower operational expenses on space, power, cooling and hardware maintenance through more efficient use of hardware.

- *Rapid deployment*. NFVs can be deployed quickly on a virtual platform while deployment of hardware equipment is time consuming. Deployment of hardware devices involves multiple steps like ordering, purchasing, deploying, configuring, and purchasing support. NFV often eliminates most of these steps.

SDN and NFV technologies provide different but complementary functionalities. SDN is a technology by which the control plane and forwarding plane of devices can be separated. This gives benefits like centralization of control and ability to program the behavior of devices using well-known APIs. NFV is a technology that is used to speed up the deployment of network services and help in reducing capital and operating expenses. NFV technology aims at consolidating networking devices into industry standard high volume servers and deploying them in data centers and customer premises.

In summary, the ways that SDN and NFV are likely to change the economic equation for allocation of cable bandwidth are the following:

- Rapid deployment of new cloud services can be achieved at very low cost.
- Agile support and deployment of new IP services and applications such as video, telephony and video conferencing featuring different levels of quality of service are possible.
- New network management techniques that optimize the speed of broadband service to each customer based upon the quality of the received signal.[23] Depending upon implementation, the amount of spectrum consumed by each customer to receive a given level of speed could vary depending upon the geographic location and quality of the nearby network. Alternatively, the overall speed available to cable broadband customers theoretically could vary depending upon these same factors, similar to the speeds provided by ADSL today.

[23] See Saifur Rahman, Joe Solomon, Jason Schnitzer, and David Early, "DOCSIS 3.1 Overdrive: Dynamic Optimization Using a Programmable Physical Layer," forthcoming INTX paper, May 2016.

- Use of congestion management techniques that implement dynamic, rule-based policy controls to manage access to network resources during times of network congestion.[24]

Figure 3 shows how the cable allocation may evolve with the use of DOCSIS 3.1, SDN and NFV technologies. Now, the 750 MHz HFC network in this hypothetical scenario is fully digital, with 32 channels (each 6 MHz) carrying legacy HDTV video service and the remainder of the network being used for IP transport to send streaming video, telephony and video conferencing applications, as well as high-speed broadband services. Other notable differences in the model:

1. The revenue metric is changed from $/channel to $/MHz to reflect the decreasing use of 6-MHz channelization in the band plan.
2. The cost benchmark for HDTV channels remains as the average cost per 6 MHz channel for the portion of bandwidth used for HDTV service, as in prior models. More advanced compression and more broadband service capacity will likely further lower the cost benchmark for video programs to facilitate a large number of broadcast and interactive video service options.
3. Using DOCSIS 3.1 the broadband service portion of the spectrum is no longer divided into 6 MHz channels, and instead is split into large blocks of spectrum up to 192 MHz in size. Such a block size can carry between 1.2 – 1.7 Gbps depending upon the modulation order.
4. Lacking 6 MHz channelization, the cost benchmark for the broadband service block of spectrum is the annualized average cost per MHz for the portion of bandwidth used for broadband service. Note, however, that this metric presumes all costs associated with providing broadband service at all times, including the busy hour of usage. To the extent all traffic is best effort, this would distribute IP transport costs uniformly across all applications creating traffic. Because QoS is applied to some traffic, the true cost of QoS could be underestimated using this metric. In this case a metric that allocates cost across the aggregated service flows would be a more accurate reflection of the distribution of IP transport costs across applications.

[24] See Samuel Patel, Mohammad Chowdhury, Jason Schnitzer, and David Early, "SDN Ground Truth: Implementing a Massive Scale Programmable DOCSIS Network," forthcoming INTX paper, May 2016.

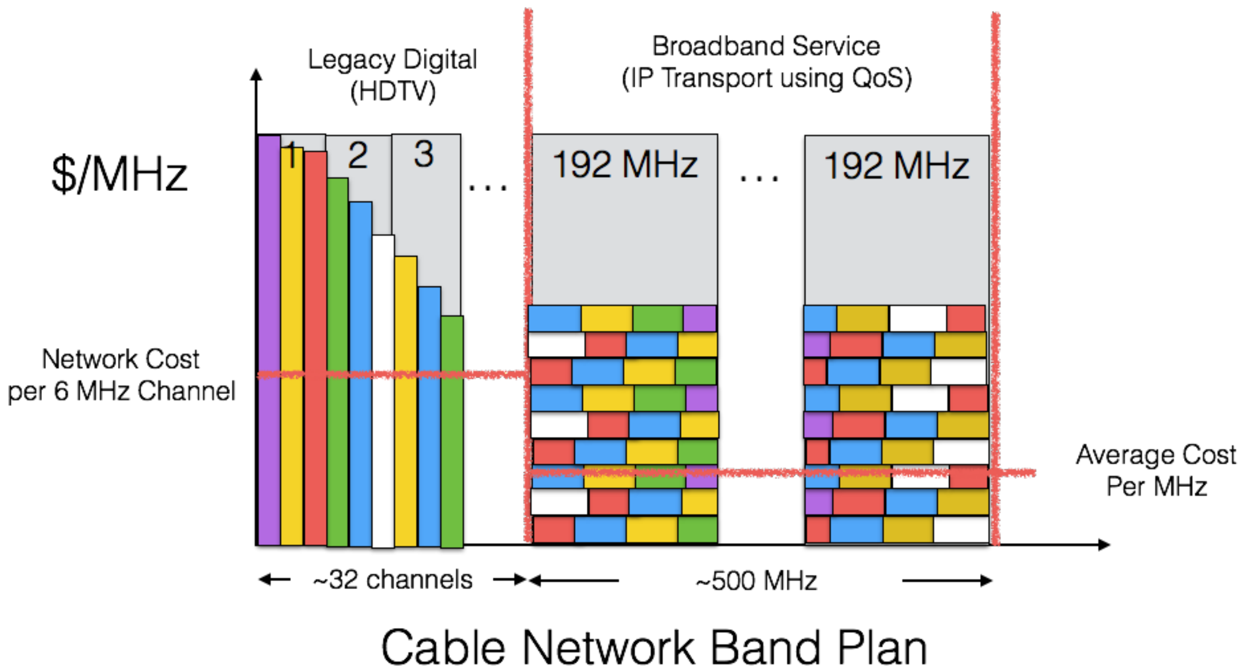

Figure 3: Allocation Framework for IP Transport

In the long run most cable operators expect to migrate to an "all IP" network platform where all network capacity uses IP transport using QoS to differentiate service flows amongst the different applications carried over the network. In this scenario the cable allocation model becomes simpler in that it uniformly consists of only IP transport, but simultaneously more complex in the management of network resources according to the level of priority afforded each service flow being carried over the IP network. This will lead to the creation of a "public" Internet as well as "private" Internet transport over the same network, sometimes with traffic from both categories being carried over the same networking equipment. How much QoS is utilized and serves as a differentiator in consumer experiences will depend upon the amount of congestion experienced on the network.

This analysis illustrates how more efficient IP transport using DOCSIS 3.1 and the new network management technologies of SDN and NFV will facilitate changes in the services and applications being carried over local access networks providing residential broadband services. From a policy perspective, the primary guideposts in place today to direct this transition can be found in the 2015 Open Internet Order, which we turn to discuss now to better understand the policy implications of the new network economics likely to emerge over cable networks over the next 5 years.

Public Policy Implications

This examination of the evolution of how capacity is allocated over cable networks over the past 50 years has been instructive by establishing how the network economics associated with cable networks is largely driven by underlying video and transport technologies. Using a simple model, this analysis showed how the economic calculus for adding new television channels and services has evolved with the transition from analog to digital video formats, followed by the current transition to IP transport. Going forward, the cable networks are migrating to become a single, shared IP "pipeline" with the use of QoS to differentiate, or prioritize, the many different service flows being carried over the network. Modern network management technologies such as SDN and NFV are moving to implement this vision with highly agile and dynamic software-centric solutions.

What are the public policy implications of this transition? Claffy and Clark in large part have provided many insights to this question, beginning with the notion that network neutrality emerged in part out of concerns that QoS can benefit services with stringent transport requirements, though potentially at the expense of other service flows on the network.[25] Claffy and Clark further provide an overview of the general policy issues generated by the use of QoS over the Internet in the current environment. Within the context of this study, some of these issues include:

- Identification of the potential incentive by network operators to defer investment in overall broadband capacity in order to grow revenues for managed services that will work better using QoS in the face of congestion. [26]
- The need for transparency in the application of reasonable network management techniques through disclosure and evaluation of the risks and benefits associated with QoS. [27]
- Identification of the FCC's prohibition on paid priority in the 2015 Open Internet order, noting the potential problem for QoS tools to be used mostly on private networks since it cannot be used on the public internet due to this ban. [28]

Building upon Claffy and Clark's discussion, this paper looks at three policy topics upon which this analysis provides some unique insights including: 1) the implications of the increasing migration of video to IP, 2) the need for clearer definition of services using QoS and 3) overall management of public Internet congestion.

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[25]See Claffy and Clark, *op. cit.*, p. 17-18.
[26]See Claffy and Clark, *op. cit.*, p. 18.
[27]See Claffy and Clark, *op. cit.*, p. 20.
[28]See Claffy and Clark, *op. cit.*, p. 21-22.

Video over IP

Two main drivers of the transition of video services to IP transport will be: 1) through use of over-the-top (OTT) services and applications delivered over the public Internet, and 2) increasing use of IP video by Multichannel Video Programming Distributors (MVPDs) to transport their current video services currently using the IP protocol in private networks.

OTT services use IP-based streaming video protocols over broadband Internet access service (BIAS) to reach customers. Most streaming video applications use adaptive streaming protocols, meaning that the speed of the download is adjusted to best utilize the bandwidth available over the path of connection. If the application estimates additional bandwidth is available in the network path, it will switch to a higher-resolution copy of the video that will use more bandwidth but also improve the user experience; alternatively, if the application senses network congestion over its path, it will shift to a lower resolution copy to reduce the speed of the download but also improve the user experience by reducing buffering delays.[29] One upshot of the heavy use of adaptive streaming protocols is that it makes it very difficult for the network operator to manage network congestion given the constant adjustments occurring in the streaming services. This may create network management issues over time as networks become more congested due to increasing video usage.

IP video services use IP transport to carry the video to cable customers. The reason that cable operators are moving this direction is that the cost advantages of IP transport are now making this technology the lowest cost option to build and operate. No major cable operators are providing pure IP video today for all their cable television services, so it is not clear how this service will be offered. The operator will need to consider how it may offer the service without violating the Open Internet rules. One model that it might follow could be the "specialized services" category defined in FCC's 2010 Open Internet order. Specialized services are defined to be services that are not part of BIAS, and the migration of the existing video platform to IP transport might fit this definition if appropriately disclosed to the FCC.[30] The FCC has indicated that it would oppose a specialized service if

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[29] In adaptive streaming, if the video player determines that the download speed over the network is greater than the bit rate of the segment downloaded, it will request the next higher bit rate segments. If the client finds the download speed for a segment is lower than the bit rate for the segment, it will request a lower bit rate segment.

[30] The FCC's example of a specialized service is the VoIP service provided by cable operators. Cable VoIP typically applies QoS for telephone calls using the same DOCSIS infrastructure used for broadband service. The telephone application does require some different network facilities to manage the phone call, though transport facilities are generally shared to some degree.

it finds that the service is "providing the functional equivalent of broadband Internet access service or is being used to evade the open Internet rules."[31]

With all the trends in technology pointing to a future migration of most video services to IP transport, some additional policy implications become clear:

1. The cost of building and maintaining IP networks will likely be the lowest cost option for providing video services. This will cause an increasing number of MVPDs to transition to IP to transport their video services, while at the same time many OTT video services will be using BIAS to deliver their services, often from BIAS offered by the same MVPD. The FCC states that the 2015 Open Internet rules only apply to IP services that travel over BIAS, which will increasingly include OTT video services. The potential for confusion among policy makers, industry and consumers seems high given these circumstances.
2. Refinement to the reasonable network management standard may need to occur due to the increasing use of OTT video services employing adaptive video streaming protocols. The benefit of these protocols is that they permit OTT providers to maximize the viewing quality of their video programs in automated fashion. The downside is that the protocols can have a significant demand for bandwidth that can be inefficient.[32] We can anticipate the OTT and MVPD space to become more competitive over time as the growing popularity of OTT services continues. As this competition intensifies, it is not unreasonable to anticipate this the quality of experience of streaming video consumers will be an area of concern. The key issue to resolve will be to establish expectations for the expected service level agreement (SLA) associated with best-effort BIAS.

Defining QoS-Based Services

If the forecasted migration to all IP occurs over time as described above, then IP transport technology will be used as the dominant transport platform for cable networks over the next decade. Whether or not the use of QoS will be a prominent attribute of this platform will depend upon two conditions: 1) the amount of congestion experienced as part of BIAS, and 2) the ability of the operators to deploy specialized services as described above.

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[31] See 2015 Open Internet Order, *op. cit.*, para. 35.

[32] For example, a lab experiment I give students is to measure the download speed of a popular OTT service to different devices including a smartphone, tablet, and 50" HDTV. The students find that the download speed is the same for all devices, even though the large variation in screen size means that the smartphone could be delivered a much lower speed copy of the video program than the HDTV without any impact on the viewing experience.

With the continuing growth in popularity of OTT video services driving more viewing of videos over BIAS, it will be a safe assumption to forecast continuing strong growth in broadband usage for the foreseeable future.

Whether or not specialized services offer a good model going forward is an open question. At the heart of the issue is the definition of specialized services – namely, that "they are not BIAS." If one interprets this to mean to limit a specialized service to a specific IP service or application, then it conceivably would permit the cable operator to deploy a number of different specialized services, each carrying a specific service flow associated with a disclosed service or application such as broadcast video, on-demand video and network DVR services. Each specialized service would have a prioritized QoS attached to its service flow of packets over the network.

There may be a further issue to address, however, if this approach were to occur. Given the paid prioritization ban that would prevent the operator from receiving any revenues for specialized services from third parties (and this type of IP transport would not be given away), then the only likely beneficiary from specialized services would be the operator itself. The regulations themselves would create this outcome by preventing any market to form for IP transport using QoS. To avoid this outcome, further definition of how QoS can fit within the definition of BIAS needs to occur.

