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NETWORK NEUTRALITY AND THE ECONOMICS OF AN INFORMATION SUPERHIGHWAY: A REPLY TO PROFESSOR YOO

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ABSTRACT: Network neutrality has received a great deal of attention recently, not just from legal academics and telecommunications experts, but from our elected representatives, the relevant agencies and the press. Our article directly replies to a series of articles published by Professor Christopher Yoo on this topic. Yoo's scholarship has been very influential in shaping one side of the debate. In our article, we explain the critical flaws in Yoo's arguments and present a series of important arguments that he and most other opponents of network neutrality regulation ignore.

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The Real Tragedy of the Internet Commons is Ignoring the Comedy[1]

In a series of law review articles, Professor Christopher Yoo has argued against network neutrality regulation and in favor of what he calls network diversity.[2] Yoo mounts a sophisticated economic attack on network neutrality, drawing from economic theories pertaining to congestion, club goods, public goods, vertical integration, industrial organization, and other economic subdisciplines. Yet he draws selectively. For example, his discussion of congestion and club goods is partial in that he ignores the set of congestible club goods that are most comparable to the Internet—public infrastructure. Yoo focuses on the negative externalities generated by users (that is, congestion) but barely considers the positive externalities generated by users (he simply assumes that they are best internalized by network owners). Yoo appeals to vertical integration theory to support his trumpeting of "network diversity" as the clarion call for the Internet, but he focuses on the teaching of the Chicago school of economics and fails to consider adequately the extensive post-Chicago school literature.

In this article, we reply to Professor Yoo's writings on the economics of network neutrality, particularly his recent article on network neutrality and the economics of congestion, and present many arguments that he ignores.

I. NETWORK NEUTRALITY

A. The Debate

Network neutrality has received a great deal of attention recently, not just from legal academics and telecommunications experts, but from our elected representatives, the relevant agencies and the press.[3] Our representatives have held multiple hearings on network neutrality and are actively considering whether to include a provision aimed at preserving network neutrality in

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1. We are alluding to the "tragedy of the commons" and the "comedy of the commons." The former is a story of how common access to a resource (say, a pasture) leads to a situation where social costs exceed social benefits because of overuse, and thus, we need to constrain access-use. The latter is a story of how common access to a resource (say, a road system) leads to a situation where social benefits exceed social costs because of increasing returns to use, and thus, we encourage use—the more, the merrier, as Carol Rose famously put it. And that appears to be the crux of the network neutrality debate—is there more tragedy or comedy with an Internet commons?

2. *See generally* Christopher S. Yoo, *Network Neutrality and the Economics of Congestion*, 95 GEO. L.J. 1847 (2006) [hereinafter Yoo, *Economics of Congestion*]; Christopher S. Yoo, *Beyond Network Neutrality*, 19 HARV. J.L. & TECH. 1 (2005) [hereinafter Yoo, *Beyond Network Neutrality*]; Christopher S. Yoo, *Would Mandating Network Neutrality Help or Hurt Broadband Competition?: A Comment on the End-to-End Debate*, 3 J. TELECOMM. & HIGH TECH. L. 23 (2004) [hereinafter Yoo, *Mandating Network Neutrality*].

3. *See* sources cited *infra* notes 4–6.

pending telecommunications reform legislation.[4] The Federal Communications Commission and the Federal Trade Commission are also considering the issue.[5] The press has been drawn to the debate by declarations that the fate of the Internet as we know it is at stake.[6]

The current Internet infrastructure evolved with the so-called "end-to-end" design principle as its central tenet.[7] To preserve the robustness and evolvability of the network and to allow applications to be easily layered on top of it,

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4. *See, e.g.*, *Net Neutrality: Hearing Before the S. Comm. on Commerce, Science & Transportation*, 109th Cong. (2006), *available at* http://commerce.senate.gov/public/_files/30115.PDF; *Network Neutrality: Competition, Innovation and Nondiscriminatory Access, Hearing Before the Task Force on Telecom and Antitrust of the H. Comm. on the Judiciary*, 109th Cong. (2006), *available at* http://judiciary.house.gov/media/pdfs/printers/109th/27225.pdf.

5. *See, e.g.*, FEDERAL TRADE COMMISSION STAFF REPORT, BROADBAND CONNECTIVITY COMPETITION POLICY (2007), *available at* http://www.ftc.gov/reports/broadband/v070000report.pdf; Federal Communications Commission, Notice of Inquiry, Broadband Industry Practices (FCC filed (WC Dkt. No. 07-52, FCC 07-31), *available at* http://fjallfoss.fcc.gov/edocs_public/attachmatch/FCC-07-31A1.pdf.

6. *See, e.g.*, Steven Levy, *When the Net Goes from Free to Fee*, NEWSWEEK, Feb. 27, 2006, at 14; Editorial, *Stuck in Neutral*, WALL STREET JOURNAL, Mar. 8, 2006, at A20; Editorial, *Tollbooths on the Internet Highway*, N.Y. TIMES, Feb. 20, 2006, at A14; Catherine Yang et al., *At Stake: The Net as We Know It*, BUSINESS WEEK, Dec. 26, 2005, at 38.

7. There are two versions of the end-to-end arguments: a narrow version, which was first identified, named and described in a seminal paper by Saltzer, Clark and Reed in 1981, Jerome H. Saltzer et al., *End-to-End Arguments in System Design*, 1981 2ND INT'L CONF. ON DISTRIBUTED COMPUTING SYS. 509 (a revised version of the paper was later published as Jerome H. Saltzer et al., *End-to-End Arguments in System Design*, 2 ACM TRANSACTIONS ON COMPUTER SYS. 277, 278 (1984)), and a broad version, which was the focus of later papers by the same authors and others. Marjory S. Blumenthal & David D. Clark, *Rethinking the Design of the Internet: The End-to-End Arguments vs. the Brave New World*, 1 ACM TRANSACTIONS ON INTERNET TECH. 70, 71 (2001); David P. Reed et al., *Commentaries on "Active Networking and End-to-End Arguments*," 12 IEEE NETWORK 66, 69 (1998). While both versions have shaped the original architecture of the Internet, only the broad version is responsible for the application-blindness of the network and is therefore relevant to the network neutrality debate. For a detailed analysis of the two versions and their relationship to the architecture of the Internet, see BARBARA VAN SCHEWICK, ARCHITECTURE AND INNOVATION: THE ROLE OF THE END-TO-END ARGUMENTS IN THE ORIGINAL INTERNET (forthcoming 2008) (manuscript at 87–129, on file with Authors). *See also* LAWRENCE LESSIG, THE FUTURE OF IDEAS 34–35 (2001); Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 917, 1007 (2005); Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925, 930–33 (2001).

Although often conflated, network neutrality is not equivalent to retaining the end-to-end architecture of the Internet. On one hand, the application-blindness of the network is only one consequence of applying the broad version of the end-to-end argument; thus, the broad version of the end-to-end argument is much broader than network neutrality. On the other hand, network neutrality does not necessarily require end-to-end compatible protocols, such as the Internet Protocol.

Still, the conflation of network neutrality with end-to-end is understandable because of the historical connection between the two principles. The blindness made possible by technology and end-to-end design disabled network providers from discriminating effectively among either uses or users. Technology has shifted so as to enable effective discrimination, and now the central issue to be resolved (through the political process) is whether to continue that disability through legal means.

the broad version of this design principle recommends that the lower layers of the network be as general as possible, while all application-specific functionality should be concentrated at higher layers at end hosts.[8] It is implemented in the logical infrastructure of the Internet through the Internet Protocol which provides a general, technology- and application-independent interface to the lower layers of the network.[9] As a consequence of this design, the network was application-blind; this prevented infrastructure providers from distinguishing between the applications and content running over the network and from affecting their execution.[10]

End-to-end design sustains an infrastructure commons[11] by insulating end users from market-driven restrictions on access and use.[12] If infrastructure providers follow the broad version of the end-to-end arguments, they cannot distinguish between end uses, they cannot base access decisions or pricing on how those packets may be used; nor can they optimize the infrastructure for a particular class of end uses. Functionally, the end-to-end principle acts as a limitation on the property rights of network owners, much like fair use operates as a limitation on the rights of copyright owners.[13]

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8. *See* VAN SCHEWICK, *supra* note 7 (manuscript at 96–105) (describing the broad version).

9. *Id.* (manuscript at 116–23) (describing how the Internet Protocol implements the two versions of the end-to-end arguments). Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 17 HARV. J.L. & TECH. 85, 91 (2003) (describing how the Internet Protocol implements the end-to-end architecture).

10. VAN SCHEWICK, *supra* note 7 (manuscript at 101–03) (describing how the application of the broad version leads to a network that is application-blind); Lemley & Lessig, *supra* note 7, at 931.

11. We use "infrastructure commons" as shorthand to refer to an infrastructure resource that is accessible to users on a nondiscriminatory basis (regardless of the users' identity or intended use). Frischmann, *supra* note 7, at 925, 933–38; *see also id.* at 974–78 (analyzing the case for managing infrastructure as commons).

12. LESSIG, *supra* note 7, at 46; Frischmann, *supra* note 7, at 1007–22. This and the next paragraph are adapted from Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 294–96 (2007).

13. We recognize that this analogy is contestable on many levels. Our point is not to make a grand point about copyright and property law, a topic Frischmann takes up elsewhere. *See* Brett M. Frischmann, *Evaluating the Demsetzian Trend in Copyright Law*, 3 REV. L. & ECON. (forthcoming 2007) *available at* http://ssrn.com/abstract=855244. We are simply saying that the functional impacts of network neutrality and fair use are comparable in terms of the manner in which they construct commons and the underlying purpose for doing so. *See* Frischmann & Lemley, *supra* note 12, at 294–95 (making this point); *see also* Posting of Brett Frischmann to Madisonian.net Blog, Lessig on Fair Use and Network Neutrality, http://madisonian.net/archives/2006/05/22/lessig-on-fair-use-and-network-neutrality (May 22, 2006) (exploring the point in a post and an extended series of comments); Posting of Lawrence Lessig to Lessig Blog, *Fair Use and Network Neutrality*, http://www.lessig.org/blog/archives/003410.shtml (May 21, 2006) (same); *cf.* Frischmann, *supra* note 7, at 1002–03, 1007–08 (explaining how fair use and the end-to-end architecture sustain commons).

There is considerable pressure for change: pressure to replace the existing "dumb," open architecture with an "intelligent," restrictive architecture capable of differentiating and discriminating among end uses and end users; pressure for property rights evolution so that network owners may more fully internalize externalities and appropriate the value of the Internet. This pressure comes from many sources, including the Internet's evolution to broadband (infrastructure, applications, and content), the rapid increase in users, demand for latency-sensitive applications such as video-on-demand and IP telephony, demand for security measures and spam regulation measures implemented at the "core" of the Internet, and, more generally and importantly, demand for increased returns on infrastructure investments.[14]

In response to these pressures, technology has become available that enables network owners to "look into" the packets traveling across their networks to determine the application or Web page they belong to and affect the transport of packets based on this information.[15] At the same time, the Federal Communications Commission has removed most of the regulations that governed the behavior of providers of broadband networks in the past by classifying the provision of broadband Internet access services over cable or DSL as an "information service" which is regulated under Title I of the Communications Act.[16]

These developments have given rise to the network neutrality debate. Network neutrality proponents are concerned that network providers[17] may use the new technology to exclude applications and content from their networks or discriminate against them. They contend that the threat of discrimination will reduce unaffiliated application and content developers' incentives to innovate;

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14. Blumenthal & Clark, *supra* note 7, at 71.

15. *See, e.g.*, Steven Cherry, *The VoIP Backlash*, IEEE SPECTRUM, Oct. 2005, at 61, 61; CISCO SYSTEMS, INC., CISCO IOS QUALITY OF SERVICE SOLUTIONS CONFIGURATION GUIDE, 105 (2006), http://www.cisco.com/application/pdf/en/us/guest/products/ps6350/c2001/ccmigration_09186a0080789b65.pdf. This technology violates the broad version of the end-to-end arguments described sup*ra* note 7, see VAN SCHEWICK, *supra* note 7, but as the end-to-end arguments are just a design principle, there is nothing that forces technology to comply with it.

16. Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, 20 F.C.C.R. 14,853, 14,857 (2005). Previously, the FCC's decision to classify the provision of broadband Internet access services over cable modems as an "information service" was upheld by the Supreme Court. Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 1002 (2005) (affirming Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities, 17 F.C.C.R. 4798 (2002)).

