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The Digital Divide and Other Economic Considerations for Network Neutrality

Michelle Connolly[1] · **Clement Lee**[1] · **Renhao Tan**[1]

Abstract In its 2016 Broadband Report, the Federal Communications Commission (FCC) recognizes that a rural/urban digital divide remains prevalent—especially with respect to broadband adoption. It also highlights several policies that the FCC has undertaken purportedly to reduce the divide, including the 2015 Open Internet Order (OIO)—in which the stated intent is to enforce "network neutrality." However, long before the OIO, studies have raised concerns that network neutrality policies will discourage investment by internet service providers (ISPs) in broadband infrastructure, to the detriment of broadband accessibility, and may increase average consumer costs—both of which would only further exacerbate the digital divide. In this paper, we provide a holistic analysis of the effects of net neutrality on the digital divide; in doing so, we draw from recent economic research on this issue. Our goal is to present a range of economic considerations that should be taken into account when evaluating the overall impact of the OIO, with particular attention to its impact on the digital divide.

Keywords Net neutrality · Internet service providers · Content service providers · Digital divide · Telecommunications · Regulation · Open Internet Order · Welfare · FCC · Broadband

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✉ Michelle Connolly
mconnoll@duke.edu

[1] Department of Economics, Duke University, 213 Social Sciences, Box 90097, Durham, NC 27708, USA

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1 Introduction

In its 2016 Broadband Progress Report, the Federal Communications Commission (FCC) highlights that a digital divide remains prevalent, especially with respect to broadband access: "There continues to be a significant disparity of access to advanced telecommunications capability across America with more than 39% of Americans living in rural areas lacking access to advanced telecommunications capability, as compared to 4% of Americans living in urban areas, and approximately 41% of Americans living on Tribal lands lacking access to advanced telecommunications capability."[1] The 2015 Digital Divide Survey conducted by Pew Research finds that 21% of households in the US do not have internet in their households.[2]

The 2016 Broadband Report signals the FCC's intention to reduce this divide by expediting broadband deployment and fostering infrastructure investment through direct subsidies, the removal of obstacles, and the promotion of competition. The 2015 Open Internet Order (OIO) is the latest among the FCC's stated strategies to promote infrastructural investment and reduce the digital divide.[3] In both of these dimensions, however, there are strong economic arguments that suggest that OIO will accomplish neither and, in fact, will likely have the exact opposite effects.

Some scholars have described such purported benefits of the OIO as "speculative" (Hylton 2016). In fact, there is already potential evidence that investment by internet service providers (ISPs) has fallen due to the introduction of the OIO.[4] Moreover, among existing models that allow for consumers to enter and exit the market for internet service based on price and/or content value, there is a clear argument that the 2015 OIO may in fact worsen the digital divide rather than reduce it (as is claimed in the OIO).

A reasonably large theoretical literature already exists that focuses on the welfare effects of different possible regulatory applications of the concept of net neutrality.

[1] 2016 Broadband Progress Report, FCC, 2016, p. 3.

[2] The absence of internet service in a household does not necessarily result from a physical lack of access to broadband. For a majority of households without internet, those households *chose* not to subscribe to the internet for various reasons such as price, a perceived lack of relevance, or a lack of digital literacy. We detail these in Sect. 2.

[3] The 2015 OIO states "The record before us also overwhelmingly supports the proposition that the Internet's openness is critical to its ability to serve as a platform for speech and civic engagement, and that it can help close the digital divide by facilitating the development of diverse content, applications, and services" (FCC, note 77, p. 27).

[4] Using data from U.S. Securities and Exchange Commission (SEC) filings, Singer (2015) reports that the capital expenditure of major ISPs decreased from 2014 to 2015, including AT&T (−29%), Charter (−29%), Cablevision (−10%), and Verizon (−4%) and averaging −12% across wireline ISPs and −8% across all ISPs, including wireless ones. Singer calls this phenomenon 'remarkable', because such 'capital flight' was observed only twice in U.S. broadband history: during the 2001 dotcom meltdown and the 2009 recession. Singer (2015) considered other factors that could have resulted in ISPs' reducing capital expenditures, including changes in GDP, consumer expenditure and ISP revenue. However, these considerations suggested a positive environment for ISPs: ISPs should have increased expenditure under these circumstances. Hence, after eliminating possible confounding factors, Singer (2015) concludes that the decrease in ISP investment may be attributed to the introduction of the Open Internet Order.

Many have direct implications for investment and general welfare impacts.[5] Unfortunately, many existing models are insufficiently rich in their structural underpinnings to incorporate the possibility of a digital divide—much less consider how it might be affected by the FCC's Open Internet Order.[6] Here we highlight a few models that incorporate at least some factors that are relevant to the digital divide. We also suggest additional dimensions within previous models that have not yet been explicitly considered but would yield a more robust analysis of the various dimensions through which net neutrality regulation may impact this divide.

Hence, while not reviewing all existing models, we hope through a few models to illustrate not only what existing models suggest, but also where they are either limited or robust in their ability to address issues of relevance to broadband infrastructure investment and social welfare—with particular attention to the digital divide.