Avoiding Public Internet Congestion

Claffy and Clark raise a concern that the emergence of the use of IP transport for private networks or specialized services might create a "shadow" activity outside the regulated sector that may hinder policy makers' ability to respond to regulatory issues in ways that may cast the public Internet as a "place for activities of lower importance and lower profitability". [33]

These concerns are to be taken seriously if we are to insure the continued benefits of the Open Internet virtuous cycle. QoS functionality is an important technical differentiator in user experience in congested network conditions. The benefits of QoS have to be balanced against the implied priority of usage for a service flow over other service flows. To date, the FCC has yet to wrestle with this specific question, and as mentioned earlier there is some concern that the paid prioritization ban could have some unintended consequences on the development of specialized services or private networks.

[33] See Claffy and Clark, *op. cit.*, p. 22.

To date, the FCC has largely left the provision and interconnection of IP transport services to market forces. The result of this approach has been the establishment of a successful IP transport infrastructure for the United States, though one missing element of the system has been the establishment of a functioning end-to-end QoS regime. As a result, to optimize control of network resources, some broadband application providers have built their own private content distribution networks (CDNs) in part to give their users the best possible experience for their applications.[34] In effect, this way is a topological approach to managing network quality by avoiding a long series of network interconnection points that might not support QoS in a unified or efficient manner. For these providers, CDNs provide complete control of the resource policies of the network.

What this analysis shows is that the transition to IP video may serve as the case study that forces the FCC to consider the treatment of QoS under the Open Internet regulatory framework.[35] IP transport and network management technologies have advanced far enough to start serious planning for the migration of cable to a fully IP transport network. The transition to video will also cause broadband usage to dramatically increase such that the broadband capacity will continue to experience some congestion pressure.

To meet this migration, an Open Internet framework that recognizes the benefits of openness and QoS will be needed. Edge providers and broadband customers should be reassured through disclosure and transparency rules that the Open Internet will continue; likewise network operators should be able to deploy efficient IP technology to carry their services without fear of regulation or concern that they are undermining the Open Internet with these actions.

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[34] See David P. Reed, Donny Warbritton, and Douglas Sicker, "Current Trends and Controversies in Internet Peering and Transit: Implications for the Future Evolution of the Internet," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, August 20, 2014), http://papers.ssrn.com/abstract=2418770.

[35] Indeed, this process might already have started as the FCC sent letters to Comcast and T-Mobile to learn more about their "zero-rating" video services in January of 2016. See Jon Brodkin, "FCC Had 'productive' Net Neutrality Talks with Comcast and T-Mobile," *Ars Technica*, January 15, 2016, http://arstechnica.com/business/2016/01/fcc-had-productive-net-neutrality-talks-with-comcast-att-t-mobile/.

Size Effects and Bargaining Power in the Multichannel Television Industry

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Abstract

We quantify how bargaining power derived from firm size affects the analysis of downstream mergers and the profitability of new downstream entrants. We estimate an empirical model of the television industry which features negotiations between upstream content and downstream distributors of varying size. We estimate that large distributors like Comcast are able negotiate about 25% lower content fees than smaller downstream firms. We evaluate the short-run welfare effects of several large proposed or consummated mergers. In conjunction, we assess the degree to which size based bargaining power creates contracts which are a barrier to entry for new distribution firms.

Keywords: bilateral oligopoly, multilateral bargaining, barriers to entry, wholesale price discrimination, merger analysis

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"It is the single biggest impediment [to Google Fiber's deployment]. [Video content] is the single biggest piece of our cost structure. We operate at a very significant difference than incumbents we compete against. We may be paying in some markets double what incumbents are paying for the same programming."[1]

– Milo Medin, Head of Google Fiber, 2014

1 Introduction

This paper quantifies the effect of size-based bargaining power on the welfare effects of mergers and the profitability of new entrants in the multichannel television industry. Over the past decade, the industry has seen significant new entry into wire-based distribution networks by Verizon, AT&T, Google, as well as actual and rumors of entry into over-the-top (OTT) streaming Internet video packages by Sony, Intel, Amazon, and Apple. Simultaneously, there has been a wave of consolidation involving existing distributors. In 2014 and 2015, Comcast sought regulatory approval for its $45B acquisition of Time Warner Cable, AT&T sought and received regulatory approval for its $49B acquisition of DirecTV, Charter Communications made a $55B bid for Time Warner Cable[2] and Brighthouse Networks, and Altice Communications acquired Suddenlink Communications for $9B and sought regulatory approval for its $18B acquisition of Cablevision.

The existence of size-based price discrimination in content fees derived from size-based bargaining leverage is central to understanding both the entry and the consolidation episodes in the downstream distribution segment of this industry. With respect to entry, size-based bargaining power creates a barrier to entry for new entrants who, being necessarily small at the time of entry, face a cost disadvantage relative to incumbents. With respect to consolidation, size-based bargaining power generates a natural marginal cost efficiency from downstream mergers by reducing the cost of upstream content to the merging parties.[3] The two effects also interact. To the extent that downstream consolidation increases the bargaining power of the merging entity, new entrants face a larger

[1] `https://www.washingtonpost.com/news/the-switch/wp/2014/10/06/video-is-holding-google-fiber-back/`

[2] This bid followed Comcast dropping its bid for Time Warner Cable in the face of regulatory scrutiny.

[3] Whether this cost reduction is associated with a monopsonistic distortion in quality is important for assessing whether these cost reductions represent a social efficiency. In this industry, the marginal cost of serving content is negligible. However, there may be effects on the introduction or quality of content which are outside the scope of our current analysis.

disadvantage than absent the consolidation. Quantifying these effects is important for policy makers deciding on whether to approve mergers or to regulate wholesale price discrimination.

To carry out the analysis, we add size-based bargaining power into a model of the industry that accounts for consumer viewership of channels, consumer subscriptions to cable and satellite distributors, pricing by cable and satellite distributors, and bilaterally oligopolistic negotiations between content and distribution over the terms of carriage following Crawford and Yurukoglu (2012) and Crawford et al. (2015). On the consumer side, households with heterogenous tastes for channels allocate their time into viewing the channels to which they have access. The households trade-off the value created from viewership against price and other characteristics to choose a distributor to subscribe to, or not to subscribe to subscription television. The distributors set prices and negotiate with the channels over the per-subscriber fee they pay for offering their subscribers access to the channel under negotiation. We parameterize the bargaining parameters to depend on the identity of the content provider, the overall size of the downstream firm as measured by total subscribers, and a time trend.

While we directly parameterize the bargaining parameters to depend on size, in Section 3.3.1, we review a theory due to Katz (1987) based on cost advantages in backwards integrating into content that would generate such an effect. We also present descriptive empirical evidence on the existence of size effects. Our formulation directly parameterizes the bargaining parameters for simplicity. The estimated bargaining parameter effects should be interpreted as a reduced form for the larger model featuring the possibility of entry into specific programming niches by distributors in the case of disagreement, or any other economy of scale in seeking alternative supply. This approach is analogous to interpreting residuals or firm effects in production function estimation as productivity where the productivity measure is a reduced form for effects such as management practices or un-modeled input quality differences.

We estimate all the model parameters jointly by the generalized method of moments to match observed ratings by channel, observed distributor market shares, observed average input costs, survey data on programming costs for small and large distributors, and observed margins of video revenue over programming costs reported in publicly available financial reports for a subset of firms. The degree of size advantage in negotiations is a key outcome of the estimation. The estimated size of the effect is such that Comcast, the largest firm with 23 million subscribers in 2010, is able to negotiate fees that are about

25% lower than smaller downstream firms such as Cablevision with 3 million subscribers. The observed ratios of programming costs to video revenue are particularly informative for this estimate. In the raw data, we see that larger distributors have lower ratios of programming costs to video revenues. If all distributors offered the same content and quality and faced the same demand conditions, this would be direct evidence of size-based bargaining power. We use the demand, oligopoly pricing, and bargaining model in conjunction with these data to account for quality and content offering and demand differences and recover the implied size-induced bargaining advantage.

We use the estimated model in 2010 to simulate several large mergers in the industry: the proposed-then-aborted Comcast acquisition of Time Warner Cable, the Charter acquisition of Time Warner Cable, and the consummated acquisition of DirecTV by AT&T. The key innovation in these merger analyses is that our model captures the marginal cost synergy achieved by increasing downstream size changing bargaining leverage. These lowered costs are passed on to consumers and must be weighed against any market power effects that arise from the merger. In the case of DirectTV-AT&T, we measure the horizontal market power effect that pushes consumer prices up.[4] We estimate that the Comcast acquisition of Time Warner Cable would have led to 9.57% lower content costs for the merged entity relative to their average prior to the merger. In turn, consumer prices would decrease by 2.45%, and consumer welfare would increase by 1.33%. Content providers are hurt as their fee revenue decreases by 6.8% in aggregate. However, some of this is partially offset by a 0.82% increase in advertising revenue due to having more subscribers in the market. In sum, total welfare increases by 0.47%.

Next, we consider the effects of size-based bargaining leverage on new entrants. The existence of size-based leverage creates a difficulty for new entrants. To achieve competitive content costs, they need to scale. However, to scale, they need competitive input costs. These concerns are real. Intel had plans for an Internet Protocol (IP)-based streaming video platform with content that is typically available in a cable television package. Industry press reports chronicle the progression from excitement around product inception[5] to struggles in content negotiations[6] to abandonment of the investment by Intel because of content costs.[7] In 2014, Brian Krzanich, CEO of Intel, described the challenges in

[4] A complete analysis should also consider the effects on investment in content, as well as any effects in other markets such as broadband provision, however these margins are outside the scope of our analysis.

[5] http://www.businessinsider.com/intels-new-iptv-might-kill-cable-2013-1

[6] http://www.fiercecable.com/story/intel-willing-pay-premium-iptv-content/2013-06-10

[7] http://www.multichannel.com/news/content/intel-lacked-volume-ott-tv-play/356602,

procuring content rights for Intel's project:

> *"When you go and play with the content guys, it's all about volume. And we come at it with no background, no experience, no volume."*

The story of Intel's aborted entry into video distribution, and the quote from Google Fiber in the epigraph suggest that size-based bargaining leverage can retard entry by new competitors which would otherwise lead to benefits for consumers from competition. To quantify these effects, we simulate the profits of Verizon and AT&T, two wire-based providers who entered the industry in 2007, with and without size-based bargaining leverage. We find that video profits for Verizon and AT&T would have been 4.79% higher if bargaining power did not depend on scale of the downstream firm. This profit increase is generated by a 8.48% reduction in marginal costs, a 2.92% decrease in average price, and an 11.37% increase in market share.

2 Related Literature

Horn and Wolinsky (1988), Hart and Tirole (1990), and McAfee and Schwartz (1994) provide theoretical foundations of business-to-business negotiations between upstream and downstream firms. Katz (1987) shows that larger downstream firms will receive better input prices when there are economies of scale to seeking alternative sources of supply. Chipty and Snyder (1999) generate size based advantages with a condition the gross surplus function created by the upstream and downstream firm trading is concave. A number of other papers explore when downstream size affects input prices, including Raskovich (2003) and Inderst and Valletti (2009). These papers provide rigor to and qualify the classical hypothesis in Galbraith (1952) that, in some circumstances, larger downstream firms can obtain lower input costs, and that this may or may not benefit society.

This paper is related to reduced form investigations of size effects in bargaining. Chipty (1995) estimates that larger downstream firms have lower marginal costs using cross-sectional data from the multichannel television industry in 1995. However, Chipty and Snyder (1999) find that advertising revenue is convex in subscribers, and use this to argue that larger buyers have worse bargaining positions in the multichannel television

http://newsroom.intel.com/community/intel_newsroom/blog/2014/01/21/verizon-to-purchase-intel-media-assets industry. Hill et al. (2015) asserts that the Department of Justice investigations during the review of the Comcast acquisition of Time Warner Cable revealed that "Across a wide range of regressions the relationship of interest was consistent and statistically significant: larger video distributors pay meaningfully lower per subscriber fees to programmers." Size effects on input prices have been documented in other industries including health insurance (Sorensen, 2003) and retail drug stores (Ellison and Snyder, 2010). Buyer power as a rationale for horizontal mergers is also a focus of the finance literature who employ cross-industry evidence (Fee and Thomas, 2004; Shahrur, 2005; Bhattacharyya and Nain, 2011).