17. Throughout this paper, the term "network provider" refers to the owner of a physical network, whether it is vertically integrated with the provider of Internet access and transport services over this network or not, and to an Internet service provider that offers Internet access and transport services over a physical network without being vertically integrated with its owner. The discrimination-enabling technology described in the text is available to all of them.

and that the resulting reduction in application-level innovation[18] will be bad for society.[19] More generally, network neutrality proponents fear that allowing network providers to exclude applications, content or other uses at will or to discriminate against them may significantly reduce the Internet's value for society.[20] According to them, the value of the Internet as a general purpose technology does not stem from the existence of the Internet as such, but from the benefits resulting from the use of the Internet in all areas of the economy and society, and from the benefits derived from the various private, public, and nonmarket goods produced by users that depend upon the Internet as an essential input.

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18. Throughout the text, the term "application-level innovation" denotes a broader set of innovative activities than may be immediately apparent. Network neutrality analysis focuses on the relationship between "the network" and "applications." In the context of the four layer model of the Internet Architecture used by the Internet Engineering Task Force, "the network" consists of the network layer and the Internet layer, while the "applications" domain consists of the transport layer and the application layer. *See, e.g.*, LARRY L. PETERSON & BRUCE S. DAVIE, COMPUTER NETWORKS: A SYSTEMS APPROACH 27–30 (3d ed. 2003). Economically, "the network" comprises two distinct layers of economic activity: the operation of physical networks and the provision of Internet access and transport services over these networks. Depending on whether the owner of a physical network is vertically integrated into the provision of Internet access and transport services or not and on whether it has decided to give unaffiliated Internet service providers the opportunity to offer Internet access and transport services over its network, these two activities may or may not be provided by two different economic actors. *See also* Barbara van Schewick, *Towards an Economic Framework for Network Neutrality Regulation*, 5 J. TELECOMM. & HIGH TECH. L. 329, 337–338 (2007).

In line with this use of the term "applications," the term "application-level innovation" is not restricted to innovation in applications in the usual sense of the word, but refers to all innovative activities taking place in the applications domain, that is, above "the network," in other words, above the level of Internet access and transport services. For example, this may include innovations in applications content or portals or innovation involving new ways of using the Internet that do not fall in the former categories. While the term innovation is often understood to refer to innovation by commercial innovators only, we will use it to refer to commercial and noncommercial innovators alike. This use of the word is quite common in the network neutrality context. *See, e.g.*, Lawrence Lessig, *Re-Marking the Progress in Frischmann*, 89 MINN. L. REV. 1031, 1041 (2005). Just to give an example, user-generated content would be a form of application-level innovation, too. Similarly, the terms "applications developer" is used as a shortcut to denote all innovators engaged in application-level innovation.

19. *See Net Neutrality*, *Hearing Before the S. Comm. on Commerce, Science & Transportation*, 109th Cong. 8–9 (2006) (testimony of Prof. Lawrence Lessig, Stanford Law School) [hereinafter Lessig, *Testimony*], *available at* http://commerce.senate.gov/pdf/lessig-020706.pdf; *Network Neutrality: Competition, Innovation and Nondiscriminatory Access*, *Hearing Before the H. Judiciary Comm. Telecom and Antitrust Task Force*, 109th Cong. 4–5 (2006) (statement of Prof. Tim Wu, Columbia Law School) [hereinafter Wu, *Testimony*], *available at* http://www.judiciary.house.gov/media/pdfs/wu042506.pdf; *Ex parte* Submission of Tim Wu and Lawrence Lessig, Cable Modem Declaratory Ruling and NPRM 5–7 (FCC filed August 25, 2003) (CS Dkt. No. 02-52) [hereinafter Wu & Lessig, *Ex parte*], *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6514683885. For a detailed economic theory along these lines, see van Schewick, *supra* note 18.

20. As Frischmann explores elsewhere in detail, Internet users engage in a wide variety of socially valuable activities without being innovative. *See* Frischmann, *supra* note 7, at 1012–20.

Network neutrality rules are designed to prevent all this from happening. In other words, network neutrality rules would prevent network providers from excluding applications or content from their networks or from discriminating against them.[21] While network neutrality proponents disagree whether certain types of behavior should be forbidden under a network neutrality regime or not,[22] a ban on blocking of and discrimination against applications and content is at the core of all network neutrality proposals.

In the legal community, Professor Christopher Yoo has become the most vocal and prominent legal scholar arguing against network neutrality; his arguments have garnered significant attention and traction in the network neutrality debate.[23] Yoo mounts a sophisticated economic attack on network neutrality, drawing from economic theories pertaining to congestion, club goods, public goods, vertical integration, industrial organization, and other economic subdisciplines. For someone not familiar with these theories, Yoo's theoretical case against network neutrality may seem persuasive. Yet there are aspects of these theories that make his case much less convincing than it appears. Therefore, our goal in this article is to reply to Yoo's writings, in particular to his recent article on network neutrality and the economics of congestion, and to highlight many arguments that he ignores.

B. The Economic Arguments

We focus on the following three arguments:

1. In his article on network neutrality and the economics of congestion, Yoo draws on the economics of congestion to present a new justification for some of the use restrictions that have been observed in practice. According to

21. This definition focuses on the core aspect of network neutrality that is part of all network neutrality proposals. *See* van Schewick, *supra* note 18, at 382.

22. More specifically, network neutrality proponents disagree whether certain practices should be considered "discrimination" under a network neutrality regime. In particular, network neutrality proponents disagree whether a network neutrality regime should allow Quality of Service, and, if yes, whom network providers should be allowed to charge for it. Other areas of disagreement concern the extent to which price discrimination should be possible. We do not enter this part of the debate here. A closer look at these issues shows that network providers' interest in the practices discussed in this part of the debate seems to be mostly driven by a desire to capture more of the value that is currently captured by users on the one hand and application and content providers on the other hand. While such a desire seems more innocent than the anticompetitive motivations discussed later in the text, allowing network providers to discriminate among users and uses in order to extract more value from users or application and content providers may be more problematic than it appears. Frischmann has addressed some of the dangers elsewhere. *See* Frischmann, *supra* note 7, at 978–80 (discussing potential problems associated with price discrimination with regard to access to infrastructure); *Id.* at 1009–12 (discussing potential problems with shifting to Quality of Service); *Id.* at 1015–22 (discussing the social value of sustaining an Internet infrastructure commons); Frischmann & Lemley, *supra* note 12, at 295–98 (similar discussion).

23. *See, e.g.* FEDERAL TRADE COMMISSION STAFF REPORT, *supra* note 5 (extensively citing Yoo in addressing network neutrality).

him, certain use restrictions constitute an efficient means to force users to internalize congestion costs. By showing that there are efficient instances of discrimination that would be prohibited under a general ban on blocking and discrimination, Yoo intends to rebut the case for per se illegality of blocking and discrimination.

We take up this argument in Part II, below. As we demonstrate, Yoo's attempt to justify use restrictions on the basis of the economics of congestion lacks the theoretical support that he claims. While the existing literature on the economics of congestion has focused on the choice between flat-rate pricing and usage-sensitive pricing as means prevent congestion, Yoo presents use restrictions as the overlooked solution to the problem of forcing users to internalize congestion costs.[24] Based on speculations that the transaction costs of metering usage are prohibitively high, Yoo advocates use restrictions as an institutional arrangement that forces users to internalize congestion costs while minimizing transaction costs. Despite the complexity of Yoo's theoretical arguments, his analysis of the economics of congestion leads to a simple conclusion: leave it to the network owners to decide how best to manage congestion on their networks, and rest assured that they will do what is sensible from a social perspective.

Our analysis reveals a number of problems with this theory: First, transaction costs are not prohibitively high. Contrary to Yoo's speculations, Internet technology does not present any major obstacles to metering usage. Standardized technology is available that enables network providers to meter usage; network providers in other countries routinely take advantage of these technologies to offer a variety of different pricing plans. In the absence of high transaction costs, the case for employing use restrictions as Coasean proxies, that is, as proxies for metering usage, is considerably weakened at best.

Second, Yoo's comparison of the different institutional arrangements for internalizing congestion costs is incomplete: in focusing on transaction costs, Yoo neglects the fact that the different means for internalizing congestion costs involve different social costs. As we show, Yoo either marginalizes or ignores them. More generally, in focusing on the problem of how to force users to internalize the negative externalities associated with additional uses, Yoo overlooks the potential positive externalities associated with these uses.

Third, Yoo's confidence in network providers' ability to do what's best for society is not justified. As we show, network providers are not necessarily in a position to internalize the social costs associated with measures to reduce congestion; there is a wedge between their private interests and social interests in this respect, and it is this wedge that network neutrality regulation intends to address.

24. *See* discussion *infra* Part II.

Beyond theory, a close analysis of the examples analyzed by Yoo reveals that only one of the six classes of use restrictions discussed by Yoo actually constitutes a useful proxy for bandwidth-intensive uses, while also being relevant to the network neutrality debate. Thus, even if Yoo's general theory on the economics of congestion had merit, it is less relevant to the network neutrality debate than it might seem.

2. Yoo argues that instances of anticompetitive discrimination are far too limited to merit a blanket restriction on discrimination. Drawing on Chicago school reasoning with respect to vertical integration, he argues that in most cases, exclusionary conduct by network providers is unlikely to be anticompetitive. Based on the theory that competition in the market for Internet access services will prevent anticompetitive conduct in complementary markets and that the relevant market for determining the amount of competition is the nationwide market for Internet access services, he argues that the relevant nationwide market for Internet access services is sufficiently competitive to mitigate the problem.

We address this argument in Part III.A below. As we show, Yoo fails to fully engage the vast post-Chicago literature on the limits of the one monopoly rent argument as well as recent research applying this literature to the network neutrality context. As this literature shows, incentives to discriminate are far more widespread than Yoo makes it appear. Moreover, such incentives exist not only if the network provider is a local monopolist in the market for last-mile broadband access. Contrary to what is commonly assumed, even limited competition in the local market is not sufficient to remove the ability and incentive to discriminate. In any event, the disciplining effect of competition—to the extent it exists—depends on the amount of concentration in the local market for Internet access services. To the extent that network providers discriminate on the basis of application, the resulting reduction in independent providers' incentives to innovate reduces the overall amount of innovation in the markets for complementary products. Because of the characteristic of the Internet as a general purpose technology, such a reduction has the potential to significantly limit economic growth.

3. Yoo rejects calls for network neutrality regulation because of their impact on competition in the market for last-mile broadband access. This is based on the belief that the most important goal of communications policy should be to increase competition in this market, which is less competitive than the markets for applications and content.

We engage this argument in Part III.B below. Yoo contends that network neutrality regulation would harm competition in the market for broadband Internet access and reduce network providers' incentives to invest in infrastructure. As we show, the impact of network neutrality regulation on competition in the market for last-mile broadband networks is not as bad as Yoo makes it seem.

It is correct, though, that by preventing network providers from discriminating against unaffiliated providers in the market for complementary products, network neutrality rules would reduce network providers' profits and, consequently, their incentives to invest in the deployment of broadband networks. Thus, there is a trade-off that network neutrality proponents recognize as well. The degree to which incentives would be dampened is unknown, however, and remains a subject of speculation.

The extent of the problem is unclear right now, but even if there is a problem, it is far from obvious whether the solution is to refrain from network neutrality regulation and enable network providers to discriminate against content and applications. By focusing only on the market for last-mile broadband networks, Yoo not only neglects the importance of unfettered application-level innovation for realizing economic growth and the role of a nondiscriminatory access regime in fostering the production of a wide range of public and nonmarket goods. His argument also neglects other ways to solve the problem of broadband deployment that would not impede competition and innovation in complementary markets.

II. THE ECONOMICS OF CONGESTION AND USE RESTRICTIONS

As the title of his recent article in the Georgetown Law Journal suggests, Yoo believes that the "economics of congestion" are important to resolving the network neutrality debate.[25] He suggests that the superficial appeal of network neutrality and the freedoms end users realize under a nondiscrimination regime reflect a narrow view of consumer welfare and that a wider view that takes into account the fact that the Internet is subject to congestion is needed.

Yoo identifies Internet congestion as a problem in need of solution. He looks to the extensive theoretical literature exploring the economics of congestion, with particular emphasis on the theory of club goods and comparative analyses of flat-rate pricing and usage-sensitive pricing.[26] As the literature on club goods and the economics of congestion shows, usage-sensitive pricing may be better able to deal with congestion than flat-rate pricing schemes, because it forces users of the congestible good to internalize the negative externality that their additional uses of the good impose on other users. If, however, the transaction costs associated with metering usage are prohibitively high, using so-called "Coasean proxies" may be a better way of solving the congestion problem. According to Yoo, the use restrictions we are seeing can be interpreted as Coasean proxies.

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25. Yoo, *Economics of Congestion*, *supra* note 2, at 1852–54, 1863–85.
26. Yoo, *Economics of Congestion*, *supra* note 2, at 1864–72.