One thing to note is that the concept of net neutrality has been around since it was first coined by Wu in 2003. However, the regulatory application of this concept could have taken many forms: For example, early discussions of net neutrality envisioned a requirement of identical pricing or identical qualities of service from ISPs to all end customers. Other discussions envisioned not allowing ISPs to charge any prices to content service providers (CSPs) even for differentiated service like priority lanes, etc.

We leave a detailed discussion of the 2015 Open Internet Order to others.[7] Here we simply wish to note that one of the primary decisions within the 2015 Order was to prohibit ISPs from charging any fees to any CSPs—no matter how that CSP's service impacts network congestion, etc. Since much of the literature on the economic impacts of net neutrality was written before the FCC's 2015 order, existing models consider somewhat different regulatory applications of net neutrality. Results from pre-2015 papers nonetheless illustrate key outcomes that are possible once market transactions between ISPs, CSPs, and end users/consumers are regulated.

2 Content Service Providers

It is important to note that in more recent years much of the data traffic on the internet has been coming from video content—especially as CSPs like Netflix and YouTube have grown and started displacing traditional television services. Brennan (2016) points out that as of March 2015, over 52% of all downstream internet traffic

[5] Depending on the mechanisms that the authors choose to highlight in the creation of their models, a wide variety of welfare impacts have been suggested by different authors. We hope to choose a few key models to highlight which mechanisms drive which overall conclusions that have been put forward by certain authors and comment on whether these can or should be considered in isolation of other mechanisms when making claims about overall welfare implications.

[6] Most clearly, any models that consider only homogeneous consumers and/or do not allow end users the choice of simply opting out of the purchase of internet service, will by definition not be able to address certain aspects of the digital divide. Similarly, assumptions of homogeneous content service providers that all provide equal amounts of utility to consumers will have misleading welfare implications.

[7] Katz (2016) provides a list of conditions that are imposed by the OIO on broadband internet access service (BIAS) providers with respect to edge providers (content, application, service and device providers). These include no blocking, no throttling, no access charges, no paid prioritization, and no unreasonable interference/disadvantage standard.

came from videos from just Netflix and YouTube. BitTorrent made up 2.76%, while Facebook made up 2.65% of downstream internet traffic. Brennan underscores that while "it has been a slogan that BIAS providers should not be allowed to turn the Internet into cable TV, subscribers have already turned the Internet into the next video delivery mechanism."[8]

Beyond demonstrating that not all CSPs have the same impact on congestion for ISPs, these facts also underscore that not all CSPs are identical in terms of size, type of content provided, type of service provided, or value to consumers. This fact is crucial to understanding the validity of any welfare results that are derived from models that assume market conditions and consumer preferences that imply that the total social value of internet content increases with the total quantity of content. Such assumptions are unrealistic and bias welfare results in favor of market interventions that artificially encourage additional entry by CSPs.

3 The Digital Divide

The term 'digital divide' is commonly used to refer to the disparity in access to and/or use of digital technology across households based on urban versus rural locations and on socioeconomic differences across households. This divide is of concern to society since these technologies have the potential to shape an individual's access to economic opportunities (Norris 2001); among other things, unequal access to such technological tools can maintain or even worsen existing inequalities.

The digital divide is not a recent occurrence. Even during the mid-1990s, the National Telecommunications and Information Administration (1999) recognized that the digital divide is "one of America's leading economic and civil rights issues." As noted in the introduction, governmental agencies such as the FCC have since adopted policies in an attempt to reduce this divide. Despite these efforts, we continue to grapple with the digital divide—especially with respect to broadband adoption (Federal Communications Commission 2016).

Demographic factors, such as income and urbanity, contribute to the digital divide (NTIA 1999). The Pew Research Survey (2015) reports that the disparity in internet use is correlated with age, income, educational attainment, urbanity, and Spanish-speaking preference. For example, internet in the home stands at 48.5% among households with less than $25,000 income, and 92.7% for households with more than $100,000. The disparity in the ability of households to afford computers and internet subscriptions is a commonly cited reason for this phenomenon. Another explanation is the disparity in quality (or even the availability) of broadband infrastructure across geographies (Greenstein et al. 2016).

However, beyond price (cited by 19% of those without internet) and accessibility due to infrastructure (cited by 7% of those without internet), there exist other commonly overlooked reasons for the digital divide. In fact, a majority of Americans who do not have internet explain that this is because they do not find the internet relevant (34%), or lack digital literacy (32%) (Pew Research Survey 2015).

[8] Brennan (2016, p. 6).

Table 1 Pew research survey: Digital Divides 2015

Reasons given by respondents for lack of internet in the home	Percentage of responses (%)
Price—unable to afford	19
Accessibility—lack of infrastructure	7
Lack of relevance—content	34
Lack of digital literacy	32

In other words, the digital divide appears to be primarily driven by issues that are related to broadband adoption rather than broadband access (Table 1).

Whether the FCC's 2015 Open Internet Order ameliorates or worsens the digital divide will depend on how it affects price, accessibility, and content. Section 3 analyzes the effect of net neutrality on the price of accessing the internet to the end consumer. Section 4 examines how net neutrality impacts investment in broadband infrastructure and therefore access and quality of service. Section 5 looks at the potential impact of net neutrality on content quality and diversity, which in turn affects the relevance of the internet to individuals. Section 6 concludes.