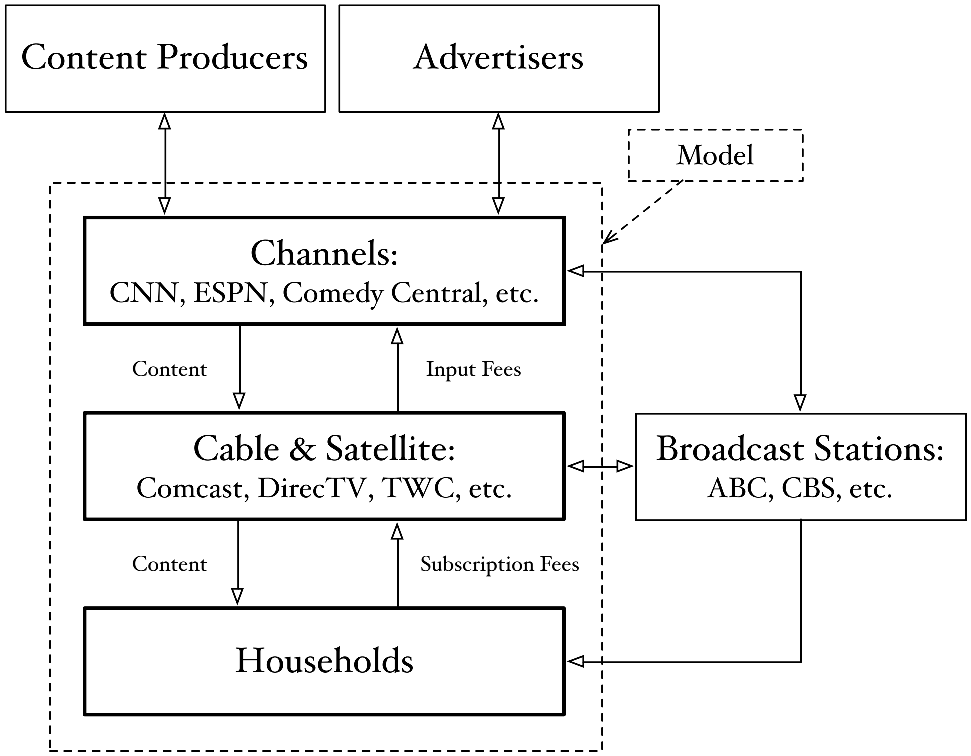
We also build upon the estimation of bilateral oligopoly models featuring business-to-business negotiations (Draganska, Klapper, and Villas-Boas, 2010; Crawford and Yurukoglu, 2012; Grennan, 2013; Gowrisankaran, Nevo, and Town, 2015; Crawford, Lee, Whinston, and Yurukoglu, 2015; Ho and Lee, 2015). Draganska et al. (2010) parameterizes the bargaining power parameter into the effects of several variables including the sizes of the negotiating firms. They find a positive effect of retailer size in the market for coffee purchased in grocery in Germany. Here we further consider the implications of size effects on downstream mergers and entrant's profits. On the methodological side, we jointly estimate the bargaining parameter and size effects with the demand parameters to improve efficiency. Crawford and Yurukoglu (2012) partially model size effects, but consider only two discrete sizes: large and small, and do not explore the implications of size effects on merger analysis or profitability of entry. Grennan (2013) analyzes the effects of banning wholesale price discrimination in the market for coronary stents, but does not consider downstream competition, size effects, nor the effect on entrants' profits. Gowrisankaran et al. (2015) consider how input markets for hospital services change when upstream market structure changes, but abstract away from downstream competition and do not consider size effects. Ho and Lee (2015) consider how input markets for hospital services change when downstream market structure changes, but do not consider size effects nor effects on new entrants.

3 Industry Overview and Data

3.1 Industry Overview

Figure 1 displays a simplified structure of the industry.

Figure 1: Multichannel Television Industry



In 2013, the four largest downstream firms by number of subscribers, Comcast, DirecTV, Dish Network, and Time Warner Cable, served approximately 60% of the total number of television households in the United States.[8] Their combined revenues amounted to almost $70 billion in 2013.[9] This revenue is generated by means of monthly subscription fees paid by the consumers of the final good to the cable and satellite companies. The downstream firms pay the negotiated input fees to the upstream firms (per subscriber per month). Advertising is another source of revenue for upstream firms.

There are three types of downstream firms: those with wire-based infrastructure (such as Comcast, Time Warner Cable, AT&T U-Verse, Verizon FiOS, etc.) satellite companies (DirecTV and Dish Network), and over-the-top streaming providers (eg Playstation Vue). The satellite companies provide nationwide service while each wire-based firm operates in a number of geographic areas. The choice set[10] and the prices are the same for every

[8] About 85% of all housing units in the United States subscribe to multichannel television.

[9] These data comes from the companies' 10k reports. For Comcast, DirecTV, and Time Warner Cable we include the revenue from the television services only. For Dish Network we take "Subscriber-related revenue."

[10] Each service provider offers several bundles of channels.

household within an area, but often differ across areas even within firm. We call each of these distinct areas served by a particular service provider a cable system. We define a local market as an intersection of several cable systems corresponding to different service providers. In other words, in each local market two different households can choose from the same set of service providers and bundles and face the same prices. Our data cover the period before the entry of OTT services.

Local markets are highly concentrated. More than 88% of the market-years in our dataset are served by three downstream firms,[11] one of the wire-based providers and the two satellite providers. In the markets served by three downstream firms, the median market share of the cable provider is 64% while the median market shares of DirecTV and Dish Network are 9% and 6% respectively.

3.2 Data

Our final data set spans the years 2000 to 2010. In total, we consider 10 distributors[12] and 37 cable channels.[13] The data we employ follow closely those used in Crawford et al. (2015). We make two key additions to the data used there. The first is the addition of individual level provider choice data from personal bank and card transactions (Yodlee). This allows us to incorporate markets with more than one wire-based distributor so that we can analyze the entry of Verizon and AT&T. The second is to employ data on programming cost differences from annual reports filed to the SEC to measure video programming costs against video programming revenue and from survey data by SNL. These provide key moments for estimating a bargaining size effect for distributors.

3.2.1 Downstream Market Data

The downstream market data includes quantities (the number of subscribers to each service providers in each marker), downstream prices, product characteristics (the list of

[11] Among the remaining markets, just over 10% are served by four downstream companies.

[12] Comcast, Time Warner Cable (TWC), Charter Communications, Cablevision, Cox Communications, RCN Corporation, Verizon FiOS, AT&T U-Verse, DirecTV, and Dish Network. The rest of the distributors are aggregated into an additional downstream firm.

[13] ABC Family Channel, American Movie Classics AMC, Animal Planet, Arts Entertainment, BET, Bravo, Cartoon Network, CMT, CNBC, CNN, Comedy Central, Discovery Channel, Disney Channel, E! Entertainment TV, ESPN, ESPN 2, ESPN Classic Sports, Food Network, Fox News Channel, FX, Golf Channel, Hallmark Channel, HGTV, History Channel, Lifetime, MSNBC, MTV, Nickelodeon, SyFy, TBS, TLC, truTV, Turner Classic Movies, TNT, USA, VH1, and Weather Channel.

channels offered by each bundle), markup data, and channel viewership data. We also use the state-specific satellite tax as a price instrument.

Quantities come from Nielsen FOCUS dataset (2000–2010), survey data from Mediamark Research & Intelligence[14] (2000–2007) and Simmons (2008–2010), and individual bank and card transaction data from Yodlee (2011–2013).[15] We add up the subscribers to all bundles offered by a particular service provider focusing on the downstream firm choice rather than bundle choice.[16] The computed market shares from Nielsen FOCUS and the surveys are averaged whenever the number of subscribers to each service provider in the market in that year exceeds 40 in the survey data. Nielsen FOCUS, MRI, and Simmons report the total number of subscribers to each bundle in each system. Therefore, when a system contains several markets (i.e. when two or more systems overlap) it is impossible to say how many households subscribe to each service provider in each market. For this reason, Crawford and Yurukoglu (2012) and Crawford, Lee, Whinston, and Yurukoglu (2015) limit their analysis to the non-overlapping systems which reduces the observed effect of direct downstream competition. We add the individual level data from Yodlee to compute the number of subscribers to each service provider in each zip code for years 2006–2010.

Yodlee is a bank and card transaction aggregator that serves both individual customers and banks. The dataset contains bank and card transactions of more than 5 million individuals.[17] There are no individual level characteristics in the Yodlee dataset. However, each transaction has a field that contains the location of the merchant. We estimate the zip code where a particular Yodlee member lives as the zip code of the most popular grocery store among those visited by this individual during the current year. The assumption is that even if the estimated zip code does not coincide with the actual zip code where the person lives, they belong to the same cable market. Then, based on the payments for cable and satellite services we estimate the person's service provider.[18]

[14]Also referred to as MRI.

[15]Though our final sample only spans the years 2000-2010, the Yodlee data is combined with national subscriber data and assumptions which we detail to help estimate market shares in relevant years.

[16]Henceforth we use "firm" and "bundle" interchangeably when referring to a downstream firm.

[17]Selection bias may be an issue. However, some of the corporate clients of Yodlee dump all of their customers' transactions into the system which may mitigate the selection problem.

[18]We limit our attention to those individuals who pay more than $500 per year for utilities (assuming that these people are the heads of their households) and those who have both bank and card transactions in the Yodlee dataset.

We have Yodlee data for years 2011–2013.[19] To use these data to aid the estimation the quantities for 2006–2010 we take the quantities in 2012 and interpolate them backwards. We assume that if downstream firm f entered zip code k in year t, the number of subscribers to firm f in this zip code in year $t + s$ is $q_{fkt}(1 + r_{f1}) \dots (1 + r_{fs})$, where $r_{f\tau}$ are assumed to be the same across zip codes. We estimate the initial quantities, q_{fkt}, and the growth rates, $r_{f\tau}$, using the national subscriber numbers and the zip code level numbers for 2012. Appendix B provides details of this procedure.

We compute the total number of households in each market using 2010 Census data.[20]

The downstream prices come from several sources including manual searches on the Internet archive (`http://archive.org/web/`), newspaper archives, archives of service providers' "rate cards" and the TNS Bill Harvesting database.[21] The TNS data set also provides the state-specific satellite tax from which we use within-state-over-time changes as an instrumental variable for price. Service providers usually offer three different bundles: (i) a limited basic bundle which offers the broadcast stations available over-the-air, (ii) an expanded basic bundle that contains the most popular cable channels, and (iii) a digital bundle that offers additional channels. The prices and bundle compositions (from the Nielsen dataset) that we use are those of the expanded basic bundle which is the most popular type of service.

We compute the markups using the distributors' 10k financial reports publicly available on the companies' websites. Comcast, Time Warner Cable, Charter, Suddenlink, Cox, DirecTV, and Dish Network separated out their video programming revenue and their video programming costs for various years in our time sample.

The viewership data (that contains for each channel the fraction of households that watches this channel and the average watching time) comes from MRI (2000–2007), Simmons (2008–2010), and Nielsen (2000–2010). When several sources are available, we use the average ratings.

Tables 10–13 in the Appendix report some of the descriptive statistics of the downstream market data.

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[19] We also have the data for the second half of 2010, but it is less reliable due to the limited number of observations.

[20] The number of households in each zip code is assumed to be fixed in 2000–2010.

[21] The TNS Bill Harvesting database contains households' cable and satellite expenditures. When prices from the web archive, newspapers and "rate cards" are unavailable, we use the mean expenditure whenever the number of respondents attributed to a particular cable system in that year exceeds 5.

3.2.2 Upstream Market Data

The upstream market data contains the input fees paid by the downstream firms to the upstream firms and the advertising revenues per subscriber. Both are taken from the SNL Kagan database.

We observe the input fees paid to each channel in each year from 2000 to 2010 averaged across service providers.

The aggregate advertising revenue (of each channel in each year) is divided by the total number of households that have access to the channel multiplied by 12 to obtain the average advertising revenue per subscriber per month.

Tables 13–14 in the Appendix report the summary statistics for the upstream market data.

3.3 Where do Size Effects Come from in Multichannel Television?

In this section, we make two related points. First, we use empirical and institutional evidence to argue that size effects in negotiations are the reality in the multichannel television industry. As the actual contracts are confidential and the SNL Kagan data do not break down channel subscriber fee revenue by downstream firm, we must infer size effects from publicly available data such as these. Second, we discuss the theory of buyer power arising from size which is plausible for this industry.

3.3.1 Preliminary Evidence on the Existence of Size Effects

First, previous studies (Crawford and Yurukoglu, 2012; Chipty, 1995) estimate that larger downstream firms have lower marginal costs. The main evidence for these findings is that prices are lower for larger downstream firms, conditional on measures of quality. As input costs for programming are the largest component of marginal costs, this suggests that input costs are lower for larger downstream firms.

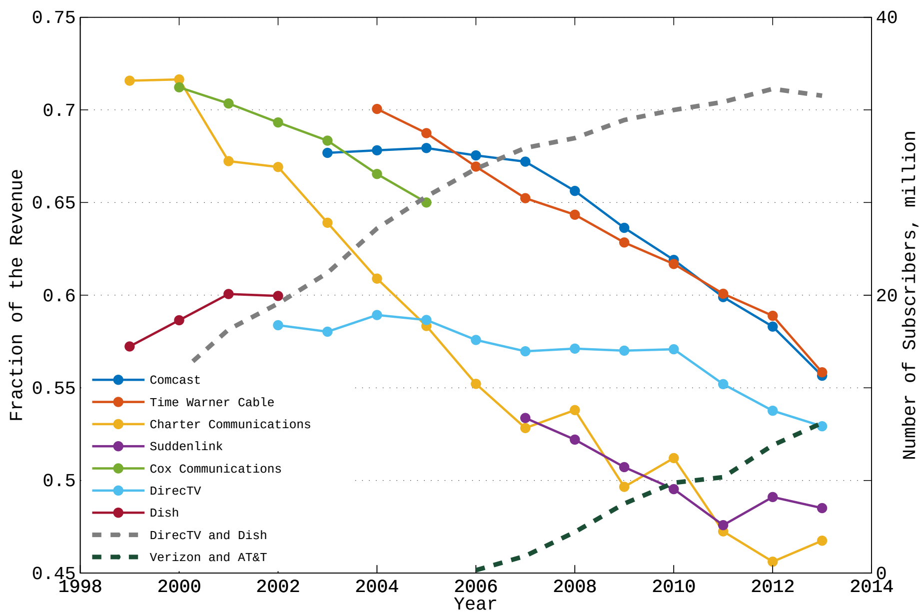
As a second piece of preliminary evidence, we examine data on video revenues and video programming costs for publicly traded downstream firms. While our model later accounts for differences in demand conditions, channels offered, and market power amongst these firms, the raw comparisons are suggestive. Figure 2, using the data from the firms' financial reports, plots the downstream markups (the left vertical axis) measured as

$$\text{Markup} = \frac{\text{Revenue} - \text{Programming Costs}}{\text{Revenue}}.$$

It shows that smaller downstream firms (Charter Communications, Suddenlink, and Cox Communications) generally have lower markups than the larger firms (Comcast, Time Warner Cable, DirecTV, and Dish Network).

The graph also shows that in 1999–2013 the markups were shrinking over time. During that period the downstream competition was growing as demonstrated by the dashed lines which show the total number of subscribers (the right axis) to the satellite companies (DirecTV and Dish Network) and the telecom companies (AT&T U-Verse and Verizon FiOS).[22] Whether the increasing downstream competition can explain the time trend in the markups is one of the questions addressed in our paper.

Figure 2: Downstream Markups



Finally, the size effect is considered common knowledge in the industry. For instance, Ross J. Lieberman, Senior Vice President of Government Affairs, American Cable Association, in his April 2014 statement before the Judiciary Committee on the proposed

[22]According to Nielsen, the total number of television households grew from 102.2 million in season 2000–2001 to 115.6 million in season 2013–2014.