In this Part, we explain what Yoo ignores and where he errs. We attack his argument on several levels: We begin within Yoo's frame, focusing on the economics literature on club goods and congestion, and question whether the conclusions he draws are based on the literature (we do not think so) or his speculation about the transaction costs of metering usage. It turns out that, contrary to Yoo's speculation, the transaction costs of metering usage are not prohibitively high, as the pricing praxis in other countries shows. Thus, usage-sensitive pricing may well be a viable alternative to using Coasean proxies.

We then examine what Yoo's frame ignores, the infrastructural nature of the Internet. Because of his narrow frame, Yoo fails to consider fully the potential social costs of network discrimination. With respect to internalizing congestion externalities, relying on Coasean proxies to meter usage entails social costs that usage-sensitive pricing does not. Thus, as a matter of economic theory (to which Yoo strongly appeals), use restrictions are not necessarily the most efficient way of dealing with congestion. More generally, measures designed to force users to internalize congestion costs may have unintended social costs by reducing the positive externalities associated with additional uses. Furthermore, contrary to Yoo's assertion, the social costs associated with use restrictions are not necessarily internalized by network owners.

Finally, we question whether the specific examples of use restrictions that Yoo analyzes support his argument against network neutrality regulation. Only some of the use restrictions mentioned by Yoo constitute effective Coasean proxies for metering usage; thus, even if his theory were correct, it could not be used to justify all of the use restrictions he discusses. Moreover, not all of the use restrictions mentioned by Yoo would be prohibited under network neutrality rules. Thus, his argument is less relevant to the network neutrality debate than it might seem.

A. Club Goods and Congestion (Negative Externalities)

The physical infrastructure of the Internet—the interconnected networks—is a partially nonrival resource, meaning that it is sharable but congestible. Infrastructures are sharable in the sense that the resources can be accessed and used by multiple users at the same time. Infrastructure resources vary in their capacity to accommodate multiple users, however, and this variance in capacity differentiates nonrival (infinite capacity) resources from partially nonrival (finite but renewable capacity) resources. Infrastructure resources of finite but renewable capacity are congestible.

Congestion is a function of capacity and the degree to which one person's consumption of a resource affects the potential of the resource to meet the demands of others. Whether a resource is congested often depends on such conditions as how the resource is managed, the number of users, and the available capacity. Consider, for example, a resource with finite, sharable capacity, such as a computer network or a highway. Up to a point, the marginal costs of allowing an additional user to access and use the resource are zero; beyond that point, the marginal costs become positive and increase with each additional user. Many partially nonrival resources are only sometimes congested, depending upon the number of users and available capacity at a particular time. Highways, in real space and cyberspace, offer excellent illustrations. During off-peak hours, consumption of these resources is often nonrivalrous. At these times, users do not impose costs on other users and the marginal cost of allowing an additional person to use the resource is zero. At some point, however, nonrivalrous consumption turns rivalrous and congestion problems arise. Congestion on the highway or on the Internet is a function of variable demand imposed on a system with finite capacity. As a general matter, congestion dissipates over time and the capacity of the resource is renewed.

Yoo notes that partially nonrival resources have been analyzed as club goods. According to Yoo, a swimming pool is the "paradigmatic example of a club good," and economists have also applied club theory to "a wide range of facilities, including golf courses, theatres, laundromats, restaurants, and roads."[27] These resources are also sharable and congestible. Facility owners manage congestion efficiently when the costs of congestion are internalized and reflected in prices that consumers pay to use facilities. There are a variety of pricing mechanisms employed by facility owners to internalize congestion costs, and the relative attractiveness of different mechanisms depends upon contextual factors and transaction costs. Generally, usage-sensitive pricing, which essentially adjusts price based on the capacity consumed and the capacity available,[28] outperforms flat rate pricing as a congestion cost internalization mechanism, although the transaction costs of implementing usage-sensitive pricing may be prohibitive. Thus, with respect to internalizing Internet congestion costs, it is possible that usage-sensitive pricing may outperform flat rate pricing. However, it also is possible that the transaction costs from usage-sensitive pricing may dominate, although technological developments may reduce the transaction costs of metering usage.[29] If network congestion is truly the economic problem to solve, then usage-sensitive pricing probably is (or will be) an appropriate solution, at least in the long run.

Assuming congestion is a problem,[30] Yoo rejects both potential solutions—usage-sensitive pricing and flat rate pricing—and instead suggests that the congestion issue has been poorly framed as a choice between these two types of pricing schemes. Putting aside the vast economics literature on con-

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27. Yoo, *Economics of Congestion*, *supra* note 2, at 1864 (footnote omitted).

28. In the literature, the appropriate usage-sensitive price is derived as follows: "The classic solution is to impose a usage-sensitive price that is equal to the congestion costs imposed by the last unit consumed. In this way, usage-sensitive pricing aligns incentives by bringing private costs into line with the true social costs of consuming an additional unit." Yoo, *Economics of Congestion*, *supra* note 2, at 1864.

29. *Id.* at 1864–72.

30. Although subject to debate, we do not challenge this assumption in this article.

gestion and club goods, Yoo turns his attention to "Coasean proxies," where network owners charge for another good "that can be metered more cheaply and that can serve as a reasonable proxy for usage of the good that needs to be metered."[31] This move by Yoo is rather difficult to understand on its face because he offers no evidence to show that such proxies are cheaper mechanisms for metering usage (that is, capacity consumption) in the presence of congestion than the tools ordinarily employed by owners of club goods. (Nor does he consider the potential social costs of relying on Coasean proxies, which is an issue we discuss in the following sections.)

Having explained that the high transaction costs involved with metering and billing for telephone service led to flat rate pricing for telephone calls,[32] Yoo speculates that "[b]ecause Internet-based communications operate on fundamentally different principles, the transaction costs associated with metering Internet traffic are likely to be even more significant than those associated with local telephone service."[33] According to him, "it is thus quite plausible that the transaction costs needed to establish and run a properly calibrated usage-based pricing regime may be sufficiently large to make alternative pricing arrangements economically desirable. Furthermore, even if metering is economical in the long run, the inevitable lag in creating such a metering system may lead Internet providers to rely on alternative institutional arrangements [, such as Coasean proxies] on a transitional basis."[34]

However, the transaction costs of metering usage are not prohibitively high. In fact, usage-sensitive pricing is currently available as an alternative to using Coasean proxies. Contrary to Yoo's speculations, Internet technology does not present any major obstacles to accounting for end users' internet usage. In most networks, end users access the Internet via a single gateway, the network access server.[35] As all data sent to and from the Internet traverses the network access server, it is the natural place to account for the use of the Internet connection.[36] Once a user disconnects from the network, technology

31. Yoo, *Economics of Congestion*, *supra* note 2, at 1873–74. Yoo appeals to Ronald Coase's famous discussion of lighthouses, but this story does not add much. At best, the lighthouse story suggests that port usage was a decent indicator of lighthouse usage—if you used the port, you used the lighthouse, and so, port usage fees are a decent mechanism for privately financing lighthouse construction and maintenance. But again, this says very little about which type of pricing mechanism best alleviates congestion, and it does not say anything meaningful about how to finance Internet infrastructure.

32. *Id.* at 1868–70.

33. *Id.* at 1875.

34. *Id*.

35. *See* D. MITTON & M. BEADLES, REQUEST FOR COMMENTS 2881: NETWORK ACCESS SERVER REQUIREMENTS NEXT GENERATION (NASREQNG) NAS MODEL 1 (2000), *available at* http://www.ietf.org/rfc/rfc2881.txt ("A Network Access Server is the initial entry point to a network for the majority of users of network services. It is the first device in the network to provide services to an end user, and acts as a gateway for all further services.").

36. Thus, contrary to Yoo's view, the fact that different packets may travel across different routes after they have passed the network access server, is irrelevant for accounting purposes. *See* Yoo, *Economics of Congestion*, *supra* note 2, at 1875.

allows network operators to store usage data, such as time spent on the Internet and the number of packets sent and received, and transfer it to another computer.[37] This technology is widely in use. For example, German DSL operators offer a variety of pricing plans, such as pay-per-minute, pay-per-bandwidth, flat-rate etc., based on this technology.[38] The widespread use of usage-sensitive pricing plans in countries such as Germany suggests that the costs associated with metering of and billing for Internet usage are not prohibitive.

Because technology for metering usage is already available, there is no need to use Coasean proxies on a transitional basis until a system for metering usage is deployed. However, as Yoo correctly points out, perfect internalization of congestion externalities on a per-packet basis might be difficult and costly to accomplish because of the need to dynamically adjust the price for each packet on the basis of overall system or network capacity available.[39] This raises the question of whether the use of Coasean proxies can be justified on a transitional basis until a system is deployed that can implement this perfect form of usage-sensitive pricing.[40] While congestion pricing that reacts dynamically to the state of the network may lead users to perfectly internalize the effect of their behaviour on congestion, such a system may not be necessary or even worth the effort. There are a variety of ways to implement congestion-sensitive or usage-sensitive pricing based on the existing technology for metering usage. Even a crude system of peak load pricing based on the time of day might suffice to effectively limit congestion; the objective from an efficiency perspective is not necessarily to internalize all congestion externalities.[41] In any event, given that technology for metering usage is already available, an analysis of the economics of congestion needs to compare the relative

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37. Usually the data is transferred to a RADIUS server. *See* C. RIGNEY ET AL., REQUEST FOR COMMENTS 2865: REMOTE AUTHENTICATION DIAL IN USER SERVICE (RADIUS) 16 (2000), *available at* http://www.ietf.org/rfc/rfc2865.txt. On accounting extensions for RADIUS, see C. Rigney, REQUEST FOR COMMENTS 2866: RADIUS ACCOUNTING 17–18 (2000), *available at* http://www.ietf.org/rfc/rfc2866.txt. Contrary to Yoo's assumptions, this data can be transmitted once for each connection to the Internet. Yoo, *Economics of Congestion*, *supra* note 2, at 1875. Accordingly, there is no need to store a separate record for each packet sent or received.

38. *See, e.g.*, T-Online, Analog/ISDN, http://www.dsl.t-online.de/c/11/67/14/86/11671486 .html (last visited Oct. 28, 2008) (showing multiple pay per use offerings); Arcor, Weitere Tarife zum Surfen: Arcor-Internet by Call, http://www.arcor.de/privat/ibc_tarife.jsp (last visited Oct. 28, 2008) (same); Alice, Alice Light, http://www.alice-dsl.de/kundencenter/export/de/residential/ produkte/alice_light/details/index.html (last visited Oct. 28, 2008) (same). *See* Holger Bleich, *Aufbewahrungsverbot: Gericht untersagt Speicherung von dynamisch zugewiesenen IP-Adressen*, C'T 15/2005 at 32, *available at* http://heise.de/ct/05/15/032.

39. *See* Yoo, *Economics of Congestion*, *supra* note 2, at 1875. Perfect internalization of congestion externalities requires that the usage-sensitive price is equal to the congestion costs imposed by the last unit consumed. *See supra* note 28. The congestion costs of the last unit consumed depend, among other things, on the current load of the system.

40. Yoo, *Economics of Congestion*, *supra* note 2, at 1875.

41. *See* Frischmann & Lemley, *supra* note 12, at 276–84.

social costs and benefits of use restrictions with (imperfect) usage-sensitive pricing. We address this issue below.[42]

Although Yoo appears to engage in comparative analysis of congestion internalization mechanisms, he does not. It seems his objective is simply to defend the rationality of network owners who choose to employ Coasean proxies. Yoo goes on to conclude:

> The significance of these transaction costs reveals why Internet providers might be interested in experimenting with alternative ways to manage the costs of congestion by forcing those who consume large amounts of bandwidth to bear the costs created by their actions. From this perspective, it would be quite sensible for providers to charge higher prices to those who engage in bandwidth-intensive activities. If enforcement of these bandwidth limits proves too costly, it may prove more efficient to prohibit certain bandwidth-intensive applications altogether.[43]

What Yoo seems to be missing is that no one really thinks that network owners are acting irrationally. It might very well be "sensible" from the network owners' perspective to stick with flat rate pricing systems in general and then "experiment" with tiering and other forms of discrimination (perhaps to deal with congestion, perhaps to price discriminate).[44] Those arguing for network neutrality are primarily concerned with the social costs of discrimination, including the impact on innovation. No one disputes whether or not network owners might sensibly discriminate. The debate is whether discrimination is sensible from a *social* perspective.