4 Price

Among costs that are borne by an end consumer for internet use are last-mile fees that are paid to ISPs such as Time Warner Cable and any additional subscription fees that are paid to CSPs for services or content access (such as a subscription to Netflix). Since the OIO prevents ISPs from charging any fees to content providers, it will affect the last mile fees that ISPs charge end-users.

The formal economic analysis of last-mile fees relies on the standard two-sided market model (Armstrong 2006; Armstrong and Wright 2007). In a two-sided market model, ISPs provide platforms that bring together two sides of the internet market: CSPs and end consumers. In such a setup, consumers and CSPs benefit when more members of the opposite side of the market are using the same platform. Hence, the value of the platform increases when it is better able to attract both sides of the market. This effect is known as a network externality.

Armstrong (2006) shows that, in an unregulated market, a platform will aggressively try to attract the side of the market that exerts a larger positive externality on the other side. For example, Armstrong observed that credit card companies often aggressively woo consumers with discounts and other material incentives. This is driven by the credit companies' belief that the participation of consumers attracts retailers more than participation by retailers attracts consumers. In other words, the consumer side of the market is seen as having a larger positive externality on retailers (and their decision to accept a given credit card) than retailers are seen as having on consumers' decision to apply for and use a given credit card. In general, platforms that are connected to more valued end users can extract a larger surplus from the opposite parties, who value those end users' participation.

In the current market, at any point in time, each end consumer/household subscribes to a single ISP.[9] Hence, ISPs act as the gateway through which CSPs reach end consumers. Figure 1 illustrates this relationship. In an unregulated market, ISPs are able to extract surplus from CSPs when content providers value the connection to subscribed consumers in the ISP networks more than consumers value the connection to the content that is provided by CSPs. Therefore, in an unregulated market, ISPs have the incentive to transfer some surplus from CSPs to consumers in order both to retain existing customers and to attract new customers. Specifically, ISPs could charge CSPs higher prices in order to lower the last-mile fees for consumers in an attempt to maximize their end-user subscriptions.

However, with current net neutrality regulation as specified in the 2015 OIO, ISPs are not allowed to charge any fees to CSPs. Hence, ISPs are forced to generate revenue solely from last-mile fees, which is likely to result in an increase in the average price that is paid by end consumers. This rebalancing of the tariff is termed the waterbed effect (Genakos and Valletti 2012). While most existing literature does not dispute the validity of this effect, some papers claim that such a price increase for consumers may still result in overall welfare gains because of other potential benefits that are associated with net neutrality, such as increased content creation. The later sections in this paper will discuss the likelihood that such claims hold.

In addition to an increase in last-mile fees, the waterbed effect can have other secondary impacts on consumers. Hermalin and Katz (2007) examine the consequences of net neutrality policies that might force ISPs to provide a *single* speed of internet connection at the same price to all end consumers. Their model demonstrates that this results in: (1) the crowding-out of users who can only afford internet access with a lower quality of service; and (2) an average quality of service that is inadequate to meet the needs of the high-end users who are willing to pay more for a higher quality of service.

Although the exact regulatory conditions that are considered by Hermalin and Katz (2007) are somewhat different from the pricing restrictions that are imposed by the current OIO, their work underscores the tendency of price or quality regulations to affect both the quality of the service provided and market participation by consumers. In this example, low-end users who are only able or only willing to pay for a cheaper, albeit lower quality service, end up choosing to have no service at all once regulations force a single tier of service. Clearly, this would widen the digital divide.

Price restrictions on ISPs' ability to charge additional fees to CSPs that cause network congestion can lead to higher prices that are charged to all end users—regardless of whether or not the end user subscribes to the content service that causes the congestion (Greenstein et al. 2016; Hylton 2016; Becker et al. 2010). At the margin, this would cause the lowest-end users to simply stop subscribing to internet services, which would further exacerbate the existing digital divide.[10] The authors further consider a distance model to simulate a "not fully covered market."

[9] This holds if one ignores mobile broadband access.

[10] Economides and Tåg (2012, p. 93) do not allow for the possibility that some consumers could choose to not have internet service: "When the market is fully covered (so everyone has Internet access), network neutrality will always increase total surplus if content providers value consumers more than consumers value content providers. The reason for the unambiguous increase is the surplus loss arising when some

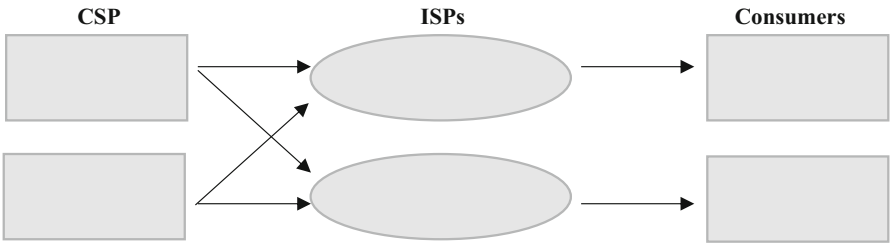

Fig. 1 Two-sided market of internet provision. *Arrows* represent connections with a platform and the direction indicates the flow of content