AT&T and DirecTV merger, said:

> *"For most MVPDs,[23] the single largest cost of providing video service is programming cost, and the relative cost of programming for smaller MVPDs is significantly higher than for larger MVPDs because of the discriminatory pricing practices of the large programmers. The spread between the largest and smallest is commonly thought to average about 30%."*

Further evidence comes from testimony in merger proceedings. For example, in support of the AT&T acquisition of DirecTV, the merging parties claimed:

> *"This transaction will create a combined entity with a much larger subscriber base than AT&T currently has and thus offer much more value to programmers. That, in turn, should result in lower content costs... No party seriously disputes that the merger will enable the combined company to reduce the cost of acquiring content, which is the largest and most critical variable cost for MVPDs."*

The Federal Communications Commission admitted these marginal cost reductions into its assessment of consumer benefits for the merger. In other words, there was a consensus between the regulator, third parties, and merging firms that increased size would lead to increased bargaining power for distributors vis-à-vis content.

3.3.2 Theoretical Justification for the Existence of Size Effects

Theory does not guarantee size-based increases in bargaining power. Indeed, many basic theories would predict that larger firms pay higher input fees, or that there is no difference at all. Consider a bilateral monopoly with Nash bargaining over a linear input cost. Making the downstream firm larger by increasing its stand-alone utility or stand-alone marginal cost would increase the equilibrium input fee. This is because the linear fee is the instrument to share surplus, and increasing the size of the downstream firm in this manner increases the surplus to be shared. Making the downstream firm larger by doubling the size of its market, in contrast, would have no effect on the equilibrium input fee. This increase in market size raises the stakes for both the upstream and downstream, but does not alter their relative positions. Other theories predict that bigger buyers may pay higher fees (Raskovich, 2003).

[23] Multichannel video programming distributors.

Katz (1987) provides an appealing theoretical foundation for the existence of size effects in the multichannel television industry. Specifically, size advantages derive from economies of scale in seeking alternative supply. Alternative supply can be from backwards integration into content, or from nurturing a new entrant, or from encouraging a content provider who you have a deal with to add content similar to the content under negotiation. To make this concrete, the theory says that Comcast, with its 23 million subscribers, has more bargaining power than Cablevision, three million subscribers, with respect to Food Network, because Comcast has an advantage in using the threat of starting its own content channel of food-related programming than Cablevision. These advantages are natural in this industry. The two revenue sources for a channel are subscription revenues and advertising revenues. Comcast has the ability to make the new channel available to its larger amount of subscribers over night. Cablevision would have to negotiate with other providers, who may have deals with Food Network already, to launch a competitor to Food Network on the same scale as Comcast. Furthermore, Comcast need not ever exercise this outside option in equilibrium to achieve lower content costs.

This formulation also explains why Google, one of the largest firms ever, does not benefit from a size effect, as the relevant measure of size in this theory is the total number of downstream video subscribers. Similarly, the National Cable Television Cooperative, a buyer cooperative which bargains on behalf of smaller cable firms, is not able to achieve as low input costs of a single downstream with the same scale, because that organization is not centralized enough to launch its own content on all its member systems at once.

While the Katz theory of scale in alternative sources of supply is appealing, an empirical verification would require a model of entry into programming which is beyond the scope of this paper. Other theories which predict the existence of buyer size effects in input prices include Snyder (1998), where big buyers affect the degree of collusion that can be supported among suppliers, and Chipty and Snyder (1999) when the bilateral surplus function is concave in the downstream quantity.

4 Model

We use a model which is a slight modification of the model from Crawford and Yurukoglu (2012), and similar to and Crawford et al. (2015). The model consists of several parts: (i) the viewing problem, (ii) the bundle/firm choice problem, (iii) the pricing problem, and (iv) the bargaining problem. The timing of the model is the following:

1. Bargaining and pricing:

   - Channels and distributors negotiate the input fees.
   - Distributors choose the downstream prices at the local level.

2. Household firm choice:

   - Households choose service providers among those available in their markets.

3. Viewing:

   - Households choose how much time to spending watching each channel to which they have access.

4.1 Viewing Problem

Let $\mathcal{C}_{fmt} \subseteq \{1, \ldots, C\}$ be the set of channels available to household i in market m in year t if the household subscribes to firm f (which is present in market m) and $c = 0$ denotes the outside option (not watching any channels). The household solves the following optimization problem

$$\begin{aligned} \max_{\{t_{ict}:\, c=0,1,\ldots,C\}} \quad & \left(\sqrt{t_{i0t}} + \sum_{c=1}^{C} \gamma_{ict} \sqrt{t_{ict}} \right) \\ \text{s.t.} \quad & \sum_{c=1}^{C} t_{ict} \leq T \\ & t_{ict} \geq 0, \quad c \in \mathcal{C}_{fmt} \cup \{0\} \\ & t_{ict} = 0, \quad c \notin \mathcal{C}_{fmt} \cup \{0\}, \end{aligned}$$

where $\{\gamma_{ict}\}_{c=1}^{C}$ are the (random) taste parameters of the household (assumed nonnegative) and T is the total time available to the household.

This problem has a closed form solution. If $c \notin \mathcal{C}_{fmt} \cup \{0\}$ or $\gamma_{ict} = 0$, then $t_{ict} = 0$. Otherwise,

$$\begin{aligned} t_{i0t} &= \frac{T}{1 + \sum_{c' \in \mathcal{C}_{fmt}} \gamma_{ic't}^2} \\ t_{ict} &= \frac{\gamma_{ict}^2 T}{1 + \sum_{c' \in \mathcal{C}_{fmt}} \gamma_{ic't}^2}. \end{aligned}$$

The indirect utility of household i from the viewing problem if it chooses firm f in year t is

$$v^*_{ifmt} = \sqrt{1 + \sum_{c' \in \mathcal{C}_{fmt}} \gamma^2_{ic't}} \cdot \sqrt{T}.$$

The household always has an option not to subscribe to any of the available firms and get the indirect utility

$$v^*_{i0mt} = \sqrt{T}.$$

4.2 Bundle/Firm Choice Problem

Let $\mathcal{F}_{mt}$ be the set of firms present in market m in year t. Then household i in market m in year t chooses firm f that gives the highest utility

$$u_{ifmt} = \beta^v v^*_{ifmt} + x'_{fmt}\beta^x + \chi^{sat}_{if}\beta^{sat}_f + \chi^{telecom}_{if}\beta^{telecom}_f + \alpha p_{fmt} + \xi_{fmt} + \varepsilon_{ifmt},$$

where v^*_{ifmt} is the household's indirect utility from the viewing problem, x_{fmt} are the year effects and the firm-state effects. χ^{sat}_{if} are random coefficients that alters the household's taste for each satellite firm f, $\chi^{telecom}_{if}$ is a random coefficient if firm f if AT&T or Verizon,[24] p_{fmt} is the bundle's price, ξ_{fmt} is an unobserved firm-market-year level shock, and ε_{ifmt} is an idiosyncratic extreme value type-I shock.

Given the assumption about the distribution of ε_{ifmt}, the probability that the household chooses firm f,

$$s_{ifmt} = \frac{\exp\left(u_{ifmt} - u_{i0mt}\right)}{1 + \sum_{g \in \mathcal{F}_{mt}} \exp\left(u_{igmt} - u_{i0mt}\right)},$$

where u_{i0mt} is the household's utility from the outside option,

$$u_{i0mt} = \beta^v \sqrt{T}.$$

The market share of firm f in market m in year t is then equal to

$$s_{fmt} = \int_i s_{ifmt}\, dG_{mt}(i),$$

[24]If f is a cable firm, $\chi^{sat}_{if} = \chi^{telecom}_{if} = \beta_f = 0$.

where G_{mt} is the distribution of random coefficients $(\gamma, \chi^{sat}, \chi^{telecom})$ in market m in year t.

4.3 Downstream Pricing Problem

Each downstream firm f present in market m in year t solves the following profit maximization problem. Following industry practice, we assume the satellite firms set nation-wide prices, while wire-based distributors set market-specific prices.

$$\max_{p_{fmt}} \pi^{down}_{fmt} \left(\{ \mathcal{C}_{gmt}, p_{gmt}, \tau_{gct},\ g \in \mathcal{F}_{mt}, c = 1, \ldots, C \} \right),$$

where

$$\pi^{down}_{fmt} \left(\{ \mathcal{C}_{gmt}, p_{gmt}, \tau_{gct},\ g \in \mathcal{F}_{mt}, c = 1, \ldots, C \} \right) = D_{fmt}(p_{fmt} - mc_{fmt}),$$

$D_{fmt} = s_{fmt} N_{mt}$ is the demand for bundle f where N_{mt} is the total number of households in market m in year t. The marginal costs, mc_{fmt}, are equal to

$$mc_{fmt} = \sum_{c:\ c \in \mathcal{C}_{fmt}} \tau_{fct} + \omega_{fmt}.$$

We denote by τ_{fct} the input fee that firm f pays to channel c in year t per subscriber per month, and by ω_{fmt} the component of the marginal costs that is not related to programming.

If $\mathcal{M}_{ft}$ is the set of markets where downstream firm f operates in year t,[25] the total profit of firm f in year t is given by

$$\pi^{down}_{ft} \left(\{ \mathcal{C}_{gmt}, p_{gmt}, \tau_{gct},\ m \in \mathcal{M}_{ft}, g \in \mathcal{F}_{mt}, c = 1, \ldots, C \} \right) = \sum_{m \in \mathcal{M}_{ft}} \pi^{down}_{fmt}.$$

4.4 Bargaining Problem

The profit of an upstream firm c in year t is

$$\pi^{up}_{ct} \left(\{ \mathcal{C}_{fmt}, \tau_{fct},\ m \in \mathcal{M}_{ct}, f \in \mathcal{F}_{mt} \}, a_{ct} \right) = \sum_{m \in \mathcal{M}_{ct}} \sum_{f:\ c \in \mathcal{C}_{fmt}} D_{fmt} \left(\tau_{fct} + a_{ct} \right),$$

[25] In other words, $\mathcal{M}_{ft} = \{ m\colon f \in \mathcal{F}_{mt} \}$.

where a_{ct} is the advertising revenue (per subscriber per month) of channel c in year t and $\mathcal{M}_{ct}$ denotes the set of markets where channel c is carried by at least one bundle.[26]

Channel c and distributor f negotiate their input fee, τ_{fct}, taking all other input fees as given, to solve

$$\max_{\tau} \left(\left[\sum_{m:\, c \in \mathcal{C}_{fmt}} \Delta_{fc}\pi_{fmt}^{down}(\tau) \right]^{\zeta_{fct}} \left[\sum_{m:\, c \in \mathcal{C}_{fmt}} \Delta_{fc}\pi_{fmt}^{up}(\tau) \right]^{1-\zeta_{fct}} \right),$$

where ζ_{fct} is the bargaining power parameter and $\Delta_{fc}\pi_{fmt}^{down}(\tau)$ and $\Delta_{fc}\pi_{fmt}^{up}(\tau)$ are the "gains from trade" of the distributor and the channel respectively. That is,

$$\Delta_{fc}\pi_{fmt}^{down}(\tau) = D_{fmt}(p_{fmt} - mc_{fmt}) - D_{fmt}^{-fc}(p_{fmt} - mc_{fmt} + \tau)$$

and

$$\Delta_{fc}\pi_{fmt}^{up}(\tau) = D_{fmt}(\tau + a_{ct}) + \sum_{g \neq f:\, c \in \mathcal{C}_{gmt}} \left(D_{gmt} - D_{gmt}^{-fc} \right) (\tau_{gct} + a_{ct}),$$

where D_{fmt}^{-fc} denotes the demand for bundle f in market m when channel c is dropped from the bundle.

If firms c and f don't come to an agreement, channel c is dropped in all local markets served by f. Relative to having an agreement, no agreement changes first the demand for f in each market m where it carries c. Second, disagreement decreases the marginal costs of f in those markets as it no longer pays c. The upstream firm likewise loses the input fees from f and all the advertising revenue generated by the subscribers of f. However, the demand increase for other firms that carry c in market m increases which has an offsetting effect on both fee revenues and advertising revenues.

We assume that downstream pricing and bargaining happen simultaneously so that if firms c and f disagree the downstream prices are not revised.[27] Given the assumption of simultaneous pricing and bargaining, finding the optimal input fees $\{\tau_{fct}\}_{f=1}^{F}$ amounts to solving a system of linear equations (one equation for each $f = 1, \ldots, F$).

[26]Namely, $\mathcal{M}_{ct} = \{m \colon \exists f \in \mathcal{F}_{mt} \colon c \in \mathcal{C}_{fmt}\}$.

[27]This assumption, made also in Crawford, Lee, Whinston, and Yurukoglu (2015), could be replaced by a sequential bargaining-then-pricing setup as in Crawford and Yurukoglu (2012). The key advantage of the simultaneous determination of pricing and bargaining is that it lowers the computational burden joint estimation of the bargaining and demand parameters dramatically.

5 Estimation and Identification

5.1 Estimation

To estimate the model, we parameterize G_{mt}, the distribution of random coefficients $(\gamma, \chi^{sat}, \chi^{telecom})$ and the bargaining power parameters $\{\zeta_{fct},\ f = 1, \ldots, F, c = 1, \ldots, C, t = 1, \ldots, T\}$.

We assume that for $c = 1, \ldots, C$ and $t = 1, \ldots, T$

$$\gamma_{ict} = \chi_{ict} \cdot \tilde{\gamma}_{ict},$$

where χ_{ict} is a Bernoulli random variable with parameter ρ_c and $\tilde{\gamma}_{ict}$ is an exponential random variable with parameter $\lambda_{ct} = \lambda_{c0} + \lambda_{c1} t$. This allows each channel's taste distribution to trend linearly over time. Controlling for changing channel quality is important, as we later attribute increases in input fees to increases in bargaining power for channels over time.