Ultimately, Yoo's analysis of the economics of congestion boils down to a common—but unpersuasive—refrain: leave it to the network owners to decide how best to manage congestion on their networks, and rest assured that they will do what is sensible from a social perspective. We suppose this might make sense if the only or primary economic issue was how best to internalize congestion costs. But Internet congestion costs are only part of the picture, the tragedy of the Internet commons. As we mentioned at the outset, the real trag-

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42. *See infra* Part II.D. We do not aim to resolve in this paper whether and to what extent congestion needs to be priced. Instead, we argue that to the extent congestion is a problem and measures that force users to internalize congestion are called for, pricing adjustments aimed at internalizing congestion costs can and should be implemented on a per-packet basis without determining the price based on the identity of user or use (application).

43. Yoo, *Economics of Congestion*, *supra* note 2, at 1875–76.

44. It is unclear whether Yoo is truly interested in internalizing congestion costs; the Coasean proxy argument better fits a different form of metering, price discrimination, which is metering on the basis of one's willingness to pay. Price discrimination is beyond the scope of this article, but we note that its welfare effects, in this context especially, are ambiguous at best. *See* Joseph Farrell, *Open Access Arguments: Why Confidence is Misplaced*, *in* NET NEUTRALITY OR NET NEUTERING: SHOULD BROADBAND INTERNET SERVICES BE REGULATED, 195, 199–201 (Thomas M. Lenard & Randolph J. May, eds., 2006); *see also* Frischmann, *supra* note 7, at 978–80.

edy is ignoring the comedy, ignoring the social benefits derived from an open, nondiscriminatory Internet.

B. Infrastructure and Spillovers (Positive Externalities)

Professor Yoo relies heavily on the economics of some traditional club goods. But the Internet is not really comparable to a private swimming pool or a golf course or any of the other congestible club goods Yoo focuses on; nor is it comparable to a lighthouse.[45] The Internet is infrastructural and socially valuable in ways that these goods are not. Like traditional club goods, infrastructure, such as road systems and the electricity grid, as well as the Internet, are also sharable and congestible. In contrast with traditional club goods, however, these infrastructure resources are *general purpose* resources that generate value primarily as *inputs into a wide variety of productive activities* engaged in by users. Users generate and realize value at the "ends."

Swimming pools, golf courses, restaurants, and the like do not serve as infrastructural inputs; such club goods are *special purpose* facilities designed to deliver primarily *consumptive* goods. Users purchase access to such facilities in order to consume the particular goods and services provided—swim in the pool, golf, or eat food.[46] Users usually appropriate most of the value associated with their consumptive uses; there are no positive externalities associated with additional uses, and many pricing mechanisms, including usage-sensitive pricing, lead to an efficient result. By contrast, uses of infrastructure resources often generate positive externalities that users cannot easily appropriate.

The Internet is currently a *mixed infrastructure* that supports the production of a wide variety of private, public, and nonmarket goods—many of which yield socially valuable spillovers.[47] Unlike a cable system or the various club facilities discussed above, the Internet is not optimized for the delivery of commercial content. While a significant amount of commercial exchange occurs over the Internet,[48] the Internet is a general purpose, enabling platform for users. Common nondiscriminatory access to this platform facilitates widespread end-user participation in a variety of socially valuable productive activities. As Frischmann described in more detail elsewhere,

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45. *See supra* note 31.

46. It is rather surprising that Yoo fails to consider infrastructure because the Internet's physical infrastructure is economically more comparable to other infrastructure than traditional club goods like swimming pools and restaurants. Yoo does acknowledge that the FCC has drawn analogies between the Internet and a road system, but he fails to go much further. Yoo, *Economics of Congestion*, *supra* note 2, at 1860.

47. *See* Frischmann, *supra* note 7, at 1005–08, 1016–20.

48. It is worth noting that the commercial interactions that take place over the Internet vary considerably in form and extend well beyond mere content delivery. *See* U.S. CENSUS BUREAU, U.S. DEP'T OF COMMERCE, E-STATS 2 (2006), http://www.census.gov/eos/www/2005/2005reportfinal.pdf (estimating e-commerce transactions at almost two trillion dollars in 2005).

> End-users . . . engage in innovation and creation; they speak about anything and everything; they maintain family connections and friendships; they debate, comment, and engage in political and nonpolitical discourse; they meet new people; they search, research, learn, and educate; and they build and sustain communities.
>
> These are the types of productive activities that generate substantial social value, value that too easily evades observation or consideration within conventional economic transactions. When engaged in these activities, end-users are not passively consuming content delivered to them, nor are they producing content solely for controlled distribution on a pay-to-consume basis. Instead, end-users interact with each other to build, develop, produce, and distribute public and nonmarket goods.[49]

Participation in these types of activities generates external benefits for society as a whole (online and offline) that are not fully captured or necessarily even appreciated by the participants.[50]

Thus, infrastructure resources such as the Internet have the potential to create negative and positive demand-side externalities. These competing potentialities make the economics of internalizing externalities much more complicated than Yoo's analysis suggests.[51] Users not only fail to fully account for the congestion costs that they impose upon other users, but users also fail to fully account for the beneficial spillovers that they create through their online activities. Pricing mechanisms designed to reduce congestions costs also may reduce spillover benefits, which would entail social opportunity costs that must be considered.[52]

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49. *See* Frischmann, *supra* note 7, at 1017.

50. *Id*. at 1016–20. For further discussion of such activities and the manner in which value is generated, see *id*.

51. For an analysis of the ways in which the existence of positive externalities associated with additional uses would affect the setting of a usage-sensitive congestion tax, see Heath R. Gibson, Easing the Internet Traffic Jam: A Comparison of Capacity Expansion and Congestion Tolls as Means of Alleviating Internet Congestion, § 3.3, (Jun. 12, 1998) (unpublished B. Com. thesis, University of Newcastle, Australia), *available at* http://www2.hunterlink.net.au/~ddhrg/econ/honours/positive_ext.html.

52. Measuring spillover effects is quite difficult and attempts to quantitatively assess trade-offs between positive and negative externalities may be impossible. *Cf*. Frischmann & Lemley, *supra* note 12, at 289. (making a similar point with respect to spillovers in the intellectual property context). We do not claim that we stand on stronger empirical ground than Yoo. Neither of us can point to empirical studies that fully measure Internet congestion and spillovers. It may be the case that many spillover benefits can only be observed through macroeconomic studies, if at all.

C. Network Owners Will Not Necessarily Internalize Positive Externalities

Yoo claims that network neutrality proponents should not worry about the social costs that network discrimination might impose on innovation because network owners have an incentive to support complementary innovation that would increase the value of their networks. To buttress his argument, Yoo adopts a rather narrow frame and conflates a wide variety of spillovers into an easily managed subset, direct network externalities. He then declares:

> Direct network externalities do not represent an economic problem. Because they arise within a physical network that can be owned, the network owner is in an ideal position to solve the collective action problem by capturing the benefits created by increases in network size. Thus, even if end users are unable to appropriate all of the benefits associated with their adoption decisions, the network owner is in a position to internalize these benefits by charging prices that reflect the benefits new users confer on incumbents. Indeed, the owner of a physically interconnected network has every incentive to maximize the value of the network in this manner. The fact that the benefits resulting from any increase in the network's value would accrue directly to the network owner effectively aligns social benefits with private benefits.[53]

Yoo's analysis is flawed, however, because its premises are wrong. Yoo seems to assume that the wedge between private and social interests that network neutrality proponents are talking about is identical with direct network externalities in the market for Internet access and transport services. It is not. The wedge between social and network owners' interest is more complex than Yoo suggests in, at least, the following two ways.

First, the wedge between private and social interests stems in part from the fact that network providers calculate the private benefits of discriminating against unaffiliated providers of complementary products without considering the resulting reduction in application-level innovation by those providers, which in turn is publicly detrimental.[54] While network effects play a role in one of the scenarios under which network providers will find discrimination privately beneficial,[55] they are used in a completely different context, in which the argument that network providers are able to internalize network effects at the Internet access and transport level is completely irrelevant: Yoo talks about direct network effects at the Internet transport level,[56] while network neutrality proponents talk about direct or indirect network effects at the application-

53. Yoo, *Economics of Congestion*, *supra* note 2, at 1891 (footnote omitted).

54. *See* van Schewick, *supra* note 18, at 364–65. *See also* Lessig, *Testimony*, *supra* note 19, at 3–4; Wu, *Testimony*, *supra* note 19, at 4–5; Wu & Lessig, *Ex parte*, *supra* note 19, at 5–7.

55. Van Schewick, *supra* note 18, at 353–56, 365–67. For a short description of the relevant scenario, see *infra* notes 107–113 and accompanying text.

56. Yoo, *Economics of Congestion*, *supra* note 2, at 1891.

level.[57] Their scenario assumes competition between two new incompatible networks; the arguments Yoo raises about excess friction or excess momentum[58] concern a completely different setup—competition between one established network and a new network and the question of whether, in the presence of network effects, consumers will switch networks too quickly or too slowly[59]—and are irrelevant here. Finally, in the scenario used by network neutrality advocates, network effects are relevant, because technologies afflicted with network effects are subject to feedback effects.[60] Once one of the two competing technologies reaches a critical mass of consumers, feedback effects set in, which make it very difficult for the second network to overtake the other at a later stage.[61] By excluding unaffiliated providers of a competing application subject to network effects from its network and selling only its own application to customers of its Internet service, a network provider may be able to reach the critical mass of customers earlier than the excluded provider, which in turn makes it much more likely that the network provider's application will win the competition. *Thus, the importance of network effects in this context is because of the feedback effect, not because of the existence of externalities in the presence of network effects.* Whether network operators would be able to internalize direct network effects at the Internet transport level (or at the application level), is completely irrelevant in this context.

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57. Van Schewick, *supra* note 18, at 353–56.

58. Yoo, *Economics of Congestion*, *supra* note 2, at 1890–91.

59. *See* the reference cited by Yoo, *Economics of Congestion*, *supra* note 2, at 1890 n.205, Joseph Farrell & Garth Saloner, *Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation*, 76 AM. ECON. REV. 940, 941–42 (1986) (analyzing "the private and social incentives for the adoption of a new technology that is incompatible with the installed base," that is, the existing technology). Also, see the definition of excess inertia and excess friction by Michael L. Katz & Carl Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93, 108 (1994) ("Some theoretical models do indeed exhibit excess inertia; that is, users tend to stick with an established technology even when total surplus would be greater were they to adopt a new but incompatible technology. . . . [M]arkets may also exhibit the opposite of excess inertia, which we call 'insufficient friction.' In other words, the market may be biased in favor of a new, superior, but incompatible technology.") (citation omitted).

60. *See* van Schewick, *supra* note 18, at 354 ("[N]etwork effects give rise to strong positive feedback in technology adoption: other things being equal, consumers derive larger benefits from a larger network. As the larger network is more attractive, more consumers will join that network, making it even more valuable, leading to even more consumers joining the network. Once this positive feedback loop sets in, the affected technology will quickly pull away from its rivals in market share, ultimately dominating the market. This phenomenon is also referred to as 'tipping.'").

61. For a detailed explanation of feedback effects in competition between technologies subject to network effects, see, for example, CARL SHAPIRO & HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY 173–226 (1998).

Second, as indicated above, many spillovers (positive externalities) from Internet activities do not appear to be a function of direct network effects and instead appear to be a function of infrastructure effects.[62] These positive externalities occur because users considering using an infrastructure for the production of public goods and nonmarket goods do not take account of the positive impact that their decision to use the infrastructure for this purpose would have on others.

Although neglected by Yoo, these externalities are relevant for the economics of congestion, because they create a problem for measures designed to force users to internalize congestion costs. If these measures ignore the positive externalities associated with some of the uses, they may lead to inefficient underuse, as users will decide how and how much to use the Internet based on the social costs of their behavior, but only on its private benefits.

If network providers could internalize these infrastructure externalities, the fact that users do not internalize them would not be a problem. While network owners can internalize direct network effects in physical networks, they cannot internalize infrastructure externalities. Network owners can internalize direct network effects, because they are able to capture most of the benefits associated with a larger network size through their pricing of the network good. This, in turn, is possible, because an increase in network size increases existing network users' valuation of the network and thus their willingness to pay.[63]

In contrast with network effects, infrastructure effects do not necessarily increase users' willingness to pay for access to the infrastructure resource, and therefore, cannot be appropriated by the network owner through its pricing of the infrastructure good.[64] In the case of network effects, the external benefits of additional uses of the network good accrue to other users of the network. By contrast, the external benefits of additional uses of an infrastructure good are

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62. A network effect exists if consumers' valuation of the good increases with the number of users of the good; this leads to an externality because a user who considers joining the network does not consider the positive impact of his adoption decision on other users. *See* Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424 (1985) (defining network effects); Katz & Shapiro, *supra* note 59, at 96–100 (describing the adoption externality). Infrastructure effects exist if an infrastructure has the potential to serve as an input to the production of public goods and nonmarket goods. *See* Frischmann, *supra* note 7, at 972–74. "Infrastructure externalities" denote the fact that a user who considers using the infrastructure for the production of public goods and nonmarket goods does not take account of the positive impact that his decision to use the infrastructure for this purpose would have on others. In other words, productive users do not fully account for spillovers from their use. The difficulties associated with internalizing these externalities may then justify the imposition of open access regimes. *Id*.