There they find that consumers and ISPs are unambiguously worse off under network neutrality and that the content sector is unambiguously better off, but that "there still exist parameter ranges for which network neutrality improves total surplus" (p. 100). This parameter range seems rather specific. More significantly, by explicitly shutting down almost all possible negative market effects from neutrality regulation, even this ambiguous finding should be considered tepid support for the statement that the model finds "parameter values such that network neutrality regulation increases total surplus suggesting that network neutrality regulation could be warranted even when some competition is present" (Economides and Tåg 2012, p. 91). The statement in Economides and Hermalin (2012, p. 603) that Economides and Tåg (2012) "find that, for most parameter values, total surplus is higher at zero fees" fails to restate the long list of limitations that the Economides and Tåg paper recognizes explicitly. And for low-end users who choose to continue subscribing, they are now paying a higher price all else being equal, essentially because of the demand for particular CSPs from higher-end users (Hylton 2016).[11]

Given the 2015 OIO, ISPs are forced to accept such negative externalities caused by only one or two current CSPs and be compensated instead by extracting surplus solely from end consumers. Within existing net neutrality regulations, there exist several tariff rebalancing options that can have reduced negative impacts on end consumers. As previously mentioned, ISPs may simply increase the price to end consumers. Alternatively (or in addition), ISPs may choose to increase profitability by: (a) lowering the quality of internet service that is provided; (b) restricting service to more profitable clients; or (c) imposing data caps on subscriptions.

Footnote 10 continued
content providers exit when positive fees are imposed on them." The authors state clearly that in this model they are abstracting from endogenous ISP investment, potential price discrimination by ISPs, and prioritization and congestion issues. Still, there are two further limitations implicit in this model: (1) if consumers are ot allowed to leave the market in this exercise, then there can by definition be no impact of pricing or quality on consumer participation (and thus by definition any possible negative welfare impact on consumers through their exiting of the market for internet is ignored); (2) the model's results rely on the assumption that the social value of content to consumers increases linearly with the number of content providers: All content providers provide the exact same positive marginal value to consumers, and this marginal value does not decrease with the total number of content providers. Hence, if any content provider exits the market, consumer welfare always decreases.

[11] Michael Powell also made this argument at the Free State Foundation's Fifth Annual Telecom Policy Conference on March 21, 2013.

For example, if an ISP is not allowed to charge a CSP such as Netflix, whose streaming service uses disproportionate amounts of data relative to other types of content on the internet, an ISP can instead increase surplus extraction from end consumers by charging customers on the basis of not just speed tiers but also data traffic usage tiers.[12] Such pricing mechanisms would effectively neutralize the "net-neutrality" order (Katz 2016; Greenstein et al. 2016).

5 Investment in Broadband Infrastructure

Internet usage in the United States has grown steadily over the past few decades. This growth was made possible with the expansion of broadband infrastructure that was largely initiated by profit-seeking ISPs. Prior to 2010, the FCC did not interfere directly with these infrastructural developments; the Commission had established only four principles of net neutrality in 2005 (FCC 2005), which existed essentially in name only until the promulgation of the Open Internet Order in December 2010. This hands-off approach contributed to the ten-fold increase in high-speed broadband lines since 2002 and gave more than 87% of individuals and 79% of households in the United States access to the internet (Pew Research Survey 2015; World Bank 2015).

To understand how net neutrality affects the digital divide through access and quality, we need to examine the abilities and incentives of ISPs to pursue network investment given the imposition of pricing rules. As previously discussed, such rules diminish ISP profit (all else being equal) and will cause ISPs to attempt to offset this loss. As summarized in Becker et al. (2010), this can have five general consequences:

1. a reduction in geographic scope of broadband,
2. a fall in the internet's backbone capacity,
3. an increase in congestion and fall in quality of service (QoS),
4. a decrease in the number of ISPs in a given area, and
5. a rise in the price to connect to the net.

A key aspect of quality of service is how well content is transmitted to the end user. The effect of net neutrality on the allocative efficiency of bandwidth and congestion is therefore relevant. First, we note that different content has different demands for bandwidth. For example, content is said to be *time sensitive* if its quality is adversely degraded by delays. A common argument is that net neutrality, which prohibits the prioritization of such content over less time-sensitive ones, could result in an allocatively inefficient use of bandwidth (Wu and Yoo 2007).

[12] Gryta and Ramachandran (2016) already noted the increased use of broadband data caps by ISPs: "Consumer complaints to the Federal Communications Commission about data caps rose to 7904 in the second half of 2015 from 863 in the first half, according to records reviewed by The Wall Street Journal under the Freedom of Information Act. As of mid-April, this year's total was 1463." (WSJ, April 22, 2016).

Choi and Kim (2010) is one of the few papers that finds conditions under which a monopolistic ISP *might* increase investment under network neutrality regulations. This is a model with two CSPs, a fixed volume of traded content, and queuing to reflect possible congestion and rationing of scarce bandwidth. In their model, network neutrality means that the monopolistic ISP is not allowed to provide a two-tiered service with a priority/fast lane and a slower lane. They find that such regulation may or may not increase ISP investment in bandwidth, and thus improve social welfare, depending on whether a network access fee effect (where greater capacity increases the fee that the ISP can charge consumers for access) or a rent extraction effect (where greater capacity lowers the fee that the ISP can charge a content provider for a priority lane) dominates.