We also assume that χ_{if}^{sat} is equal to zero if f is a cable firm and is distributed as an exponential random variable with parameter one if f is a satellite firm. Similarly, $\chi_{if}^{telecom}$ is equal to zero if f is a cable firm and is distributed as an exponential random variable with parameter one if f is AT&T or Verizon. We simulate $N = 150$ households per market-year, and later account for simulation error in the standard errors. For the counterfactuals, we increase the number of simulations to $N = 300$ households per market-year.

For the bargaining power parameter we let for $c = 1, \ldots, C$, $f = 1, \ldots, F$, and $t = 1, \ldots, T$

$$\zeta_{fct} = \zeta_{c0} + \zeta_1 t + \zeta_s \cdot size_{ft},$$

where $size_{ft}$ is the size of firm f in year t measured by the total number of subscribers in that year. This mechanically gives larger downstream firms more bargaining power at a rate which we estimate. Our interpretation is that this parameter substitutes for modeling the backwards integration decision which would generate bargaining leverage for the larger downstream firms as discussed in Section 3.3.2. Avoiding modeling entry into channels is desirable because the dynamic entry process would significantly increase the computational burden of the model. Furthermore, as backwards integration need not happen in equilibrium, the data for estimating the parameters of such a model will be limited. The key question is whether the bargaining power parametrization we employ here can be reasonably held fixed in counterfactual analysis.

A useful analogy can be made between estimated bargaining parameters and productivity residuals in production function estimation. These parameter capture un-modeled effects that generate either more production given inputs in the case of productivity, or different input fees given demand and costs in the case of bargaining. The estimated productivity residuals are thought to capture forces such as management practices, input quality heterogeneity, quality of legal system, among other possible determinants of output. We are effectively adding size as a co-variate into the input fee determination process without going so far as to model the full entry game that would generate such an advantage. This would be analogous to adding a measurement of management practices as a covariate into a production function without modelling how the management practices precisely increases output given measured inputs.

We assume that the downstream firms treat the bargaining power parameters as fixed and do not strategically choose prices to increase their bargaining power (or decrease the bargaining powers of the competitors) through the total number of subscribers.

5.1.1 Moment Conditions

We match the following moments computed from the model with their analogs observed in the data.

1. **Viewership moments.** For each channel $c = 1, \ldots, C$ and year $t = 1, \ldots, T$:
    - The fraction of households that spend nonzero time watching channel c in year t.
    - The average time that households spend watching channel c in year t.
2. **Markup moments.** For a subset of downstream firms $f = 1, \ldots, F$ and years $t = 1, \ldots, T$ such that the data are available in the 10k reports:
    - The (average) markup of firm f in year t.[28]

[28] These data are available for Comcast in 2003–2010, Time Warner Cable in 2004–2010, Charter Communications in 2000–2010, Cox Communication in 2000–2005, DirecTV in 2002–2010, and Dish Network in 2000–2002.

3. **Size effect moments.** For a subset of downstream firms $f = 1, \ldots, F$ and years $t = 1, \ldots, T$ such that the data are available in the 10k reports:

   - The programming costs of firm f in year t as a fraction of the programming costs of the benchmark firm (Comcast) in year t.[29]
   - We set a moment that Verizon and AT&T aggregate input costs should be 32.5% more than Comcast in 2007 following a data point from SNL Kagan.[30]

4. **Input fee moments.** For each channel $c = 1, \ldots, C$ and each year $t = 1, \ldots, T$:

   - The average (across distributors) input fee, $\overline{\tau}_{ct}$.
   - For each distributor-year, the average deviation of ω from the year average is zero. That is, we regress the difference in implied marginal costs minus the sum of input fees on year dummy variables. We form moments that the average residuals from this regression for each firm-year should be zero.

5. **Price coefficient.**

   - The unobserved shock, ξ_{fmt}, must be uncorrelated with the price instrument (the state-specific satellite tax). As we include state by firm fixed effects and year effects in the utility function, this moment requires the within-state-firm deviations from mean unobserved quality over time to be uncorrelated with changes in the satellite tax rate.

6. **Indirect utility coefficient.**

   - The average (across all households in market m in year t) indirect utility, $\overline{v}^*_{fmt}$, must be uncorrelated with the unobserved shock, ξ_{fmt}.

We currently adjusted the weights on the moments manually to deal with differences in units across moments. In the next iteration, we will weight the moments optimally by their inverse variance.

[29] Available for Comcast, Time Warner Cable, and Charter Communications in 2006–2010.

[30] "FiOS's programming costs are growing more slowly than their competitors' because the fees started higher — seven years ago, when FiOS launched, it was paying 30%-35% more than other multichannel players." From `http://go.snl.com/rs/snlfinancialllc/images/SNL-Kagan-US-Multichannel-Subscriber-Update-Programming-Cost-Analysis.pdf`

5.2 "Empirical" Identification

In this section we provide some intuition on how the derived moment conditions determine the model parameters in practice. While all parameters affect all moments through the non-linear structure of the model, certain parameters are more sensitive to certain moments which is what we refer to as "empirical identification," rather than the formal identification of the model given the data generating process.

1. The channel taste parameters, $\{\rho_c, \lambda_{c0}, \lambda_{c1}\}$, $c = 1, \ldots, C$. These parameters are identified from two sources of variation. First, the variations in the viewing times and fractions of households that spend nonzero time watching a channel (both across channels and over time) identify the taste parameters. Second, as these parameters affect households' willingness to pay for the channels which in turn affects the negotiated input fees through the bargaining problem, the variation in input fees across channels and across time helps identify the parameters.

2. The satellite firm taste parameters, β_f^{sat}, $f = 1, \ldots, F$, are identified from the markup moments. In the absence of random coefficients (or if $\beta_f^{sat} = 0$) the markups would be determined by the satellite market shares (which determine the elasticities). As the market shares of satellite bundles are considerably smaller than those of the cable companies while the markups are comparable, random coefficients (and positive $\beta_f^{sat} = 0$) help fit the markups observed in the data by creating a captive subset of consumers who subscribe to the satellite firm despite a relatively high price.

3. The telecom firm taste parameter, $\beta_f^{telecom}$, is pinned down by the condition that differences in input costs and implied marginal costs are mean zero within firm-year. This implies that the mark-ups earned by telecom providers can not be too high, and thus limits the size of their random effects.

4. The indirect utility coefficient, β^v, is identified from the variation in the market shares of bundles that carry different sets of channels.

5. The price coefficient is identified from the variation in the market shares when the state-specific satellite tax changes.[31] Table 1 reports the states that increased their

[31] As the observed characteristics, x_{fmt}, include state×firm dummies, changes in the state-specific satellite tax are required to identify the price coefficient.

satellite taxes between 2000 and 2010. Table 2 provides a reduced form evidence in favor of using the satellite tax as an instrument.

6. The channel-specific bargaining power parameters, $\{\zeta_{c0}\}$, $c = 1, \ldots, C$ are identified from the levels of each channel's input fees. Advertising revenue and value of viewership create a zone of mutually-agreeable input fees for each pair of channel and distributor. The bargaining parameter for each pair picks out a value in that zone. As ζ_{c0} increases the implied input fee for every distributor for a given channel, it is strongly sensitive to the observed average input fee. Changes in the input fees over time identify ζ_1. Differences in the total programming costs between the distributors of different size identify ζ_s.

Table 1: Satellite Tax Changes in 2000–2010

State	Year	Tax Change
Connecticut	2003	+5%
Florida	2002	+10%
Kentucky	2006	+5%
Massachusetts	2009	+5%
North Carolina	2003	+7%
Ohio	2003	+6%
Utah	2003	+5%

Notes: Each row corresponds to a state which changed its excise tax on satellite during out sample period along with the corresponding change in the rate.

Table 2: Satellite Tax as a Price Instrument

	log(Market Share) − log(Outside Good Market Share)			
	(OLS)		(2SLS)	
Parameter	Estimate	Standard Error	Coefficient	Standard Error
α	-0.0039^{**}	0.0016	-0.0862^{***}	0.0163
Channel Dummies	✓		✓	
Year Dummies	✓		✓	
State×Firm Dummies	✓		✓	
Number of Observations	24,341		24,341	

Notes: * p-value ≤ 0.10, ** p-value ≤ 0.05, *** p-value ≤ 0.01. The 2SLS column corresponds to a specification where we instrument for price with the satellite tax rate. As we are including state x firm dummy variables, the variation in satellite tax rates is due to the states listed in Table 1.

6 Results

Tables 3 and 4 report the estimates of the channel taste parameters and Figure 3 shows the implied monthly willingness to pay for selected channels in 2010. Table 15 in the Appendix reports the average monthly willingness to pay for all of the channels in 2000 and 2010. As λ_{c1} is positive for most of the channels, the implied willingness to pay is generally increasing over time. This is a consequence of the channel ratings rising from 2000 to 2010. As can be seen from Figure 3, the distribution of willingness to pay for ESPN stochastically dominates those of the other channels.

Table 3: Channel Taste Parameters (Part 1)

Channel	$\hat{\rho}_c$	std.err.($\hat{\rho}_c$)	$\hat{\lambda}_{c0}$	std.err.($\hat{\lambda}_{c0}$)	$\hat{\lambda}_{c1}$	std.err.($\hat{\lambda}_{c1}$)
ABC Family Channel	0.3135	0.00009	0.0685	0.00003	0.00169	0.000005
American Movie Classics	0.3132	0.00026	0.0769	0.00003	0.00126	0.000006
Animal Planet	0.3870	0.00012	0.0532	0.00002	0.00260	0.000005
Arts Entertainment	0.4216	0.00017	0.1005	0.00003	0.00011	0.000005
BET	0.1289	0.00015	0.0511	0.00013	0.00118	0.000017
Bravo	0.1742	0.00024	0.0366	0.00010	0.00378	0.000012
Cartoon Network	0.2017	0.00024	0.0934	0.00007	−0.00084	0.000007
CMT	0.1174	0.00004	0.0288	0.00038	0.00158	0.000035
CNBC	0.3308	0.00033	0.0706	0.00005	−0.00005	0.000004
CNN	0.5495	0.00018	0.0921	0.00003	0.00021	0.000004
Comedy Central	0.3116	0.00015	0.0582	0.00004	0.00223	0.000006
Discovery Channel	0.5578	0.00006	0.0937	0.00002	0.00043	0.000004
Disney Channel	0.3632	0.00009	0.0873	0.00004	0.00301	0.000005
E! Entertainment TV	0.2689	0.00013	0.0571	0.00004	0.00110	0.000004
ESPN	0.7048	0.00031	0.1065	0.00004	0.00342	0.000004
ESPN 2	0.2966	0.00017	0.0586	0.00004	0.00202	0.000005
ESPN Classic Sports	0.1373	0.00011	0.0202	0.00066	0.00090	0.000060
Food Network	0.3742	0.00015	0.0469	0.00003	0.00538	0.000008
Fox News Channel	0.5119	0.00020	0.0575	0.00003	0.00693	0.000005

Notes: The standard errors are computed using 1,000 bootstrap simulations. Each time we sample from the set of market×year observations and draw a set of new simulated households.

The estimates of α, β^v, and β_f^{sat} are reported in Table 5. Table 6 reports the own- and cross-price elasticities implied by the estimated parameters. We compute the elasticities separately for the markets with only three and more than three downstream competitors. The estimates suggest that the demand for satellite bundles is more elastic which is consistent with the previous findings in the literature.[32]

Table 7 shows the estimates of the channel-specific bargaining power parameters and

[32] See Crawford, Lee, Whinston, and Yurukoglu (2015).

Table 4: Channel Taste Parameters (Part 2)

Channel	$\hat{\rho}_c$	std.err.($\hat{\rho}_c$)	$\hat{\lambda}_{c0}$	std.err.($\hat{\lambda}_{c0}$)	$\hat{\lambda}_{c1}$	std.err.($\hat{\lambda}_{c1}$)
FX	0.2808	0.00027	0.0536	0.00003	0.00300	0.000007
Golf Channel	0.1079	0.00018	0.0241	0.00040	0.00227	0.000044
Hallmark Channel	0.2140	0.00021	0.0105	0.00011	0.00695	0.000012
HGTV	0.3372	0.00009	0.0575	0.00003	0.00459	0.000006
History Channel	0.4447	0.00018	0.0781	0.00003	0.00279	0.000006
Lifetime	0.3809	0.00033	0.0921	0.00004	0.00097	0.000005
MSNBC	0.3629	0.00014	0.0593	0.00003	0.00220	0.000006
MTV	0.2628	0.00009	0.0764	0.00004	0.00000	0.000005
Nickelodeon	0.2380	0.00024	0.1128	0.00006	−0.00026	0.000006
SyFy	0.2595	0.00012	0.0606	0.00003	0.00205	0.000005
TBS	0.4584	0.00014	0.1008	0.00003	0.00105	0.000004
TLC	0.3289	0.00016	0.0684	0.00003	0.00239	0.000005
truTV	0.2681	0.00010	0.0410	0.00005	0.00263	0.000007
Turner Classic Movies	0.2480	0.00014	0.0418	0.00005	0.00397	0.000006
TNT	0.4732	0.00022	0.0988	0.00003	0.00303	0.000005
USA	0.3767	0.00016	0.0939	0.00003	0.00305	0.000006
VH1	0.2199	0.00005	0.0551	0.00004	0.00034	0.000010
Weather Channel	0.5667	0.00008	0.0648	0.00002	0.00081	0.000004

Notes: The standard errors are computed using 1,000 bootstrap simulations. Each time we sample from the set of market×year observations and draw a set of new simulated households.