63. For example, the network owner can internalize this externality by charging a lower price to the joining user and a higher price to the existing users. *See* STAN J. LIEBOWITZ & STEPHEN E. MARGOLIS, WINNERS, LOSERS & MICROSOFT. COMPETITION AND ANTITRUST IN HIGH TECHNOLOGY 76–79 (1999); Yoo, Economics of Congestion, *supra* note 2, 1891.

64. *See* Frischmann, *supra* note 7, at 973–74.

often diffuse and do not necessarily accrue to other users. Neither do they accrue directly to the network owner, making the prospect much less likely that infrastructure suppliers will internalize infrastructure externalities.

D. Comparing Usage-Sensitive Pricing with Use Restrictions (Coasean Proxies)

Relying on use restrictions as Coasean proxies to meter usage may have social costs that usage-sensitive pricing does not. Thus, as a matter of theory, use restrictions are not necessarily the most efficient way of dealing with congestion. Use restrictions impose a congestion tax on the restricted applications only. If the right to use these applications can be bought at a higher price, the congestion tax equals the difference in price; if this is not possible, the congestion tax is infinitely high (and the use is effectively banned). In any event, the congestion tax is not usage sensitive; if it is possible to buy the right to use the application, the tax does not rise with the intensity of use or with the capacity consumed. By contrast, usage-sensitive pricing spreads the congestion tax over all uses and users; with respect to one use of a specific application, the resulting tax will usually be lower.

Use restrictions introduce several inefficiencies: First, they do not force users of nonrestricted applications to internalize the congestion costs of their usage; similarly, use restrictions do not encourage developers of nonrestricted applications to improve the bandwidth-efficiency of their application. Second, use restrictions do not provide incentives for more efficient behavior of developers or users of restricted applications. The provider of a banned application cannot evade the restriction by reducing the amount of bandwidth needed by the application and, consequently, does not have an incentive to do so.[65] Once a user has bought the right to use an application, she does not have an incentive to consider the congestion costs her use imposes on other uses and adjust her use of the application accordingly (for example, by adjusting her timing of use).

Use restrictions distort the markets for applications and services by raising the price for using some applications, but not others, and thereby decreasing the size of the market for restricted applications, but not for others:[66] Often, there will be some users who would use the application in a world with usage-

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65. This is because use restrictions usually ban certain classes of applications, for example, file sharing or online gaming, not individual applications produced by a particular provider. As a result, unless all applications belonging to the class become more bandwidth-efficient, changes that make a particular provider's application more bandwidth efficient will not motivate network providers to lift the use restriction concerning the class of applications to which that application belongs.

66. For a similar argument in the context of use restrictions as the basis for price discrimination, see van Schewick, *supra* note 7 (manuscript at 280–84) (noting the distortion introduced by such pricing schemes and the negative implications for users and innovators); Tim Wu, *Network Neutrality, Broadband Discrimination*, 2 J. TELECOMM. & HIGH TECH. L. 141, 156–69 (2003) (noting the distortion introduced by such pricing schemes).

sensitive pricing, but not in a world with use restrictions. For example, if the personal benefit from using the application is lower than the cost of buying the right to use it, a user will not buy the right to use the application. By contrast, under a usage-sensitive pricing regime, the costs of congestion are spread over all users and uses, so the congestion costs associated with one use of a specific application may be lower. As a result, more of the lower value users may be able to use the application in question. With use restrictions, not only will fewer users be able to realize the benefits associated with using the restricted application, developers of this application will be able to make less profits, which, in turn, reduces their incentives to innovate.[67] The impact of use restrictions is even worse if the right to use the application cannot be bought (that is, if the application is banned): In this case, even high-value users will not be able to use the application; from the point of view of application developers, no buyers will be left.

More generally, as we explained in previous sections, measures designed to force users to internalize congestion costs may have unintended social costs by reducing the positive externalities associated with a wide range of socially valuable uses. This is a problem for use restrictions and usage-based pricing. At the same time, the transaction costs associated with identifying producers of positive externalities and the inherent difficulties in measuring positive spillover effects[68] may make it infeasible to set congestion prices in a way that adequately accounts for these externalities.

However, while use restrictions and usage-based pricing may both reduce positive spillovers, the adverse impact of usage-sensitive pricing may be less severe. First, while both methods of internalizing congestion costs may reduce positive spillovers by raising the price of infrastructure access where capacity constraints arise, use restrictions risk such distortions even during times of no congestion. By contrast, under a usage-sensitive pricing regime, the cost of additional usage during times of no congestion is zero.[69] As a result, usage-sensitive pricing may only reduce positive spillovers during times of congestion.

Second, implementing use restrictions effectively requires discrimination on the basis of the identity of use or user; usage-sensitive pricing, by contrast, can be implemented on a nondiscriminatory basis. This has important consequences. Within the framework of infrastructure theory, nondiscrimination is a rather blunt broad subsidy for users (uses) that produce positive externalities,

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67. Thus, compared to a world without use restrictions, use restrictions create a distortion between innovation in unrestricted and restricted applications.

68. *Cf.* Frischmann & Lemley, *supra* note 12, at 289 (making a similar point with respect to spillovers in the intellectual property context). It may be the case that many spillover benefits can only be observed through macroeconomic studies, if at all.

69. As indicated *supra* note 28, under usage-sensitive pricing, the usage-sensitive price is equal to the congestion costs imposed by the last unit consumed. If there is no congestion, the congestion costs imposed by the last unit consumed are zero.

and it is justified in part by the difficulty in directing targeted subsidies to those user-producers.[70] Usage-sensitive pricing can be implemented in a nondiscriminatory way that maintains the broad blunt subsidy, albeit with some reduction in the cross subsidies among users or uses on the margins,[71] while use restrictions require knowledge of and pricing based on the identity of use or user and thus dismantle the nondiscriminatory regime across the board.

The management of congestion in other infrastructure resources in practice seems to be in line with these theoretical observations. Most infrastructure resources are managed as commons, such that access to and use of resources are allocated on a nondiscriminatory basis without regard to the identity of the users or the activity that the user will engage in. While we occasionally employ congestion pricing to alleviate congestion on infrastructure, such as major highways during peak load times, these pricing mechanisms (1) are the exception rather than the rule, (2) tend to be either flat fees[72] or usage-sensitive fees that vary based on the time of day or actual crowding effects, or both,[73] and (3) do not employ "Coasean proxies" that differentiate among users based on their identity, destination, or activity at their final destination. Thus, where congestion pricing of infrastructure access has been employed, it has been implemented in a manner that sustains the infrastructure commons.

So far, the analysis has compared use restrictions with perfect usage-sensitive pricing, that is, with a system that can dynamically adjust the price of usage such that it is equal to the congestion costs imposed by the last unit consumed. In this scenario, usage-sensitive pricing is clearly superior: It affects all users, uses and application-developers according to their contributions to congestion, creating incentives for congestion-sensitive behavior across the board. Apart from the potential reduction of positive externalities, it does not cause any of the inefficiencies resulting from use restrictions, and even this distortion is limited to times of congestion. By contrast, use restrictions do not change dynamically in response to the level of congestion, making them a constant source of inefficiencies.

As indicated above, perfect usage-sensitive pricing may be difficult and costly to accomplish, making it necessary to compare the relative social costs and benefits of use restrictions with imperfect usage-sensitive pricing. There are numerous ways to implement imperfect usage-sensitive pricing based on the existing technology for metering usage: peak-load pricing based on time of day may be one of them. Clearly, an accurate assessment of the corresponding

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70. *See* Frischmann, *supra* note 7, at 974–78, 1015–22.

71. *Cf. id.* at 990, 1021 (explaining how nondiscrimination maintains a broad blunt subsidy).

72. For example, London has implemented a daily flat fee for driving private automobiles in its central area during the week. *See* Andrew Clark, *London Companies Learn To Love Congestion Charge*, THE GUARDIAN (UK), February 16, 2004.

73. *See Congestion Pricing for Highways*, *Hearing Before the J. Economic Comm.*, 108th Cong. (2003) (Statement of Douglas Holtz-Eakin, Director of the Congressional Budget Office), *available at* http://www.cbo.gov/ftpdocs/41xx/doc4197/05-06-CongestionPricing.pdf.

inefficiencies depends on the specific pricing system under consideration. With this in mind, some general observations may be possible: Compared to perfect usage-sensitive pricing, any pricing system that loosens the link between the price of usage and the level of congestion in the network causes additional inefficiencies. During times when the price is higher than justified by the level of congestion, such a system may lead to inefficient underuse and unnecessarily reduce positive externalities. During times when the price is lower than justified by the level of congestion, it may lead to inefficient overuse, but will be less detrimental than perfect usage-sensitive pricing with respect to positive externalities.[74]

While imperfect usage-sensitive pricing introduces some inefficiencies, it does maintain the general characteristics that make usage-sensitive pricing preferable to use restrictions: it affects all users, uses and application developers equally without introducing the distortions that result from use restrictions' focus on specific applications and from their all-or-nothing character. With respect to positive externalities, it can be implemented on a nondiscriminatory basis and therefore preserves at least some of the benefits associated with a nondiscriminatory access regime for the production of public and nonmarket goods. Finally, even if the inability to perfectly price according to the costs of congestion leads to some inefficient overuse during times of congestion, the impact of usage-sensitive pricing on the behavior of users and application developers may be sufficient to effectively limit congestion. As Frischmann and Lemley have shown in a different context, an efficient solution to a problem caused by externalities does not necessarily require the perfect internalization of externalities.[75] Thus, while it is possible to come up with an imperfect usage-sensitive system that introduces inefficiencies that surpass the social costs associated with use restrictions, the social costs of reasonably imperfect usage-sensitive pricing seem to be lower than the social costs associated with use restrictions.

E. Yoo's Examples of Use Restrictions

To demonstrate the relevance of his theory for the network neutrality debate, Yoo analyzes six classes of use restrictions, which, according to him, can be interpreted as Coasean proxies: (1) prohibitions on reselling bandwidth

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74. As defined in the text, perfect usage-sensitive pricing will result in a price that is equal to the congestion costs imposed by the last unit consumed. As explained above, this would lead to inefficient underuse by users whose uses would create positive externalities, as they would base their decision to use the Internet on the social costs of their behavior (because of usage-sensitive pricing), but only on the private benefits. If under imperfect usage-sensitive pricing the usage-sensitive price is lower than the actual congestion costs, users will use the Internet more than under perfect usage-sensitive pricing. If their use creates positive externalities, this increase in Internet use is socially beneficial. In a way, setting the price lower than the actual costs of congestion subsidizes the uses that create positive externalities.

75. *See generally* Frischmann & Lemley, *supra* note 12.

or acting as an Internet service provider;[76] (2) restrictions on home networking;[77] (3) restrictions on attaching devices such as gaming consoles, Internet phones and WiFi routers;[78] (4) restrictions on operating file servers such as Web-page hosting, game servers and file sharing;[79] (5) discrimination against particular applications such as commercial uses or file-sharing programs,[80] and (6) discrimination against particular content.[81]

Only some of the use restrictions mentioned by Yoo constitute effective Coasean proxies for metering usage; thus, even if his theory were correct, it couldn't be used to justify all of the use restrictions he discusses.

To be in line with his theory, the use restrictions discussed by Yoo must concern bandwidth-intensive uses. This is not always the case, however. VoIP services such as Skype have very modest bandwidth requirements;[82] similarly, while bandwidth demands of online games vary, a lot of them do not use a lot of bandwidth.[83] Thus, VoIP and online gaming do not necessarily constitute good proxies for bandwidth-intensive uses. Of course, some VoIP applications

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76. Yoo, *Economics of Congestion*, *supra* note 2, at 1876.

77. *Id.* at 1877.

78. *Id.* at 1877–79.

79. *Id.* at 1879.

80. *Id.* at 1879–80.

81. *Id.* at 1880–83.