Economides and Hermalin (2012) also consider a monopolistic ISP, but assume congestion that is based on an endogenous volume of traffic. In such a setting, they find that the ability of an ISP to discriminate "unambiguously results in the ISP installing greater bandwidth. This effect is welfare enhancing."[13] However, the authors then suggest that "if household utility is a significantly greater component of welfare than content providers' profits, then network neutrality can still be the welfare-superior policy even accounting for the ISP's bandwidth-building incentives."[14] It should be noted that Economides and Hermalin appear to ignore ISP profits in their calculations of total welfare and that their model is set up in such a way that the total amount of content that is traded in equilibrium is a sufficient statistic for welfare.

Economides and Hermalin (2012) do a far more complete job than almost all other existing research of trying to incorporate different dimensions of the two-sided market. For example, they allow for variation in the time-sensitivity of content, endogenous entry of content and service providers, endogenous investment in bandwidth, and diminishing marginal utility for content all within a single model. Still, the model is inherently limited by its setup, which yields the result that "welfare is in fixed proportion to the total amount of content sent" and that "content providers' gross profits increase in the amount they sell by a constant factor."[15] Both of these are limiting assumptions that significantly affect the estimated total welfare effects in the paper.

Even with these assumptions, Economides and Hermalin (2012) still find only certain parameter conditions under which the consumer welfare gains from content increase under network neutrality regulations are sufficiently large as to offset the welfare losses from decreased ISP bandwidth provision. Specifically, their definition of total welfare increases under net neutrality regulations if and only if their "equilibrium consumer surplus factor" is at least 1.3 times the value of a content provider's "equilibrium gross profit factor."[16] This condition is more likely to hold in their model if the incentive for an ISP to increase bandwidth when it is able to charge content providers is small. There is no explanation given for whether this is a

[13] Economides and Hermalin (2012, p. 605).

[14] Ibid.

[15] Ibid, pp. 609–610.

[16] Ibid, p. 619.

likely condition to hold. The authors further explain that consideration of heterogeneous consumers would also lead their net welfare results to show additional losses due to neutrality regulations.[17]

Unlike Choi and Kim (2010) and Economides and Hermalin (2012), Njoroge, Ozdaglar, Stier-Moses, and Weintraub (2013) consider a duopoly setting for ISPs. They provide a game theoretic two-sided market model where two interconnected ISPs compete over quality and prices for both heterogeneous CSPs and heterogeneous consumers. In this model, ISPs' quality-investment levels are determined by the trade-off from softening price competition on the consumer side and increasing revenues from content providers. Without neutrality regulation, ISPs extract surplus from the CSPs, which leads to higher investment levels. Consumer surplus increases both because of a fall in ISP last-mile fees and because of improved platform quality. What is particularly interesting is that despite having some surplus extracted by the ISPs, the improvement in quality of service ends up increasing the profits of content providers. Hence, Njoroge et al. (2013) provide a two-sided model with duopoly ISP competition in which overall ISP investment (and social welfare) is higher without the imposition of network neutrality regulations.

Ultimately, the absence of mandated net neutrality allows CSPs to pay for priority access if it is profitable for them.[18,19] If anything, net neutrality constrains the market to allocating bandwidth equally across applications. This cannot result in allocative efficiency if the marginal utility from additional bandwidth for the applications differs.

All else being equal, the ability of ISPs to maintain differential prices among CSPs enables greater investments and higher quality and coverage of service, including in geographical areas that have low returns on investments. Again this implies that the OIO will likely lead to decreased investment relative to the absence of such regulation and will help to maintain the digital divide by further slowing investment in lower return geographic areas.

6 Content Quality and Diversity

The internet is valuable by virtue of its ability to connect people and to deliver content and services from one party to another. Whether the internet is relevant to individuals depends on whether it provides content and services that they value. Content diversity and quality are therefore crucial when appropriately considering *heterogeneous* consumers. This rests on the assumption that with rising content quality and diversity, not only will a given consumer find greater utility, but also more people may find information or services on the internet that are relevant to their particular interests or tastes. In our analysis that follows, we broadly define

[17] Ibid, p. 622.

[18] The fact that some CSPs pay content delivery networks to help provide faster access to their content demonstrates that some CSPs find such actions to be profitable.

[19] Katz (2016, p. 25) further points out that there are "well established conditions … under which paid prioritization *facilitates* entry" (emphasis in the original).

content quality as the inherent value of the content to viewers and *diversity* as the variety of content types that are available.

Proponents of net neutrality argue that such regulation will raise content diversity and quality through three possible mechanisms:

1. by acting as a subsidy to content (Lee and Wu 2009)[20];
2. by preventing anti-competitive behavior that prioritizes the content that is affiliated with ISPs; and
3. by preventing the possibility of censorship by ISPs.

Even if as a society we wish to subsidize content creation (1), this would be a poor method (Katz 2016).[21] Moreover, as pointed out by Katz (2016) there is no obvious social reason why content creation is deserving of greater subsidization than end users or broadband infrastructure. There is even less obvious a social reason why content creation is deserving of subsidization *at the expense of* end users and broadband penetration and adoption. Finally, given the nature of at least certain types of content creation, policies to encourage entry of CSPs may actually lead to inefficient entry and hence lower quality and diversity of content; In markets that are marked by innovation/creation, greater market concentration may lead to greater innovation.[22]

The second concern brought up in the literature is that ISPs may engage in anti-competitive behavior by prioritizing affiliated content or blocking applications that diminish their revenues sources (Cerf 2006; Frischmann and van Schewick 2007; van Schewick 2007); Krämer and Wiewiorra 2012). Such behavior would raise the cost of entry for and diminish the profitability of independent content providers, thereby diminishing total opportunities for content innovation.