Table 5: The Estimates of α, β^v, β^{sat}_f, and β^{tele}

Parameter	Estimate	Standard Error
α	−0.1681	
β^v	44.0496	
$\beta^{sat}_{DirecTV}$	6.0550	
β^{sat}_{Dish}	2.4139	
β^{tele}	7.4582	

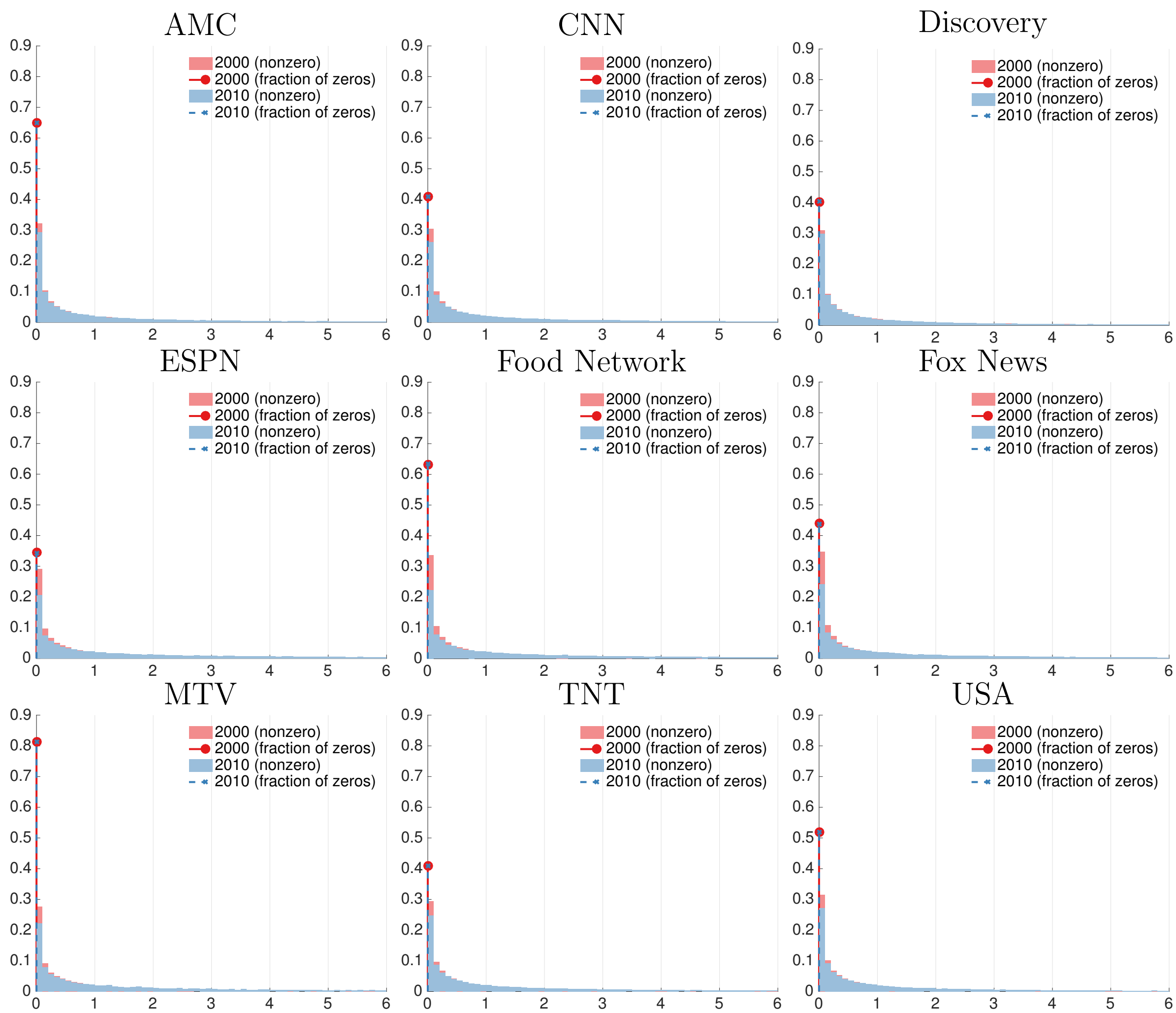
Notes: The standard errors are computed using 1,000 bootstrap simulations. Each time we sample from the set of market×year observations and draw a set of new simulated households.

their standard errors. As $\zeta_{fct} = \zeta_{c0} + \zeta_1 t + \zeta_s \cdot size_{ft}$ determines the bargaining power of distributor f versus channel c, the higher is ζ_{c0} the stronger is the average bargaining power of the distributors against channel c.

The estimate of ζ_1 is 0.0006 with the standard error of XX. The fact that this coefficient so small suggests that the rise in input fees over time can be explained by increasing downstream competition alone.

The estimate of the size effect parameter, ζ_s, is equal to 0.0037 and its standard error is ZZ. As the estimate is positive, the model implies that a merger of two downstream

Figure 3: The Distributions of Willingness to Pay in 2010



Notes: The distribution of willingness to pay (in dollars per month) is truncated at $10.

firms would lead to an improved bargaining position of the merged firm and lower input fees. In concrete terms, Figure 4 displays the model's predictions for differences in input costs for Comcast and Cablevision. The larger Comcast is able to negotiate about 25% lower fees in aggregate in 2010. The figure also displays that the model matches the input fees for the 37 channels we analyze quite well over time despite a bargaining power parameterizations that has a common linear time trend.

The bargaining power parameters vary significantly across channels. The sport channels (ESPN, ESPN 2, ESPN Classic Sports, and Golf Channel) generally have higher bargaining power (lower bargaining power parameters). This is a consequence of the input fees observed in the data (e.g. the input fees paid to ESPN are ten times higher than

Table 6: The Estimates of Own- and Cross-price Elasticities

3 Distributors			
Firm	Cable	DirecTV	Dish
Cable	−1.3986	0.1778	0.2991
DirecTV	1.1120	−1.6506	0.1408
Dish	2.8933	0.2223	−3.9962
$>$ 3 Distributors			
Firm	Cable	DirecTV	Dish
Cable	−2.4783	0.2787	0.5538
DirecTV	0.8592	−2.0785	0.2557
Dish	2.2433	0.3270	−4.3324

Notes: Cell (f_1, f_2) reports the average price elasticity of demand for f_1 with respect to f_2's price.

Table 7: Channel-specific Bargaining Power Parameters

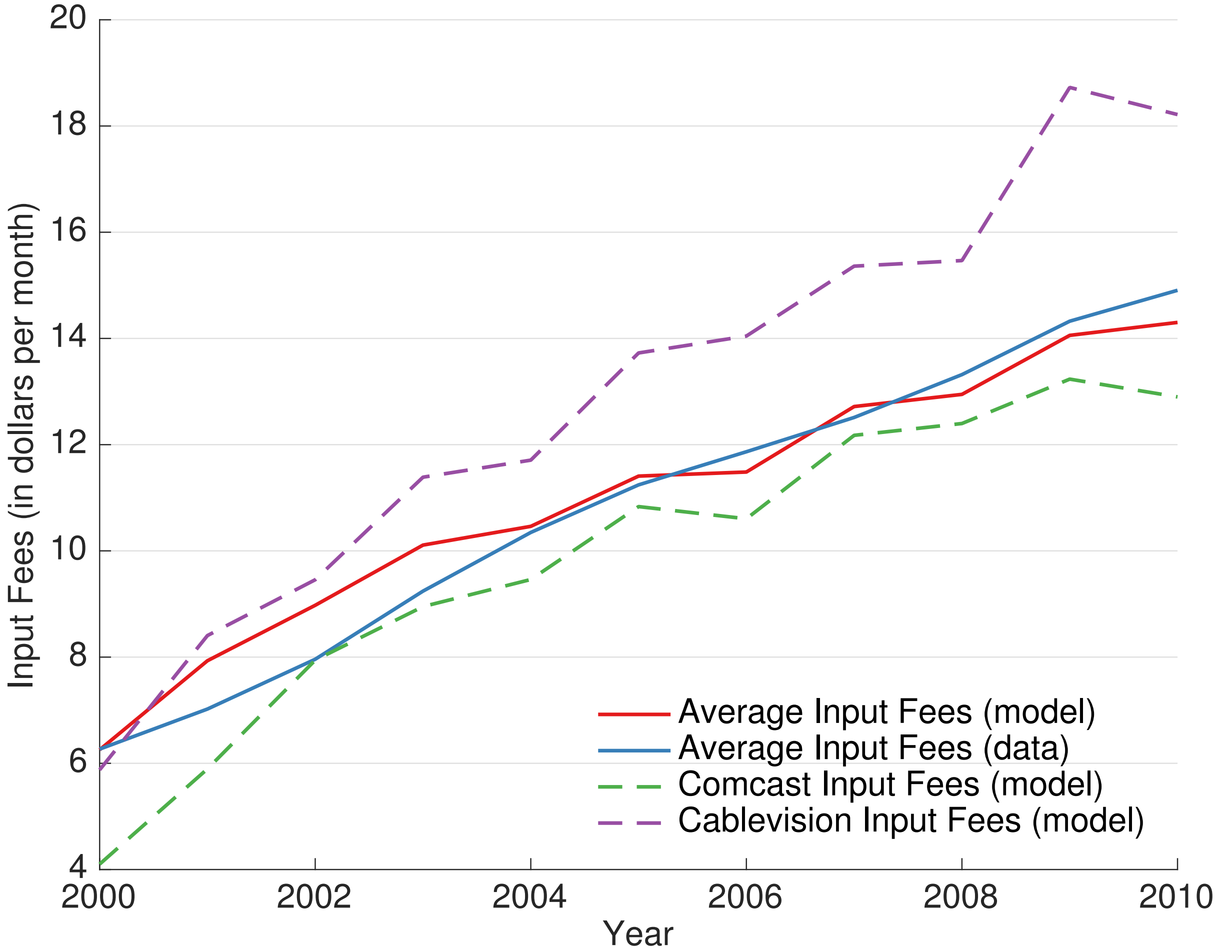
Channel	$\hat{\zeta}_{c0}$	std.err.($\hat{\zeta}_{c0}$)	Channel	$\hat{\zeta}_{c0}$	std.err.($\hat{\zeta}_{c0}$)
ABC Family Channel	0.5433		FX	0.2401	
American Movie Classics	0.4195		Golf Channel	0.0323	
Animal Planet	0.5532		Hallmark Channel	0.5979	
Arts Entertainment	0.6005		HGTV	0.6779	
BET	0.4785		History Channel	0.6297	
Bravo	0.3904		Lifetime	0.6031	
Cartoon Network	0.6750		MSNBC	0.5269	
CMT	0.3963		MTV	0.3776	
CNBC	0.4488		Nickelodeon	0.5386	
CNN	0.5402		SyFy	0.4934	
Comedy Central	0.5955		TBS	0.5261	
Discovery Channel	0.5731		TLC	0.4404	
Disney Channel	0.1909		truTV	0.6252	
E! Entertainment TV	0.4257		Turner Classic Movies	0.3741	
ESPN	0.0000		TNT	0.3628	
ESPN 2	0.0076		USA	0.3860	
ESPN Classic Sports	0.1929		VH1	0.3769	
Food Network	0.7425		Weather Channel	0.6566	
Fox News Channel	0.5919				

Time and Size Effects

Effect	$\hat{\zeta}$	std.err.($\hat{\zeta}$)
Time Trend (per year)	0.0006	
Size Effect (per million subscribers)	0.0037	

Notes: The standard errors are computed using 1,000 bootstrap simulations. Each time we sample from the set of market×year observations and draw a set of new simulated households.

Figure 4: Estimated Input Costs



Notes: These lines correspond to the weighted (by subscribers) sums of input costs for the 37 cable channels as predicted by the model at the estimated parameters.

those paid to some other channels). Our viewing model implies a direct link between the watching time (ratings) and the willingness to pay for the channel. A more flexible model that allows different consumer values from a unit of time spent watching different channels would reduce the variation in the bargaining power parameters across channels as in Crawford et al. (2015).

7 Counterfactuals

In this section, we show how accounting for size-based bargaining leverage is important for merger analysis and for the analysis of entry. For merger analysis, size-based bargaining leverage provides a natural efficiency in lower input costs that a regulator can weigh against any market power effects. For new entrants, size-based bargaining leverage creates a disadvantage that can materially affect profits.

7.1 Merger Analysis

We simulate several proposed or consummated mergers using the year 2010 which is the most recent year for our data. To simulate these mergers, we join the merging parties into a new firm. In markets where both firms were present, we maintain the two products of each party, but their prices are now jointly set by a common owner. We compute counterfactual input fees, downstream prices, and market shares. We then compute the implied consumer surplus, upstream profits (decomposed into advertising and fee revenue), and downstream profits.

The two main effects in these simulations are: (i) if the merging firms compete at the local level, the merger will reduce downstream competition– the classic horizontal market power effect, and (ii) the merged firm will have a stronger bargaining position against the channels and will be able to negotiate lower input fees due to its size– the size-based bargaining effect. The first effect will tend to increase industry profits and decrease consumer surplus. The second effect will tend to lower upstream profits, increase downstream profits, and increase consumer surplus. The net effect of these mergers on industry profits and consumer surplus is ambiguous in theory. As a caveat, there are several other non-modeled considerations that regulators analyzed in the review of these mergers. These include vertical considerations as some of the merging parties own content or Internet video platforms, and the effects of the mergers on incentives to invest both upstream in channel quality and downstream in distribution and broadband network quality. As described in Hill et al. (2015), the Department of Justice concluded that Comcast's acquisition of Time Warner Cable would increase their leverage in the programming market, and interpreted this as bad for welfare because of interactions with other vertical considerations, however the details of this logic are not public. The model we employ could be embedded into a larger model that captures these effects, but these are outside the scope of the analysis in this paper.