82. "On average, Skype uses 3–16 kilobytes/sec [24–128 kilobits/sec] depending on bandwidth available" while on a call, and "0–0.5 kilobytes/sec [0–4 kilobit/sec] while idle." Skype Limited, Skype Technical Frequently Asked Questions, http://www.skype.com/help/faq/technical.html (last visited Sep. 16, 2007). Skype automatically selects how much bandwidth to use based on the characteristics of the connection between both callers. *Id.* Vonage allows customers to choose between algorithms that require 30, 50 and 90 kilobits/sec. Posting of scerruti, to http://www.vonage-forum.com/ftopic8299.html (Sep. 8, 2005, 8:58 P.M.). For comparison, "[t]he Federal Communications Commission (FCC) generally defines broadband service as data transmission speeds exceeding 200 kilobits per second (Kbps), or 200,000 bits per second, in at least one direction: downstream (from the Internet to your computer) or upstream (from your computer to the Internet)." Federal Communications Commission, High-Speed Internet Access—"Broadband," http://www.fcc.gov/cgb/consumerfacts/highspeedinternet.html (Mar. 15, 2006). In reality, most broadband offerings offer more than that. *See, e.g.*, AT&T Residential, Internet, http://www.att.com/gen/general?pid=6431, (last visited Oct. 10, 2007) (offering a choice of 768 kbps, 1,5 Mbps, 3 Mbps and 6 Mbps).

83. For example, bandwidth requirements for various game clients range as follows: 3 kilobits/sec for the real time strategy game Age of Kings, JANI LAKKAKORPI, ANDREAS HEINER & JUSSI RUUTU, MEASUREMENT AND CHARACTERIZATION OF INTERNET GAMING TRAFFIC 4 (2002), *available at* http://users.tkk.fi/~jlakkako/GameTrafficModeling.pdf (February 2002); 5 kilobits/sec for the real-time strategy game Warcraft III, Nathan Sheldon et al., *The Effect of Latency on User Performance in Warcraft III*, 2 WORKSHOP ON NETWORK & SYS. SUPPORT FOR GAMES 3, 10 (2003); 7 kilobits/sec for the massive multiplayer online role playing game ShenZhou Online, Kuan-Ta Chen et al., *Game Traffic Analysis: An MMORPG Perspective*, 50 COMPUTER NETWORKS 3002, 3003 (2006), *available at* http://www.iis.sinica.edu.tw/~cychen/pub/gta.pdf; 15 to 20 kilobits/sec for most Xbox games, SANDVINE INC., TURNING GAMING INTO REVENUE 2 (2005) *available at* http://www.sandvine.com/general/getfile.asp?FILEID=86; 16 kilobits/sec for first person shooter game Counter Strike, Johannes Faerber, *Network Game Traffic Modeling*, 1 WORKSHOP ON NETWORK & SYS. SUPPORT FOR GAMES 53, 53 (2002).

or online games may be bandwidth-intensive,[84] but restricting the right to attach Internet phones and online gaming consoles to attack congestion would also ban VoIP applications or online games with only modest bandwidth requirements. This is even more obvious for the ban on WiFi routers, home networking or commercial uses; these categories have no predictive power with respect to the bandwidth intensity of the corresponding uses. A WiFi router offers wireless access to a given Internet connection. Whether this Internet connection is used for bandwidth-intensive applications, is completely independent of this access mode. A user in a one-person household can use a WiFi router and a home network, because she wants to be able to download e-mails and surf the Web not only on the PC in her study, but also on the laptop in the rest of the house. Another user can use the router to participate in extensive online file sharing or, in combination with home networking, to offer simultaneous access to other members of his household. Similarly, whether a specific use is commercial does not say anything about its bandwidth requirements; there are many commercial uses that are not bandwidth intensive.

As this discussion shows, proxies can be over- or underinclusive. The usefulness of proxies depends upon their accuracy and how much bandwidth intensity varies within the category. Over-inclusive proxies, for example, would unnecessarily ban low bandwidth uses. In this respect, the examples of banned uses discussed above do not appear to be particularly useful proxies.

Put differently, as we have shown above,[85] use restrictions are less efficient in dealing with congestion than usage-sensitive pricing. The analysis was based on the assumption that the restricted uses were bandwidth-intensive uses. If, however, some of the uses within a restricted category are not very bandwidth-intensive, the social costs associated with use restrictions are exacerbated, because the low bandwidth uses within the category would be unnecessarily restricted.

Finally, not all of the use restrictions mentioned by Yoo would be prohibited under network neutrality rules. For example, prohibitions on reselling

84. For example, a game console acting as a server needs more bandwidth than a game console acting as a client. Whether a game console can act as a server at all depends on the specific game. For example, in the Xbox Game Halo 2, one player needs to act as a server. In a game with 1 player per Xbox and 6 players (5 clients, 1 server), each client needs an average upstream (from the Xbox to the Internet) bandwidth of 15 kilobit/sec and an average downstream (from the Internet to the Xbox) bandwidth of 40 kilobit/sec. By contrast, the server needs an average upstream bandwidth of 225 kilobit/sec and an average downstream bandwidth of 75 kilobit/sec, E-mail from Sebastian Zander to Barbara van Schewick (July 21, 2006) (on file with the authors); Sebastian Zander & Grenville Armitage, *A Traffic Model for the Xbox Game Halo 2*, 2005 INT'L WORKSHOP ON NETWORK & OPERATING SYS. SUPPORT FOR DIGITAL AUDIO & VIDEO 13, 16 fig.11.

85. See *supra* Part II.D.

bandwidth or acting as an internet service provider are not of concern to network neutrality proponents.[86]

Ultimately, only one of the six classes of use restrictions discussed by Yoo (restrictions on operating fileservers) constitutes a useful proxy for bandwidth-intensive uses, while also being relevant to the network neutrality debate.[87] Thus, even if Yoo's general theory on the economics of congestion were correct, it is less relevant to the network neutrality debate than it might seem.

III. BEYOND CONGESTION

In his article, Yoo relies on a series of additional arguments (that is, in addition to those based on the problem of congestion) to oppose network neutrality regulation and support network owners' ability to discriminate. In this Part, we address two: (1) the argument that network neutrality regulation is overly broad, as there will be only limited instances of harmful discrimination; and (2) the argument that network neutrality would harm competition in the market for broadband access networks and undermine incentives to invest in infrastructure.

A. The Likelihood of Discrimination

Calls for network neutrality regulation are based in part on the concern that, in the absence of such regulation, network providers will discriminate against unaffiliated providers of complementary products or exclude them from their network. Yoo downplays this possibility.[88] While he admits that there may be instances of anticompetitive behavior,[89] he posits that these will

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86. None of the network neutrality proposals before the U.S. Congress would ban restrictions on reselling bandwidth or acting as an ISP. These restrictions are sometimes associated with the network neutrality debate, because they appeared in a survey of restrictions employed by providers of broadband networks in an article by Tim Wu that was one of the first to draw attention to network neutrality. *See* Wu, *supra* note 66, at 158 tbl.1.

87. Apart from the examples of use restrictions discussed above, Yoo also briefly discusses some other practices, such as implementing Quality of Service or access tiering. *See* Yoo, Economics of Congestion, *supra* note 2, at 1880–83. While relevant to the network neutrality debate, these practices do not fit his definition of using Coasean proxies. *Id.* at 1873, 1876. ("identifying [. . .] another good [the proxy good] that can be metered more cheaply and that can serve as a reasonable proxy for usage of the good that needs to be metered," and then, instead of charging for the use of the original good, charging for the use of the proxy good, or, in the context of identifying specific application categories as proxies for bandwidth-intensive uses, prohibiting the use of the proxy good altogether.) We do not enter this part of the debate here.

88. *Id.* at 1888–89, 1899–1900.

89. He explicitly mentions the possibility that a broadband provider may "bar access to an Internet application that competes directly with its core business." *Id.* at 1899. For example, a phone company may exclude Voice over Internet Protocol (VoIP) traffic from its network to protect its income from traditional phone calls. *Id.* While this is one of the exceptions from the one monopoly rent argument relevant to the network neutrality debate, see van Schewick, *supra* note 18, at 345–46, 367–68, it is not the only one.

be very limited and, therefore, do not merit the blanket restrictions on discrimination advocated by proponents of network neutrality.

Yoo's assessment of the likelihood of discriminatory conduct is based on two arguments: First, drawing on Chicago school reasoning with respect to vertical integration, he argues that in most cases, exclusionary conduct by network providers is unlikely to be anticompetitive.[90] Second, based on the theory that competition in the market for Internet access services will prevent anticompetitive conduct in complementary markets and that the relevant market for determining the amount of competition is the nationwide market for Internet access services, he argues that the relevant nationwide market for Internet access services is sufficiently competitive to mitigate the problem.[91]

Both arguments are incomplete. As we discuss below, Yoo fails to fully engage the vast post-Chicago literature on the limits of the one-monopoly-rent argument as well as recent research applying this literature to the network neutrality context. With respect to his second argument, recent research casts doubt on the ability of (limited) competition in the market for Internet access services to discipline network providers in the markets for complementary products. In any event, as we show below, the disciplining effect of competition—to the extent it exists—depends on the amount of concentration in the local market for Internet access services.

1. *Discrimination and the Economics of Vertical Integration*

According to Chicago school reasoning, a monopolist in a primary market does not generally have an incentive to exclude its competitors from a secondary, complementary market. There is only one monopoly profit for the combined product, which the monopolist can usually extract through its pricing of the primary good; this is the well-known "one monopoly rent argument."[92] Moreover, because of the complementarity between both markets, the monopolist may benefit from the presence of independent producers of complementary products; in this case, the monopolist will welcome, not exclude independent producers of complementary products. This argument has been labeled "internalizing complementary efficiencies (ICE)."[93]

While Yoo is right in recounting these arguments as the baseline for discussion,[94] they represent only part of the story: Post-Chicago research has shown that this line of reasoning is incomplete.[95] In some cases, the monopo-

90. *See* discussion *infra* Part III.A.1 below.

91. *See* discussion *infra* Part III.A.2 below.

92. *See* ROBERT H. BORK, THE ANTITRUST PARADOX: A POLICY AT WAR WITH ITSELF 372–75 (1993); RICHARD A. POSNER, ANTITRUST LAW 198–99 (2nd ed. 2001).

93. Farrell & Weiser, *supra* note 9, at 89.

94. Yoo, *Economics of Congestion*, *supra* note 2, at 1888–89.

95. *See* Dennis W. Carlton & Michael Waldman, *The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries*, 33 RAND J. ECON. 194 (2002); Steven C. Salop & R. Craig Romaine, *Preserving Monopoly: Economic Analysis, Legal Standards, and Microsoft*, 7

list is unable to extract all the monopoly profit through its pricing of the primary good, making the "one monopoly rent argument" inapplicable. Similarly, while the monopolist generally profits from the presence of independent producers in the complementary market, it sometimes profits even more by excluding them from the market. Thus, there are exceptions from the "one monopoly rent argument" and ICE,[96] and the network neutrality debate turns on how relevant these are in the network neutrality context.[97]

Yoo essentially sidesteps this issue. While he acknowledges that there are exceptions to the one-monopoly-rent argument, he does not discuss any of them in detail. Referencing one of his earlier articles, he reports that models underlying these exceptions "explicitly or implicitly assume that the relevant markets are both concentrated and protected by barriers to entry."[98] According to him, the market for Broadband Internet access does not meet these structural preconditions, and thus the exceptions to the one–monopoly-rent argument are not applicable.[99] His assessment is based on the view that what matters is the amount of concentration in the nationwide market for Internet access,[100] not the amount of concentration in the local market. We take up this argument below.[101]

As van Schewick has shown in a recent article, incentives to discriminate are more pervasive than Yoo assumes.[102] Not only do some of the known exceptions indeed apply in the Internet context.[103] Even more importantly, there are new exceptions to the one-monopoly-rent argument that have not been previously identified, but are quite common in the Internet context.[104]

GEO. MASON L. REV. 617, 624–26 (1999); Michael D. Whinston, *Tying, Foreclosure, and Exclusion*, 80 AM. ECON. REV. 837 (1990). It should be noted that the Chicago school recognizes some exceptions to the one monopoly rent argument as well. For example, it recognizes that the argument does not apply if the primary and the secondary good are not used in fixed proportions (in this case, monopolizing the secondary market enables the monopolist to price discriminate), POSNER, *supra* note 92, at 199–200, or if regulation in the primary market prevents the monopolist from realizing the complete monopoly profit through its pricing of the primary good. BORK, *supra* note 92, at 376.

96. For an overview of exceptions that may be relevant in the Internet context with links to the relevant literature, see VAN SCHEWICK, *supra* note 7 (manuscript at 245–67); Farrell & Weiser, *supra* note 9, at 105–19. *See also* POSNER, *supra* note 92, Ch. 8 (discussing exclusionary practices in the new economy).

97. *See, e.g.*, van Schewick, *supra* note 18, at 336 (arguing that if network providers do not have an incentive to discriminate, there is no need for regulation).