[20] Choi and Kim (2010, p. 466) suggest that net neutrality regulations could potentially increase CSP profit margins and incentives for investment in content (since a monopolist ISP would be prevented from potentially extracting rent from CSPs for utilizing high priority channels). However, they find that the privately optimal level of rent extraction by the ISP depends negatively on the efficiency of a content provider's R&D process and positively on the cost differentials between the two content providers. The authors conclude, "We find that the relationship between the net neutrality regulation and investment incentives is subtle. Even though we cannot draw general unambiguous conclusions, we identified key effects that are expected to play important roles in the assessment of net neutrality regulations."

[21] Katz (2016, pp. 10–11) has a good discussion of why banning access fees is an inefficient means of "subsidizing creativity" even if one agrees that this is socially desired. Moreover, he emphasizes that this means of subsidization likely harms end users by reducing broadband penetration and decreasing adoption.

[22] Schumpeter (1942) first posited that imperfectly competitive markets are conducive for innovation. Accordingly, he argued that measures that are taken to reduce market concentration could reduce technical progress. Since then, much empirical literature on this topic has followed, but results have broadly been unable to either support or reject this "Schumpeterian hypothesis". Arrow (1962) famously opposed this hypothesis because he believed that "the preinvention monopoly power acts as a strong disincentive to further innovation." Arrow argued that, even though firms with strong monopoly power may have the ability to innovate, they would not have the incentive to do so. More recent research has demonstrated market structures in which the threat of entry can be sufficient to provide incentives for innovation by current market leaders (Peretto 1996; Tirole 1992).

Although this anti-competitive behavior is a theoretical possibility, there has to date not been significant evidence of such behavior.[23] The simple threat of possible exclusion does not justify costly regulation, especially given the existence of antitrust laws. Furthermore, it should be noted that, by design, different network platforms are better suited for different content applications. Therefore, even if ISPs do engage in some form of product differentiation, the content applications that they respectively prioritize would most probably differ. Yoo (2005) points out that this might be good for society insofar as "it allows for greater experimentation with different ways to take advantage of technological differences".[24]

The final concern that is raised by proponents of net neutrality is that ISPs may be able effectively to censor content by significantly raising the price that they charge or by reducing the bandwidth that they assign to particular CSPs. Such a scenario would not only diminish the diversity of content, but also threaten the role of the internet as a platform for free speech. However, ISPs have incentives *not to censor* popular content since doing so could cause consumers to switch to other ISPs that still offer this desired content and would lead to a lowered willingness to pay on the part of end consumers for connecting to the censoring ISP (Connolly and Prieger 2013; Katz 2016; Becker et al. 2010; Jamison and Hauge 2007).[25]

Some studies have explicitly attempted to understand how net neutrality might affect content diversity through its effects on the market structure of the creation and provision of content. Within imperfectly competitive industries that are marked by high fixed costs for innovation or creation, several market traits are particularly important to the determination of market outcomes.

To illustrate, let us consider just the market for the provision of video content on the internet. In this market, we know that all of the firms that compete to provide video content to consumers are not identical. But exactly how are they different?

[23] Brennan (2016) points out that the FCC cited only two cases in the ten years prior to the OIO as instances that definitely would have been in violation of the 2015 OIO.

[24] Yoo (2005) suggests that it is possible to think of ISPs as firms that operate under classic Chamberlinian monopolistic competition in which product differentiation could allow for short-run supernormal profits. Yoo notes that one way that product differentiation might exist is through protocol nonstandardization. This means that if there is sufficient heterogeneity in content application, multiple networks may "coexist simply by targeting their networks towards the needs of different subgroups […] and it [is] possible for three different last-mile networks to coexist: one optimized for traditional Internet applications such as e-mail and website access, another incorporating security features to facilitate ecommerce and to guard against viruses and other hostile aspects of Internet life, and a third that prioritizes packets in the manner needed to facilitate time-sensitive applications such as streaming media and VoIP.

[25] Using firm-level FCC Form 477 data from June 2005 to June 2008, Connolly and Prieger (2013) find much larger rates of absolute broadband service provider entry and exit within markets defined by zip codes than can be measured when considering only the publically available data on net changes in the number of broadband firms in that market. This suggests that at the zip code level, there is far more competition (and churn by broadband providers themselves) that occurs than is generally recognized when the data involve only the total number of broadband providers that are present in a market at any one point in time. This finding holds both for disaggregated markets (zip code levels) and for the national U.S. market. Moreover, as early as 2008, FCC data suggest that 99.7% of zip codes in the U.S. had two or more providers of high-speed internet lines (FCC 2009). At the consumer level, Becker et al. (2010) note that data from 2007 and 2008 demonstrated similar rates of customer churn in broadband services as among other telecommunications services such as cable and cellphones.

- Do they each provide completely different content, or do some have overlapping content?[26]
- Is the social value of the content of each provider different?
- Are the providers equal in size? Do they provide equal amounts of content? Or will some firms be large aggregators of content (like Netflix) that provide not only a large quantity, but also a large variety of content, while other firms will be small and highly specialized in the provision of particular types of content?
- Do providers face the same costs, whether in terms of content creation or content delivery?
- How many firms will the market support?