7.1.1 Comcast - Time Warner Cable

Comcast and Time Warner Cable are the two largest wire-based distributors in the United States. In 2013, they together served video programming to more than 32 million cus-

Table 8: Counterfactual Merger Outcomes

	(1) Status Quo	(2) Comcast - TWC		(3) Charter-TWC		(4) AT&T-DirecTV	
	Level	Level	%Δ	Level	%Δ	Level	%Δ
Prices and Market Shares							
Total Market Share	0.82	0.83	0.86	0.83	0.22	0.82	-0.01
Cable Market Share	0.57	0.58	2.27	0.57	0.58	0.55	-3.16
Satellite Market Share	0.26	0.25	-2.22	0.26	-0.57	0.28	7.00
Average Cable Price	57.96	57.20	-1.32	57.76	-0.34	58.00	0.07
Average Satellite Price	67.53	67.39	-0.20	67.49	-0.06	67.01	-0.77
Average Household Expenditure	50.30	50.18	-0.23	50.29	-0.01	50.29	-0.01
Merging Parties Market Share (in market)							
Comcast + TWC	0.49	0.51	4.83				
TWC + Charter	0.43			0.44	2.52		
AT&T + DirecTV	0.17					0.17	-0.05
Average Marginal Cost for Merging Parties							
Comcast + TWC	30.45	27.54	-9.57				
TWC + Charter	35.13			33.82	-3.73		
AT&T + DirecTV	36.77					36.18	-1.59
Average Price for Merging Parties							
Comcast + TWC	56.96	55.57	-2.45				
TWC + Charter	59.38			58.73	-1.10		
AT&T + DirecTV	69.65					69.67	0.02
Components of Welfare							
Consumer Welfare	34.75	35.21	1.33	34.86	0.31	34.74	-0.01
Downstream Profits	24.09	24.73	2.64	24.23	0.58	24.21	0.50
Comcast + TWC	8.67	9.51	9.61				
TWC + Charter	3.83			4.02	4.94		
AT&T + DirecTV	5.17					5.29	2.29
Upstream Fee Revenue	11.75	10.95	-6.80	11.59	-1.39	11.63	-1.03
Upstream Advertising Revenue	10.26	10.35	0.82	10.28	0.22	10.26	-0.01
Upstream Profits	22.02	21.30	-3.25	21.87	-0.64	21.89	-0.55
Total Welfare	80.85	81.24	0.47	80.96	0.13	80.85	-0.01

Notes: This table reports predictions of counterfactual mergers in the year 2010. Column (1) corresponds to the model's predictions for the status quo at the estimated parameters. (2), (3), and (4) correspond to counterfactual simulations under mergers between the identified parties.

tomers. The proposed merger was announced in February 2014 and was reviewed by the Federal Communication Commission since April 2014. At the time of the announcement the value of the deal was estimated as $45.2 billion. On April 24, 2015 Comcast announced that the deal was terminated.

There is no market power effect in the case of Comcast and Time Warner Cable merger because these distributors do not compete at the local level. This has implications for the direction of the overall effect of the merger. The larger firm will negotiate lower input fees which will lead to lower downstream prices. Our model implies that in the short-run the consumers as well as the merged downstream firm will definitely be better off and the profits of the upstream firms will be lower.

To compute the new input fees and downstream prices we re-solve the bargaining problem and iterate the best-response prices of the downstream firms until convergence.[33]

Our estimates imply that the programming costs of the merged firm will be 9.6% lower than the average programming costs of Comcast and Time Warner Cable before the merger.[34] This will allow the firm to optimally reduce the average downstream price by 2.45% (as compared to the average of Comcast and Time Warner Cable prices before the merger). The model predicts consumer surplus would increase by 1.33%, which is about $176 million per year in the short-run. Upstream profits decrease due to decreases in fee revenue. However, about 10% of these losses are recouped from increased advertising revenue as more subscribers enter the market. Total welfare increases by 0.47%.

While the merger analysis in this case turned on additional issues, such as broadband price discrimination and set top box integration, the short-run efficiencies created by scale are an important component of the analysis.

7.1.2 Charter - Time Warner Cable

After Comcast abandoned its merger with TWC, Charter made a bid for Time Warner Cable. Here, we do the same simulation as above but for Charter and Time Warner Cable. The overall scale of the combined firm is less than Comcast, so the results mirror Comcast in direction, but are scaled down. Again, there is no direct horizontal effect of this merger.

[33] We do not change the bundle compositions.

[34] The programming costs are obtained by adding up the input fees paid to all channels.

7.1.3 AT&T - DirecTV

The AT&T acquisition of DirecTV was approved and consummated. Given AT&T's modest size in 2010, the model's predictions for this merger are also modest quantitatively. In this case, there is a direct horizontal competition effect which must be traded off against scale efficiencies. We find that the profits of the merged entity increase by 2.29%, upstream fee revenue decreases by 1.03%, and total welfare is effectively unchanged. In terms of total welfare, the benefits of scale in bargaining with content are off-set by the increased market power of the combined firm.

7.2 Contracts and Entry

Another significant implication of size-based bargaining power is that the equilibrium contracts create a barrier to entry in the industry.[35] An entrant needs low input costs to scale up, but needs scale to achieve low input costs. In Table 9, we calculate counterfactual outcomes when size does not effect bargaining power, that is we set ζ_S to zero. We then calibrate the overall level of bargaining power through ζ_{c0} so that upstream revenues are unchanged. This allows direct comparisons with the status quo that aren't contaminated by a shift in the overall level of bargaining power for downstream firms.

Table 9: Size Effects and Barriers to Entry Counterfactual Outcomes

	Status Quo	No Size Effects	
	Level	Level	%Δ
Prices and Market Shares			
Verizon + AT&T Market Share	0.14	0.15	4.52
Verizon + AT&T Price	55.02	53.42	-2.92
Verizon + AT&T Marginal Cost	20.86	19.09	-8.48
Verizon + AT&T Profits	1.50	1.57	4.79
Components of Welfare			
Consumer Welfare	34.75	34.68	-0.21
Downstream Profits	24.09	24.20	0.45
Upstream Fee Revenue	11.75	11.75	-0.01
Upstream Advertising Revenue	10.26	10.26	-0.01
Upstream Profits	22.02	22.01	-0.01
Total Welfare	80.85	80.89	0.04

Notes: This table reports predictions of counterfactual outcomes in the year 2010. The first column of results corresponds to the model's predictions for the status quo at the estimated parameters. The next two columns correspond to the model's predictions for eliminating size-based differences in bargaining.

[35] Aghion and Bolton (1987) model the use of contracts between a supplier and incumbent to foreclose entry, however the mechanism here is different in that the barrier is created purely from the size effect.

We find that video profits for Verizon and AT&T would increase by 4.79% if they did not face a disadvantage due to size based bargaining parameters. This increase in profits is coming from a combination of a decrease in content costs of 8.48%, a decrease in price of 2.92%, and an increase in market share of 4.52%. Unfortunately, we do not know the exact cost of capital and the planned revenue stream associated with building out Verizon's and AT&T's wire-based networks, so we can not say which markets would be rendered profitable to build out by this change in profits.

8 Conclusion

This paper estimates, models, and analyzes the cost advantages large downstream distribution firms enjoy in procuring content. In this context, we analyze the short-run effects of potential mergers between Comcast and Time Warner Cable, Charter and Time Warner Cable, and AT&T and DirecTV. Wed conclude that in the absence of downstream competition between the two firms, these mergers will result in the lower downstream prices and the consumers will be better off. The merger between AT&T and DirecTV is not as clear cut as it also involves a loss of horizontal competition. Here we estimate that consumer welfare and total welfare are unchanged. Finally, we considered the degree to which size-based price discrimination lowers the profits of new entrants who have not achieved scale. We find that eliminating size-based bargaining power would increase the video profits of AT&T and Verizon by about 5%.

In terms of future research, the current model does not take into account that some of the distributors and channels are vertically integrated. It also ignores the long-run consequences of mergers such as the effect on investment, both in programming quality and in network quality. Long run changes due to changes in investment or entry could potentially change the predictions of these models for merger effects dramatically.

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A Appendix: Tables

Table 10: Descriptive Statistics of the Downstream Market: Distributors

	Price				Market Share				Number of Channels			
Distributor	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Comcast	47.6	10.3	10.0	101.7	0.59	0.17	0.02	0.96	34.0	4.3	9	37
TWC	45.7	10.3	16.0	122.9	0.56	0.17	0.07	0.96	34.8	3.5	12	37
Charter	45.9	12.5	11.3	94.7	0.59	0.17	0.03	0.93	33.1	5.2	11	37
Cablevision	49.2	9.9	10.4	76.0	0.69	0.15	0.16	0.96	34.2	3.6	20	37
Cox	39.9	7.9	16.8	72.6	0.65	0.15	0.03	0.91	32.3	4.6	11	37
RCN	52.4	12.4	30.8	68.9	0.17	0.19	0.01	0.92	34.9	3.0	16	37
Verizon	51.8	4.4	40.9	55.4	0.18	0.11	0.01	0.73	36.2	0.6	34	37
AT&T	54.5	10.1	26.0	98.6	0.14	0.13	0.00	0.82	36.2	1.8	20	37
DirecTV	50.2	11.2	37.8	76.7	0.11	0.07	0.00	0.53	36.8	0.4	36	37
Dish	49.5	8.2	35.0	68.3	0.08	0.07	0.00	0.62	36.7	0.5	36	37
Other	41.8	11.0	11.4	95.9	0.60	0.19	0.01	0.96	31.3	5.7	9	37

Notes: The statistics are computed for the full set of bundles (24,341 observations) for each distributor (across years 2000–2010).

Table 11: Descriptive Statistics of the Downstream Market: Viewership (Part 1)

	Rating				Fraction of Households that Watch			
Channel	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ABC Family Channel	0.0046	0.0007	0.0038	0.0056	0.2504	0.0480	0.1642	0.3316
American Movie Classics	0.0053	0.0005	0.0047	0.0062	0.2353	0.0303	0.1640	0.2698
Animal Planet	0.0040	0.0006	0.0026	0.0051	0.2858	0.0589	0.1928	0.3700
Arts Entertainment	0.0070	0.0009	0.0057	0.0088	0.3453	0.0446	0.2510	0.4004
BET	0.0032	0.0005	0.0022	0.0038	0.0927	0.0216	0.0614	0.1178
Bravo	0.0028	0.0010	0.0014	0.0047	0.1502	0.0404	0.0804	0.1970
Cartoon Network	0.0070	0.0013	0.0052	0.0087	0.1507	0.0333	0.0892	0.1892
CMT	0.0014	0.0003	0.0009	0.0018	0.0801	0.0161	0.0592	0.1138
CNBC	0.0037	0.0004	0.0029	0.0041	0.2597	0.0545	0.1614	0.3382
CNN	0.0085	0.0011	0.0067	0.0102	0.4493	0.0888	0.2732	0.5452
Comedy Central	0.0045	0.0009	0.0029	0.0054	0.2352	0.0538	0.1592	0.3038
Discovery Channel	0.0077	0.0004	0.0069	0.0082	0.4546	0.0778	0.2986	0.5466
Disney Channel	0.0078	0.0015	0.0055	0.0097	0.1606	0.0358	0.1088	0.2120
E! Entertainment TV	0.0032	0.0003	0.0027	0.0036	0.2115	0.0477	0.1264	0.2668
ESPN	0.0094	0.0014	0.0080	0.0125	0.3619	0.0522	0.2438	0.4194
ESPN 2	0.0037	0.0007	0.0030	0.0049	0.2144	0.0335	0.1596	0.2674
ESPN Classic Sports	0.0007	0.0002	0.0004	0.0010	0.0687	0.0193	0.0414	0.0946
Food Network	0.0055	0.0020	0.0023	0.0087	0.2698	0.0611	0.1600	0.3514
Fox News Channel	0.0095	0.0031	0.0034	0.0136	0.3665	0.0846	0.2122	0.4588

Notes: The statistics are computed for each channel (across years 2000–2010).

Table 12: Descriptive Statistics of the Downstream Market: Viewership (Part 2)

	Rating				Fraction of Households that Watch			
Channel	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
FX	0.0042	0.0010	0.0027	0.0056	0.1947	0.0452	0.1428	0.2682
Golf Channel	0.0009	0.0004	0.0006	0.0018	0.0562	0.0092	0.0396	0.0696
Hallmark Channel	0.0031	0.0022	0.0003	0.0060	0.1101	0.0767	0.0000	0.1986
HGTV	0.0058	0.0020	0.0032	0.0094	0.2389	0.0373	0.1604	0.2852
History Channel	0.0069	0.0015	0.0052	0.0097	0.3622	0.0469	0.3110	0.4342
Lifetime	0.0078	0.0007	0.0071	0.0091	0.2967	0.0198	0.2594	0.3242
MSNBC	0.0044	0.0008	0.0031	0.0059	0.2730	0.0605	0.1760	0.3366
MTV	0.0047	0.0006	0.0040	0.0057	0.1905	0.0353	0.1278	0.2360
Nickelodeon	0.0095	0.0011	0.0079	0.0109	0.1418	0.0205	0.1028	0.1616
SyFy	0.0043	0.0009	0.0032	0.0062	0.1792	0.0307	0.1366	0.2140
TBS	0.0084	0.0004	0.0077	0.0092	0.3432	0.0469	0.2648	0.4248
TLC	0.0048	0.0012	0.0035	0.0071	0.2549	0.0200	0.2150	0.2944
truTV	0.0037	0.0010	0.0016	0.0049	0.1399	0.0398	0.0906	0.2014
Turner Classic Movies	0.0036	0.0012	0.0018	0.0057	0.1519	0.0310	0.1008	0.1838
TNT	0.0108	0.0017	0.0084	0.0133	0.3698	0.0542	0.2980	0.4466
USA	0.0091	0.0020	0.0069	0.0128	0.3264	0.0367	0.2610	0.3688
VH1	0.0030	0.0004	0.0025	0.0035	0.1628	0.0366	0.0820	0.1942
Weather Channel	0.0041	0.0003	0.0036	0.0046	0.4515	0.0606	0.3262	0.5120

Notes: The statistics are computed for each channel (across years 2000–2010).