98. Yoo, *Economics of Congestion*, *supra* note 2, at 1888 (citing Christopher S. Yoo, *Vertical Integration and Media Regulation in the New Economy*, 19 YALE J. ON REG. 171, 202–05, 265–67 (2002), which only discusses a limited set of models, none of which have been used to justify network neutrality regulation).

99. Yoo, *Economics of Congestion*, *supra* note 2, at 1888.

100. *Id.* at 1888, 1892–94.

101. *See infra* Part III.A.2.

102. Van Schewick, *supra* note 18, at 342–52.

103. *Id*. at 353.

104. *Id*. at 342.

Finally, exclusion may be a profitable strategy, even if the monopolist does not manage to drive its competitors from the complementary market.[105] Taken together, these insights imply that in many complementary markets, an incentive to discriminate may not be the exception, but the rule.[106]

Two examples may illustrate this point. A well-known exception to the "one monopoly rent argument", which is sometimes called "primary good not essential," applies when the following preconditions are met.[107] First, the economic actor, in our case the network provider, has a monopoly in the primary market, that is, in the market for Internet access services. Second, the primary good is not essential, that is, there are uses of the complementary product that do not require the primary good. These uses constitute the stand-alone market. Third, the complementary market is subject to economies of scale or network effects, or both. Finally, the monopolist has a mechanism at its disposal that enables it to exclude its rivals from access to its primary good customers. Under these circumstances, the monopolist is unable to capture monopoly profits in the stand-alone market, making it necessary to monopolize the complementary market.

Assuming that the network provider has a local monopoly in the market for Internet access services (the first condition), these preconditions will often be met:[108] If the network provider offers a complementary product not just to customers of its Internet service, but to customers nationwide, its primary product (Internet service) is nonessential to all customers except its Internet service customers (the second condition). This business model is quite common: AOL offers its portal, stand-alone Web sites such as MapQuest or its Instant messenger not only to its Internet service customers, but to anybody using the Internet. Microsoft's search engine or Hotmail, Microsoft's Web mail service, are available to anybody, not just to customers of Microsoft's Internet service. Most applications, content offerings or portals are subject to

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105. While exclusionary conduct that does not manage to monopolize the complementary market may not be relevant from an antitrust perspective, it is relevant for the network neutrality debate. *See* the discussion *infra* notes 119 and 128.

106. Van Schewick, *supra* note 18, at 364.

107. This exception was developed by Whinston, *supra* note 95, at 854–55, and is widely accepted as an exception to the one-monopoly-rent argument. *See* Dennis W. Carlton, *A General Analysis of Exclusionary Conduct and Refusal to Deal: Why* Aspen *and* Kodak *Are Misguided*, 68 ANTITRUST L.J. 659, 667–68 (2001); Carlton & Waldman, *supra* note 95, at 195; Jay Pil Choi & Christodoulos Stefanadis, *Tying, Investment, and the Dynamic Leverage Theory*, 32 RAND J. ECON. 52, 55 (2001); Michael D. Whinston, *Exclusivity and Tying in U.S. v. Microsoft: What We Know; and Don't Know*, 15 J. ECON. PERSP. 63, 71 (2001). For a detailed exposition of this exception with links to the relevant literature, see van Schewick, *supra* note 18, at 353–56.

108. For a more detailed analysis, see van Schewick, *supra* note 18, at 356–57.

economies of scale[109] or network effects, or both[110]; thus, the third condition will almost always be met. Finally, network providers have access to technology that enables them to distinguish between applications running over their network and to control their execution,[111] making it easy to meet the fourth condition.

If these conditions apply to a specific network provider and one of its complementary offerings, it has an incentive to monopolize the corresponding complementary market. A variety of factors will determine whether the network operator may reach this goal by excluding its competitors in the complementary market from access to its Internet service customers, such as the exact size of economies of scale with respect to the complementary product in question, the strength of any potential network effects, and the relationship of the number of the provider's Internet service customers to the overall number of customers in the complementary market.[112] In a lot of cases, monopolization may not be a realistic option. Thus, if monopolization of the complementary market were a necessary condition for the existence of an incentive to discriminate, network providers would have an incentive to discriminate only in some of the cases in which the four preconditions were met.

In markets that are characterized by high fixed costs and very low marginal costs, however, a network provider need not monopolize the complementary market to increase its profits.[113] As goods in these markets are priced above marginal costs, selling more goods at the market price is sufficient to

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109. The cost structure low marginal costs relative to average costs, which results in significant economies of scale, is generally viewed as a key economic characteristic of the markets for these products. *See* Michael L. Katz & Carl Shapiro, *Antitrust in Software Markets*, *in* COMPETITION, INNOVATION, AND THE MICROSOFT MONOPOLY: ANTITRUST IN THE DIGITAL MARKETPLACE 29, 34–36 (Jeffrey A. Eisenach & Thomas M. Lenard eds., 1999) (discussing market for Internet content, portals and software); JEFFREY K. MACKIE-MASON, AN AOL/TIME WARNER MERGER WILL HARM COMPETITION IN INTERNET ONLINE SERVICES 14 (2000), *available at* http://www-personal.umich.edu/~jmm/papers/aol-tw00-public.pdf, (discussing market for broadband portals); POSNER, *supra* note 92, at 245–46 (discussing market for Internet content, portals and software); SHAPIRO & VARIAN, *supra* note 61, at 3–4, (discussing market for information goods in general); Daniel L. Rubinfeld & Hal J. Singer, *Vertical Foreclosure in Broadband Access?*, 49 J. INDUS. ECON. 299, 307 (2001) (discussing market for broadband content).

110. The existence of direct or indirect network effects is a fundamental economic characteristic of many software markets. *See, e.g.*, Katz & Shapiro, *supra* note 109, at 32–34; David S. Evans & Richard L. Schmalensee, *Some Economic Aspects of Antitrust Analysis in Dynamically Competitive Industries* 9–11 (Nat'l Bureau of Econ. Research, Working Paper No. 8268, 2001).

111. *See* sources cited *supra* note 15.

112. *See* Rubinfeld & Singer, *supra* note 109, at 310–13 for a numerical example. The paper assesses the likelihood of content discrimination (that is, blocking or degrading the quality of outside content) by a broadband network provider that is vertically integrated into the market for broadband content and portals in the context of the merger between AOL and Time Warner.

113. For a detailed exposition of this argument, see van Schewick, *supra* note 18, at 365–67.

increase profits.[114] Given that this cost structure (high fixed costs and very low marginal costs) is typical for Internet applications and content,[115] excluding its rivals in the complementary market from access to its Internet service customers will be a profitable strategy, so long as the exclusion enables the network provider to increase the number of sales of its own complementary product[116] and the additional profits resulting from more sales at the market price are larger than the costs of exclusion.[117]

Thus, the exclusionary conduct in the complementary market may increase the network provider's profits regardless of whether it manages to monopolize the complementary market. Accordingly, the likelihood that a network provider may have an incentive to discriminate is greatly increased if the conditions underlying the "primary good not essential" exception are met.[118] Given how often this is the case, this exception is highly relevant for the network neutrality debate.[119]

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114. SHAPIRO & VARIAN, *supra* note 61, at 161. The importance of market share and number of units sold in knowledge-based products is also described by ALLAN AFUAH & CHRISTOPHER L. TUCCI, INTERNET BUSINESS MODELS AND STRATEGIES: TEXT AND CASES 52–54 (2001). For an economic model demonstrating this effect in the context of tying, see Patrick DeGraba, *Why Lever into a Zero-Profit Industry: Tying, Foreclosure, and Exclusion*, 5 J. ECON. & MGMT. STRATEGY 433 (1996). In DeGraba's model, oligopolists sell a differentiated good (the primary good) and a homogeneous good (the complementary good) that are used in fixed proportions to produce the final good. The homogenous good can be produced at constant marginal cost by any firm incurring a certain fixed cost. The homogenous market is characterized by free-entry Cournot competition. In such a market, the zero-profit price of the good is greater than the marginal cost. As a result, the oligopolist in DeGraba's model will tie in order to increase the sales of the complementary good. Note that this model does not require the complementary good to be a differentiated good.

115. *See* sources cited *supra* note 109.

116. *See* van Schewick, *supra* note 18, at 364–65 (explaining why exclusion may result in a higher number of sales of the network provider's complementary product).

117. *See id.* at 375–77. (describing the costs of exclusion).

118. *Id*. at 365–67.

119. In this respect, the focus of analysis by network neutrality proponents differs from a normal antitrust analysis. In general, U.S. antitrust law only cares about exclusionary conduct in complementary markets if there is a "'dangerous probability of success'" that the conduct will enable the primary good monopolist to monopolize the secondary market as well. Verizon Communications, Inc. v. Law Offices of Curtis Trinko, L.L.P., 540 U.S. 398, 415 n.4 (2004) (citing Spectrum Sports, Inc. v. McQuillan, 506 U.S. 447, 459 (1993)). Thus, from an antitrust perspective exclusionary conduct in a complementary market is only relevant if there is a dangerous probability that it will manage to drive competing producers from that market. Network neutrality theory goes beyond this. Proposals for network neutrality are driven by concerns about a reduction in application-level innovation. *See* Lessig, *Testimony*, *supra* note 19, at 8–9; Wu, *Testimony*, *supra* note 19, at 4–5; Wu & Lessig, *Ex parte*, *supra* note 19, at 5–7; van Schewick, *supra* note 18, at 332. In particular, network neutrality proposals are based on the concern that network providers' discriminatory conduct will reduce independent application developers' incentives to innovate. To reduce independent application developers' incentives to innovate, the exclusionary conduct does not need to drive them from the market; it suffices if it reduces their profits. Thus, exclusionary conduct that does not manage to monopolize the market for a specific application or content may not be relevant from an antitrust perspective, but will be relevant in the network neutrality context. For a detailed analysis of the impact of discrimination on application-

One of the new exceptions applies whenever at least part of the revenue associated with a complementary product comes from outside sources, for example, if a firm sells access to customers of its complementary product to third parties.[120] In this case, it may be more profitable for the network provider to exclude its rivals from the complementary market and capture the outside revenue directly than to allow rivals in the market and to try to extract the outside revenue from them.[121]

Realizing revenue by selling access to customers to third parties such as advertisers or online merchants is a common business model in the markets for Internet applications, content or portals.[122] For example, today's search engines make all of their revenue from advertising fees; portals are financed at least in part by advertising fees and commissions for online sales.

If a network provider is vertically integrated into such a product, its outside revenue will usually be higher if it excludes its rivals and captures the outside revenue directly.[123] Because of the logic of pricing in advertising markets, selling access to a large group of customers as a whole is more profitable than selling access to smaller groups of customers individually.[124] In addition, because of its billing relationship with its Internet service customers, the network provider has data on customer demographics that enables it to charge higher advertising fees or online commissions than many of its rivals.[125] Finally, the transaction costs associated with negotiating and administering schemes designed to extract rivals' outside revenue further reduce the amount of profits.[126]

Again, the ability to make higher profits by discriminating against rivals is not dependent on monopolizing the complementary market; discrimination will be a profitable strategy so long as it results in a higher number of sales of the complementary product.[127] Thus, vertical integration with a complemen-

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level innovation and for a justification of the focus on application-level innovation, see van Schewick, *supra* note 18, at 378–81 (showing that discrimination reduces the amount of application-level innovation) and *id.* at 382–89 (outlining the social benefits of additional innovation in applications, content or portals). For a short discussion of the importance of application-level innovation for economic growth, see also *infra* note 168 and accompanying text. While competition and innovation are important aspects in the debate, they are not the only aspects network neutrality proponents care about. *See* the discussion *infra* Part III.B and in the conclusion.

120. This exception was first described by van Schewick, *supra* note 18, at 342–45.

121. In contrast to the "primary goods not essential" exception described above, this exception is applicable regardless of whether the network provider offers the complementary product only to customers of its Internet service, or to anybody on the Internet.

122. AFUAH & TUCCI, *supra* note 114, at 56; SHAPIRO & VARIAN, *supra* note 61, at 162–63.

123. For a detailed exposition of this argument with links to the relevant literature, see van Schewick, *supra* note 18, at 342–45.

124. *Id.* at 344 (citing Rubinfeld & Singer, *supra* note 109, at 316; MACKIE-MASON, *supra* note 109, at 23).

125. Van Schewick, *supra* note 18, at 344–45 (citing SHAPIRO & VARIAN, *supra* note 61, at 34–35; MACKIE-MASON, *supra* note 109, at 11).