This long (and incomplete) list highlights the complexity of interactions between all of these market dimensions and hence how complex any modeling of even just the provision of video content can be. Current models that attempt to consider the impact of net neutrality regulations have therefore tended to focus on just one or perhaps two dimensions of the CSP market.

For example, some models consider only product differentiation (without differences in social value); some consider only differences in market concentration; some consider differences in time sensitivity; etc. In each case, the conclusions with respect to the impact of net neutrality regulation on the quantity and quality of content are accurate when focusing only on a single dimension of competition in this market, but are also necessarily inaccurate to the extent that other dimensions of competition in the market are ignored.

As previously mentioned, Economides and Hermalin (2012) assume that the content that is traded increases with the number of CSPs. There is therefore a positive effect from neutrality regulations on the numbers of CSPs and thus directly on content volume, since each CSP is assumed to have differentiated content.[27] Many existing models make the assumption that with an increase in CSPs, there will be an increase in the volume of content. In turn, there is a reasonable implicit assumption that as content volume increases, diversity and value of total content increase.

There is, however, a caveat to the initial assumption: Specifically, the assumption that more CSPs inherently increase the diversity and overall value of content is a reasonable assumption when there is no duplication of content or services by CSPs and when entry by new CSPs does not lead to too great a diversion of resources from other CSPs. We will come back to this point below.

Among papers that are focused particularly on heterogeneous CSPs and the creation of content, most find that the possibility of prioritization of content (absent net neutrality regulation) leads to an increase in content (Reggiani and Valletti 2016; Krämer and Wiewiorra 2012; Hermalin and Katz 2007).

Reggiani and Valletti (2016) present a congestion model with endogenous investment in infrastructure and advertising-supported CSPs. Absent neutrality

[26] If different content, are these substitutes or complements?

[27] This positive content effect is only under certain parameters that are large enough to offset the negative ISP investment effect in their model.

regulations, prioritization redirects resources towards a large CSP and the ISP, and away from small CSPs. This could be seen as decreasing the diversity of content, *if* one assumes that smaller fringe firms can now provide less unique content. Still, both total content and infrastructure investment increase, which leads to overall welfare gains in the absence of net neutrality regulations.

Krämer and Wiewiorra (2012) demonstrate that if the congestion-sensitivity of CSPs is uniformly distributed, then prioritization leads to greater ISP investment in broadband infrastructure and thereby allows for the entry of new, congestion-sensitive CSPs. This increases content variety, broadband investment, and welfare.[28]

Finally, Hermalin and Katz (2007) suggest that by restricting all CSPs to using bandwidth of the same quality and price, net neutrality prices out applications that would only purchase low quality bandwidth—for example, email services that are less time-sensitive than video streaming services may not derive additional value from priority access. In this way, net neutrality would reduce content diversity.

We note again that a frequently made assumption in discussions of net neutrality is that content diversity depends positively on the number of CSPs. This assumption could be true if: (a) additional firms offer content that is not readily provided by existing CSPs; and (b) if the entry of new CSPs does not divert too many resources from existing CSPs.

6.1 Duplication of Content

In many cases there is overlap in content and services that are provided by CSPs. Hence it is not necessarily true that the addition of another CSP will guarantee new and clearly differentiated content or services.

Consider digital music service providers such as Spotify and Pandora: They have hugely duplicative song offerings because they know that not having a large enough selection of popular songs would limit their ability to attract and retain customers. If a new digital music service provider wishes to enter the market and gain significant market share, as did Apple Music in 2015, it will offer much of the same music that is currently provided by other digital music service providers. Moreover, the presence of bundling of content for at least some CSPs (such as Netflix, Spotify, etc.) means that they will have a greater incentive when creating or adding content, to add content that is more differentiated from the existing content that they provide.[29] In other words, for certain types of CSPs, greater diversity of content may

[28] Greenstein et al. (2016, p. 144) put forward the possibility that non-net neutrality may in fact help smaller CSPs, who unlike large CSPs, do not have "other means to deal with the congestion issue." In other words, smaller CSPs that lack vast financial resources could choose to pay ISPs more for greater bandwidth to deal with data congestion, since the smaller CSPs may be unable to invest in more expensive solutions (e.g., data compression technologies, data handling algorithms). Such an option is unavailable under net neutrality.

[29] With bundling of content, profitability increases with the addition of dissimilar content since it increases the number of subscribers (of differing tastes) who will be willing to subscribe to a particular service such as Hulu or Netflix. In particular, the economics of bundling suggests that the most profitable addition to a programming bundle is for content that is *negatively correlated* with content that is already offered in the bundle. As an illustration, Crawford and Cullen (2007, p. 388) simulate outcomes

result when there is increased concentration of resources among similar types of CSPs.[30]

6.2 Reduction in Efficiency from Over Entry

In terms of the market structure of imperfectly competitive industries (such as those that create and provide content), additional entry by firms will divert resources from other CSPs and may actually lead to a fall in total content, content quality, and content diversity. Reggiani and Valletti (2016) provide the only model of which we are aware that currently allows for this type of market structure effect within the discussion of network neutrality. However, this is a well-known possibility within models of industrial organization. In essence, in markets that are defined by innovation/creation, greater market concentration may lead to greater innovation, rather than less.[31]

Economies of scale allow larger CSPs both to create and to provide more content. Netflix has many such original series, as does Amazon Prime and other large

Footnote 29 continued
in an "average" cable television market to see the effects of selling channels in bundles on cable operators and on subscribers. They find that the two key factors in determining the impact of bundling on profits and welfare were "the difference between marginal cost and mean WTP [Willingness-to-Pay] for [channels] and [negative] correlation in that WTP for [channels]." This also implies that bundling will cause more niche programing to be carried (Crawford 2008).