Table 13: Descriptive Statistics of the Upstream Market: Input Fees and Advertising Revenues (Part 1)

	Input Fee				Advertising Revenue			
Channel	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ABC Family Channel	0.1918	0.0223	0.1600	0.2200	0.2111	0.0550	0.1424	0.2941
American Movie Classics	0.2200	0.0155	0.2000	0.2500	0.1092	0.0694	0.0138	0.2123
Animal Planet	0.0718	0.0125	0.0600	0.0900	0.0921	0.0205	0.0659	0.1233
Arts Entertainment	0.2100	0.0332	0.1600	0.2600	0.3050	0.0407	0.2520	0.3815
BET	0.1364	0.0201	0.1100	0.1700	0.2436	0.0567	0.1576	0.3204
Bravo	0.1473	0.0297	0.1100	0.2000	0.1623	0.0817	0.0627	0.2850
Cartoon Network	0.1400	0.0303	0.0800	0.1800	0.2502	0.0721	0.1525	0.3246
CMT	0.0573	0.0224	0.0300	0.0900	0.0970	0.0176	0.0646	0.1156
CNBC	0.2436	0.0434	0.1600	0.3000	0.2254	0.0897	0.1333	0.4090
CNN	0.4327	0.0546	0.3500	0.5200	0.3873	0.0496	0.2979	0.4716
Comedy Central	0.1064	0.0225	0.0800	0.1400	0.3245	0.0684	0.2210	0.3988
Discovery Channel	0.2691	0.0435	0.2200	0.3500	0.3437	0.0540	0.2623	0.4250
Disney Channel	0.8055	0.0572	0.7500	0.9100	0.0000	0.0000	0.0000	0.0000
E! Entertainment TV	0.1855	0.0186	0.1500	0.2100	0.1487	0.0204	0.1238	0.1867
ESPN	2.8082	1.1211	1.1400	4.3400	0.9970	0.2047	0.6524	1.2452
ESPN 2	0.3682	0.1398	0.1700	0.5800	0.1782	0.0430	0.1088	0.2315
ESPN Classic Sports	0.1409	0.0291	0.1000	0.1800	0.0658	0.0152	0.0388	0.0833
Food Network	0.0609	0.0318	0.0300	0.1400	0.2506	0.1025	0.1101	0.4048
Fox News Channel	0.3182	0.1793	0.1700	0.7000	0.3016	0.1730	0.0647	0.5243

Notes: The statistics are computed for each channel (across years 2000–2010) per subscriber per month.

Table 14: Descriptive Statistics of the Upstream Market: Input Fees and Advertising Revenues (Part 2)

	Input Fee				Advertising Revenue			
Channel	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
FX	0.3409	0.0587	0.2700	0.4300	0.2458	0.0965	0.1015	0.3800
Golf Channel	0.2018	0.0483	0.1300	0.2600	0.1096	0.0169	0.0882	0.1327
Hallmark Channel	0.0336	0.0220	0.0000	0.0600	0.1393	0.0711	0.0000	0.2111
HGTV	0.0782	0.0382	0.0300	0.1400	0.3209	0.0840	0.2069	0.4283
History Channel	0.1773	0.0361	0.1300	0.2300	0.2208	0.0592	0.1219	0.2997
Lifetime	0.2127	0.0553	0.1300	0.2900	0.5200	0.0363	0.4418	0.5564
MSNBC	0.1418	0.0160	0.1200	0.1700	0.1358	0.0295	0.1042	0.1884
MTV	0.2673	0.0473	0.2000	0.3500	0.6704	0.0927	0.5446	0.7959
Nickelodeon	0.3700	0.0544	0.2900	0.4700	0.7820	0.1380	0.5618	0.9217
SyFy	0.1655	0.0350	0.1200	0.2200	0.2898	0.0463	0.1835	0.3288
TBS	0.3673	0.1152	0.1900	0.5400	0.5553	0.0502	0.4906	0.6352
TLC	0.1555	0.0093	0.1400	0.1700	0.2307	0.0281	0.1957	0.2875
truTV	0.0882	0.0087	0.0800	0.1000	0.1452	0.0565	0.0600	0.2108
Turner Classic Movies	0.2182	0.0340	0.1600	0.2700	0.0000	0.0000	0.0000	0.0000
TNT	0.8318	0.1612	0.5500	1.1000	0.5711	0.0870	0.4449	0.7058
USA	0.4600	0.0717	0.3600	0.5700	0.5767	0.1286	0.4397	0.7959
VH1	0.1218	0.0218	0.0900	0.1600	0.2821	0.0520	0.1949	0.3485
Weather Channel	0.0982	0.0117	0.0800	0.1200	0.1291	0.0129	0.1082	0.1537

Notes: The statistics are computed for each channel (across years 2000–2010) per subscriber per month.

Table 15: Average Monthly Willingness to Pay in 2000 and 2010

Channel	2000	2010	Channel	2000	2010
ABC Family Channel	0.4104	0.6583	FX	0.2544	0.5832
American Movie Classics	0.5135	0.6784	Golf Channel	0.0231	0.0719
Animal Planet	0.3354	0.7020	Hallmark Channel	0.0000	0.4468
Arts Entertainment	1.1893	1.1645	HGTV	0.3961	1.0409
BET	0.1037	0.1494	History Channel	0.8098	1.5255
Bravo	0.0819	0.2788	Lifetime	0.9154	1.0583
Cartoon Network	0.4869	0.3970	MSNBC	0.3919	0.6918
CMT	0.0333	0.0751	MTV	0.4262	0.4383
CNBC	0.4587	0.4446	Nickelodeon	0.8484	0.7779
CNN	1.2532	1.2455	SyFy	0.2714	0.4713
Comedy Central	0.3325	0.5787	TBS	1.2675	1.5845
Discovery Channel	1.4027	1.4731	TLC	0.4468	0.8053
Disney Channel	0.8682	1.3498	truTV	0.1534	0.3617
E! Entertainment TV	0.2517	0.3430	Turner Classic Movies	0.1466	0.4962
ESPN	2.3553	3.8411	TNT	1.3634	2.1759
ESPN 2	0.2955	0.5526	USA	1.0077	1.6371
ESPN Classic Sports	0.0174	0.0352	VH1	0.1917	0.2072
Food Network	0.2897	1.1124	Weather Channel	0.7039	0.8051
Fox News Channel	0.6070	2.5057			

Notes: The averages are computed across all simulated households.

B Appendix: Data Collection

We take individual level bank and card transaction data from Yodlee in 2011–2013 and estimate household cable usage by zip code. We consider "debit" transactions only. The set of criteria that an individual needs to satisfy to be considered "the head of a domestic household" and counted towards the number of subscribers to a service provider is the following:

1. Has more than $500.0 in utility payments in the current year.[36,37]

2. Has both bank and card transactions present in the dataset.

3. The aggregate amount of US dollar transactions exceeds the aggregate amount of foreign currency transactions (measured in the US dollars).

Yodlee files do not contain user level geographic information. Consequently, zip codes in which Yodlee users[38] live are estimated. We treat the zip code of the grocery store most often visited by the member in a given year as the zip code of his or her living address. Zip codes of the grocery stores are taken from the 2012–2015 Yodlee files that contain merchant locations.

We estimate zip code level market shares for the following cable and satellite service providers: AT&T U-Verse, Bright House Networks, Cablevision, Charter, Comcast, Cox, DirecTV, Dish Network, RCN, Time Warner Cable, and Verizon FiOS. The rest of the providers are pooled into category "Other."

The cable/satellite service provider that a user subscribes to is taken from either the merchant name field (first choice) or the description field (second choice) of the "Cable/Satellite Services" transactions. We parse the descriptions searching for firm names listed in Table 16. The most popular firm in a given year is treated as the main service provider if

- Either there are 3 or more payments to that firm in the current year.

- Or at least one payment in the current year exceeds $100.0.

[36]Utility payments are taken from the transactions of type "Utilities."

[37]The date of the transaction is comes from "Post date" field.

[38]Henceforth, a (Yodlee) "user" or "member" refers to an account that satisfies the criteria for being considered the head of a domestic household.

If this does not lead to an estimate of the service provider in the current year we do a few other adjustments to ensure that we capture as many multichannel television subscribers as possible.

First, we try to fill in the gaps. We find the first preceding and succeeding years such that the service provider estimates are available. If these two estimates are the same as well as the zip code estimates for all three years, we conclude that the user subscribed to the same service provider in the current year.

Second, we try to capture those members that subscribe to AT&T U-Verse or Verizon FiOS and may be paying for the cable services together with the telephone/cell phone services. To do this we start by estimating the user's telephone service provider. Table 17 lists all the keywords we are searching for in the merchant names and descriptions of the "Telephone Services" transactions. Keywords "u-verse", "uverse", or "fios" clearly indicate that the member subscribes to AT&T or Verizon cable services. Otherwise, we count the user as a subscriber to a new (temporary) service provider, "Telco," if

- Either there are 3 or more payments to AT&T or Verizon in the current year.
- Or the aggregate amount paid to AT&T or Verizon divided by the number of payments to that firm exceeds $100.0.

We also require that the aggregate payments to AT&T and Verizon combined exceed $2,000.0 in the current year.

We fill in the gaps using the same procedure as the one described above.

Finally, if we are still unable to estimate the service provider, but the user has recurrent (at least 5 in the current year) check payments of the same amount between $100.0 and $150.0, we record the user as a cable subscriber to firm "Other."

We assume that the remaining Yodlee members do not subscribe to multichannel television (they are attributed to category "None").

Table 16: Cable / Satellite Service Providers

Firm	Spelling	Firm	Spelling	Firm	Spelling
Adelphia	adelphia				
Advanced Cable	advancedcable				
Allegiance	allegiance				
Armstrong	armstrong				
Atlantic	atlantic				
Comcast	alameda				
	cmcast				
	cmcst				
	comcast				
	comcst				
	xfinity				
DirecTV	directv				
	DTV				
Time Warner Cable	timewarner				
	twarner				
	twc				
Dish Network	dish				
	echostar				
Verizon FiOS	fios				
	verizon				
Mediatti Broadband	mediatti				
AT&T U-verse	att				
	at&t				
	at&t				
	uverse				
	u-verse				
Wave	astound				
	wave				
Other					

Notes: We search for all the alternative firm name spellings in the "Merchant Name" and "Description" fields of the transaction lines. The fields are transformed into lowercase and trimmed off whitespaces.

Table 17: Telephone / Cell Phone Service Providers

Firm	Spelling
AT&T	at&twire
MetroPCS	
Sprint	
T-Mobile	
US Cellular	
Verizon	

Notes: We search for all the alternative firm name spellings in the "Merchant Name" and "Description" fields of the transaction lines. The fields are transformed into lowercase and trimmed off whitespaces.

Appendix: Interpolation

We want to estimate zip level downstream market shares for years 2006–2010. However, Yodlee data is only available from 2011.[39] We rely on an interpolation technique described in this section.

First, we classify every service provider except AT&T U-Verse, Bright House Networks, Cablevision, Charter, Comcast, Cox, DirecTV, Dish Network, RCN, Time Warner Cable, Verizon FiOS, and special categories "Telco" and "None" as "Other."

Second, we take all AT&T and Verizon subscribers that (according to our estimation procedure) live in zip codes not served by the corresponding provider according to the Nielsen data. We divide these subscribers evenly between all zip codes that share the first three digits with their estimated zip code and that are served by AT&T or Verizon.[40]

Third, we split the "Telco" category into AT&T and Verizon depending on the provider availability in the current zip code. For example, if Verizon in present in the current zip code and AT&T is not, all "Telco" subscribers in the current zip code are attributed to Verizon. When both providers are present the "Telco" subscribers are divided evenly between them.

Fourth, if neither AT&T nor Verizon are present in the current zip code we divide the "Telco" subscribers between AT&T and Verizon in the zip codes that share the same first three digits with the current zip code.

We attribute to "Other" all AT&T subscribers in years before 2007 and all Verizon subscribers in years before 2006.

Fifth, we perform the interpolation. We estimate separate for each of the providers[41] the following numbers:

- The number of subscribers, $S_{i,1}$, in each of the zip codes in the first year when the firm enters that zip code, i (in time period 2006–2010).

- The growth rates, r_t, $t = 1, \ldots, T$ (depending on the provider we estimate at most $T = 6$ different numbers). Growth rate r_t determines the growth in the number of

[39] It is also available for the second half of 2010, but the data are limited and we ignore it.

[40] E.g. if a Verizon subscriber lives in a zip code not served by Verizon according to Nielsen, he/she is added to each of the zip codes within the same area with equal probability.

[41] AT&T U-Verse, Bright House Networks, Cablevision, Charter, Comcast, Cox, DirecTV, Dish Network, RCN, Time Warner Cable, Verizon FiOS, Other, None.

subscribers from year t to $t+1$. In other words, $S_{i,t+1} = S_{i,t}(1+r_t)$. These growth rates are assumed to be the same across zip codes, but different across providers.

These parameters are estimated by matching zip code level subscriber numbers in 2012 and national level subscriber numbers in 2006–2011 (the exact time periods differ depending on the provider).[42]

These estimates allow us to compute the number of subscribers to each of the listed provider in 2006–2010 and, consequently, the market shares.

Finally, as the zip code level number of subscribers in 2012 estimated from Yodlee data can be small, we shrink the obtained market shares towards the state level market shares using a procedure similar to that in Gandhi, Lu, and Shi (2013) to decrease the variance of our estimates. Let n_i^{2012} be the aggregate number of subscribers to all providers (including "Other" and "None") in zip code i in 2012 based on Yodlee data. For provider $f \in \mathcal{F}_{it}$ (where $\mathcal{F}_{it}$ is the set of all providers that serve zip code i in year t including "None") let s_{fit} be the market share obtained using the interpolation procedure described above. Let $st(i)$ denote the state that zip code i belongs to, and let $s_{fit}^{st(i)}$ the state level estimate of market share in zip code i computed using the following formula

$$s_{fit}^{st(i)} = \frac{n_{ft}^{st(i)}}{\sum_{g \in \mathcal{F}_{it}} n_{gt}^{st(i)}},$$

where $n_{ft}^{st(i)}$ is the state level number of subscribers to firm f in state $st(i)$ in year t.

We adjust the estimates of the market shares using the following expression

$$\tilde{s}_{fit} = \frac{n_i^{2012} s_{fit}}{n_i^{2012} + 1/s_{fit}^{st(i)}} = s_{fit} \frac{n_i^{2012} s_{fit}^{st(i)}}{n_i^{2012} s_{fit}^{st(i)} + 1} + s_{fit}^{st(i)} \frac{1}{n_i^{2012} s_{fit}^{st(i)} + 1}.$$

Hence, the closer is n_i^{2012} to zero, the more $\tilde{s}_{fit}$ will be based on the state level estimate, $s_{fit}^{st(i)}$. When n_i^{2012} goes to infinity, $\tilde{s}_{fit}$ approaches s_{fit}.

[42]We adjust the national level numbers so that the number of subscribers in 2012 in our dataset coincides with the total number of subscribers taken from the firm's financial report.