There has also been related empirical research on playlists that are offered by radio stations. While radio stations do not create original content as do some CSPs, radio stations do choose their playlists in an attempt to maximize profits. From these studies, we observe that commonly owned stations in the same radio market do not wish to cannibalize each other and hence seek to differentiate their format and/or playlists. Sweeting (2016, p. 1) examines station airplay logs and finds that a "common owner of stations playing the same type of music in the same local radio market differentiates their playlists and their audiences increase." In a similar vein, Chipty (2007, p. 3) examines the effect of radio ownership on content diversity with the use of cross-sectional format information as well as content information that uses data for all U.S. stations in the third quarter of 2005. Chipty finds that "Consolidation of radio ownership does not diminish the diversity of local format offerings. If anything, the market level analysis suggests that more concentrated markets have less pile-up of stations on individual format categories, and that large national radio owners offer more formats and less pile-up." She additionally finds that "stations operating in markets with other commonly owned stations achieve higher ratings, than do independent stations."

[30] It is worth noting that instead of product differentiation based on song offerings, music streaming services have focused on product differentiation based on the user's listening experience. According to Waelbroeck (2013), these differentiations include: "the quality and comfort of listening (with or without advertising); repeated listening of the same title or album; degrees of flexibility with listening on demand, interactive or semi-linear streaming; portability with playlists being transferable to smartphone." It is however not immediately clear that the increase in consumer utility from these types of product differentiation strategies fully offsets the potential reduction in efficiency from duplication of content and (as we discuss next) possible decreased economies of scale arising from the accommodation of more CSP entrants.

[31] This is similar to the model that was put forward by Horstmann and Markusen (1986), where protectionist trade policies lead to inefficient entry and higher average costs of production in imperfectly competitive markets.

CSPs.[32] Net neutrality policies that artificially encourage additional entry by small CSPs in content and application services that are marked by significant innovation costs would well actually lead to lower levels of socially valued content both in terms of quantity and in terms of diversity.

7 Conclusion

On balance, existing economic models with more realistic underlying structural assumptions predict that the Open Internet Order is more likely to result in higher last-mile prices, lower infrastructure investment, and poorer content quality and diversity. From this perspective, economic theory seems to support Singer's (2015) suggestion that the Open Internet Order has already played a role in discouraging ISP investment. If the models hold true, the Open Internet Order will—contrary to its intent—only further worsen the digital divide.

We have not here proposed our own model to estimate the impact of the 2015 OIO's application of the concept of net neutrality. However, there are key features that any such model would need if it wishes to fully consider the dynamic and endogenous market outcomes under the imposition of these new regulations:

- Heterogeneous consumers: needed to consider digital divide issues. Differences in preferences are important to the adoption of broadband due to perceived relevance and quality of service, and to the social value of diversity of content.
- Heterogeneous CSPs: needed to consider allocative efficiency issues, both in terms of prioritization and in terms of resources for innovation.
- Endogenous entry and exit of CSPs: needed to consider market structure effects.
- Non-monopolistic ISPs: needed to compete for both consumers and CSPs and consequently endogenously determine investment in broadband infrastructure.

It is commonly assumed that ISPs enjoy monopoly power while CSPs are small and fragmented. Evidence of significant broadband provider turnover (Connolly and Prieger 2013)—as well as the presence of large, influential CSPs such as Netflix, Google, and Facebook—suggest that this assumption is both misguided and misleading. Armstrong and Wright's (2007) analysis of two-sided markets suggests that market structure and power dynamics can considerably change the outcomes. Moreover, the assumption that the encouragement of entry in a market always increases the value or the efficiency with which outputs are produced does not necessarily hold for CSPs with significant innovation/creation costs.[33]

In this article, we have reviewed recent developments in the economic understanding of net neutrality, and analyzed studies that are relevant to

[32] It is worth noting that not only is this content original but also that at least some of this original content has had significant success with end consumers. It is not simply the diversity, but also the quality of content (from the end consumer's perspective) that matters when estimating the net impact of any policy on consumer welfare.

[33] Horstmann and Markusen (1986) provide a nice example of how government policies can lead to inefficient entry and reduced social welfare in imperfectly competitive markets.

understanding the effects of the Open Internet Order on: (1) last-mile price; (2) internet infrastructure investment; and (3) content quality and diversity. These are all factors that influence the digital divide. On balance, models that focus on aspects that are particularly relevant to the digital divide suggest that network neutrality regulation is more likely to worsen than improve the digital divide, based on these three factors.

The FCC's 2015 Open Internet Order is a regulation that can have profound impact on the internet industry and the consumers it serve. The social welfare considerations in question are not trivial.

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