126. Van Schewick, *supra* note 18, at 345.

127. For a detailed explanation of this argument, see *id.* at 367–68.

tary product that is based at least in part on the outside revenue business model is all that is needed for this exception to apply; given the pervasiveness of this business model, discrimination based on this exception is highly probable.[128]

2. *The Impact of Competition in the Market for Internet Access Services*

Having posited that exclusionary conduct will usually be harmless, Yoo argues that in the limited instances where anticompetitive activity may occur, competition in the market for Internet access services is sufficiently robust to ameliorate the problem.[129] His assessment is based on two arguments: First, competition in the market for Internet access services will prevent anticompetitive conduct in complementary markets[130] and second, network neutrality proponents focus on the wrong market to determine the extent of competition.[131] According to Yoo, the relevant geographical market is the nationwide market for Internet access services, not, as network neutrality proponents contend, the local market.

While participants in the debate usually share the view that competition in the market for Internet access services will mitigate the problem,[132] recent

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128. As indicated *supra* note 119, the network neutrality debate is driven by concerns about the impact of discrimination on application-level innovation. As a result, the focus of analysis in this field is different from a normal antitrust analysis. While a normal antitrust analysis cares about potential monopolization, network neutrality proponents care about the reduction in independent-application-developers' profits, which in turn reduces their incentives to innovate. Thus, exclusionary conduct that does not drive the producers of a complementary product from the market but reduces their profits, would be relevant for the network neutrality debate, but not for antitrust. Moreover, as we discuss below, while competition and innovation are important aspects in the debate, they are not the only aspects network neutrality proponents care about. *See* the discussion *infra* Part III.B and in the conclusion.

129. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 60–61; Yoo, *Economics of Congestion*, *supra* note 2, at 1892–95, 1899–1900.

130. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 60–61; Yoo, *Economics of Congestion*, *supra* note 2, at 1892–95, 1899–1900.

131. Yoo, *Economics of Congestion*, *supra* note 2, at 1892–94.

132. *See* Wu, *Testimony*, *supra* note 19, at 7; ROBERT D. ATKINSON & PHILIP J. WEISER, INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION, A "THIRD WAY" ON NETWORK NEUTRALITY 7–10 (2006), *available at* http://www.innovationpolicy.org/netneutrality.pdf. For a similar view in the context of the debate over ISP access to broadband networks, see *Ex parte* Submission of Mark A. Lemley & Lawrence Lessig, Application for Consent to the Transfer of Control of Licenses MediaOne Group, Inc. to AT&T Corp. (F.C.C. filed November 10, 1999) (CS Dkt. No. 99-251), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6009850930; Applications for Consent to the Transfer of Control of Licensees and Section 214 Authorizations by Time Warner Inc. and America Online, Inc., Transferors, to AOL Time Warner Inc., Transferee. 16 F.C.C.R. 6547, 6594–95, ¶ 107 (2001); James B. Speta, *The Vertical Dimension of Cable Open Access*, 71 U. COLO. L. REV. 975, 986 (2000); Christopher S. Yoo, *Vertical Integration and Media Regulation in the New Economy*, 19 YALE J. ON REG. 171, 249–50, 253 (2002). *But see* Lessig, *Testimony*, *supra* note 19, at 4–5 nn.5–7 and accompanying text (noting recent scholarship doubting the positive impact of competition, but concluding that the question is moot because of the existence of effective duopoly).

research casts doubt on the ability of (limited) competition[133] in the market for Internet access services to discipline network providers in the markets for complementary products.[134]

As van Schewick has shown elsewhere,[135] three arguments drive this result: First, in the Internet context, the ability to exclude competitors from a complementary market (the markets for applications, content and portals) is not dependent on a monopoly position in the primary market (the market for Internet access services). Instead, the power to exclude is conferred by network technology.[136] Second, realizing the benefits of exclusion, that is, an increase in profits (or, sometimes, a preservation of current profits), does not require a monopoly position in the primary market. The lack of monopoly in the primary market even increases the network provider's incentive to increase profits by engaging in exclusionary conduct in the complementary market, as the network provider cannot simply extract the available monopoly profit by charging higher prices in the primary market.[137] Third, because of various factors such as the existence of switching costs, long-term contracts, or the ability to use discrimination instead of exclusion, the exclusion of rivals will not necessarily cause the network provider's Internet service customers to switch to another provider, making the costs of exclusion lower than is commonly assumed.[138]

Second, Yoo contends that network neutrality proponents focus on the wrong market to determine the extent of competition.[139] While network neutrality proponents usually agree that competition is able to mitigate the problem, they go on to conclude that the market for Internet access services is too concentrated, pointing to the local markets for Internet access services. By

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133. In this context, limited competition means that the network provider competes with at least one other network provider, van Schewick, *supra* note 18, at 368–76. This assumption includes, but is not limited to duopoly and reflects the reality in the broadband market for residential customers in the U.S. According to a recent study by the United States Government Accountability Office, the median number of broadband providers available to residential users is two. U.S. Gov't Accountability Office, GAO-06-426, TELECOMMUNICATIONS: BROADBAND DEPLOYMENT IS EXTENSIVE THROUGHOUT THE UNITED STATES, BUT IT IS DIFFICULT TO ASSESS THE EXTENT OF DEPLOYMENT GAPS IN RURAL AREAS 18 (2006), http://www.gao.gov/new.items/d06426.pdf. Farrell calls the market structure to which his analysis applies, "Duopoly +/−," *supra* note 44, at 201–04.

134. Farrell, *supra* note 44, at 201–04, van Schewick, *supra* note 18, at 368–76. For a similar argument in the context of the debate over censorship by private proxies, see Seth F. Kreimer, *Censorship by Proxy: The First Amendment, Internet Intermediaries, and the Problem of the Weakest Link*, 155 U. PA. L. REV. 11, 33–36 (2006) (arguing that competition between Internet service providers may not be sufficient to discipline Internet service providers that disable content needlessly).

135. Van Schewick, *supra* note 18, at 368–76.

136. *Id*. at 371.

137. *Id*. at 372.

138. *Id*. *Cf.* Kreimer, *supra* note 134, at 33–36 (arguing that competition between Internet service providers may not be sufficient to discipline Internet service providers that disable content needlessly based on arguments very similar to the ones advanced in the text).

139. Yoo, *Economics of Congestion*, *supra* note 2, at 1892–94.

contrast, Yoo thinks that competition is sufficiently robust. According to him, the relevant geographical market is the nationwide market for Internet access services: "[A]pplication and content providers care about the total number of users they can reach. So long as their potential customer base is sufficiently large, it does not really matter whether they are able to reach users in any particular city. . . . What matters is not the percentage of broadband subscribers that any particular provider controls in any geographic area, but rather the percentage of a nationwide pool of subscribers that that provider controls."[140]

This is only partly correct. The disciplining effect of competition is usually ascribed to the fact that under competition, customers that are unhappy with the exclusionary conduct can obtain the good they want from other sources.[141] Losing customers who want access to the excluded complementary product to a competing Internet service provider is a cost of exclusion that a network provider needs to consider. Whether customers will be able to switch Internet service providers depends on the amount of competition in the local market for Internet access services. Thus, Yoo is not correct in disregarding the amount of concentration in the local market for Internet access services.

At the same time, the percentage of subscribers that the network provider controls is not irrelevant, either. How many potential customers of the complementary product are controlled by the network provider determines how much rivals in the complementary market are harmed if the network provider decides to exclude them from access to its Internet service customers.[142] If the percentage of customers controlled by the network provider is rather small, excluding rivals from access to these customers may enable the network provider to increase the number of sales of its complementary product at the ex-

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140. *Id.* at 1892–93.

141. *See* van Schewick, *supra* note 18, at 375–77; Bill D. Herman, Article, *Opening Bottlenecks: On Behalf of Mandated Network Neutrality*, 59 FED. COMM. L.J. 103, 128–30 (2006). It is interesting to note that in the same paper where he argues that the national market is the appropriate market for determining the extent of competition, Yoo repeatedly describes the ability to switch providers as the mechanism by which competition mitigates anticompetitive behavior; the ability to switch providers, however, is clearly dependent on the existence of competition in the local market: "The presence of competition drastically reduces the ability of network owners to use exclusivity arrangements to harm competition, since disgruntled consumers can simply transfer their subscriptions to another network." Yoo, *Economics of Congestion*, *supra* note 2, at 1894; "If a sufficient number of competitive options exist, any attempt to use exclusivity in an anticompetitive manner should be disciplined by the market over the long run, as end users who dislike the exclusivity arrangement will simply transfer their subscriptions to a different network." Yoo, *Economics of Congestion*, *supra* note 2, 1900. *See also* Yoo, *Mandating Network Neutrality*, *supra* note 2, at 67 (Noting that "regulators can adopt a more humble posture about their ability to distinguish anticompetitive from procompetitive behavior and attempt to resolve the problem by promoting entry by alternative broadband platforms. Once a sufficient number of alternative last-mile providers exist, the danger of anticompetitive effects disappears, as any attempt to use an exclusivity arrangement to harm competition will simply induce consumers to obtain their services from another last-mile provider.")

142. *See* VAN SCHEWICK, *supra* note 7 (manuscript at 253–54).

pense of its rivals, but may not suffice to drive the rivals from the complementary market.

Two points are worth noting here: First, contrary to what Yoo assumes, if one is interested in determining how much the producers of complementary products are harmed if they are excluded by a particular network provider, it is not necessarily the percentage of customers from the nationwide pool of subscribers controlled by this network provider that matters. The proper market for this assessment is the market for the complementary application under consideration.[143] Depending on the application or content in question, the relevant market may be regional, national or global. For example, the producer of a local news site or of local yellow pages needs to reach customers locally; if there is only one local network provider and that provider decides to block these offerings, the excluded producer cannot reach any of its customers. Whether it remains able to reach customers nationwide is irrelevant. In other words, for offerings with local reach, it is still the concentration of the local market that matters.

Second, while the percentage of customers in the complementary market that the network provider controls is not irrelevant, its relevance for the network neutrality debate is limited. As indicated above, discrimination may be a profitable strategy even if the network provider does not manage to drive its competitors from the complementary market;[144] thus, the incentive to discriminate exists regardless of the percentage of complementary market customers that the network provider controls. If the provider chooses to discriminate, independent producers will usually be hurt: in most cases, discrimination will reduce their number of sales, which reduces their profits and their incentives to innovate.[145] It is this reduction in independent producers' incentives to innovate that network neutrality proponents want to prevent.[146]

To sum up, contrary to what is commonly assumed, limited competition in the local market for Internet access services does not necessarily remove a network provider's incentive to discriminate. Thus, the amount of competition in the market for Internet access services is less relevant to the network neutrality debate than Yoo assumes. In any event, the disciplining effect of competition—to the extent it exists—depends on the amount of competition in the local market for Internet access services, not, as Yoo contends, on the amount of concentration in the nationwide market for Internet access services. While

143. The same argument is made by Herman, *supra* note 141, at 130.

144. This argument is developed in detail in van Schewick, *supra* note 18, at 364–68.

145. *Id.* at 364–65 (explaining how exclusion hurts independent providers of complementary products).

146. *See* Lessig, *Testimony*, *supra* note 19; at 8–9 Wu, *Testimony*, *supra* note 19, at 4–5; Wu & Lessig, *Ex parte*, *supra* note 19, at 5–7; van Schewick, *supra* note 18, at 382. (highlighting the specific benefits of innovation by independent innovators); *id.* at 383–86. (outlining the social benefits of additional innovation in applications, content or portals). For a short discussion of the importance of application-level innovation for economic growth, see also the discussion *infra* note 168 and accompanying text.

the amount of concentration in the nationwide market determines the extent to which a single network provider can harm producers of a complementary product that is offered nationwide, this question is more relevant from an antitrust perspective that cares about potential monopolization, but less relevant for the network neutrality debate, which cares about the reduction in incentives for independent producers of complementary products to innovate.[147]

B. Network Neutrality and the Market for Broadband Networks

Finally, Yoo rejects calls for network neutrality regulation because of their impact on competition in the market for last-mile broadband access. This is based on the belief that the ultimate goal of communications policy should be to increase competition in this market, which is less competitive than the markets for applications and content.[148] We address both arguments in turn.

According to Yoo, the negative impact of network neutrality regulation on the market for last-mile broadband networks is threefold: First, by reducing network providers' profits, network neutrality regulation reduces their incentives to invest in the deployment of broadband networks.[149] Second, it reduces new entry by decreasing the incentive of developers of complementary products to finance new networks. Third, by preventing diversification, network neutrality regulation deprives network providers of an important tool to overcome barriers to entry in the form of direct network effects.[150]

First, while network neutrality regulation reduces network providers' profits, it is far from clear whether this reduction pushes their incentives to deploy infrastructure below a socially efficient level. On the one hand, the reduction in profits resulting from network neutrality regulation is rather limited.[151] Network neutrality regulation does not restrict network providers' ability to vertically integrate into complementary markets[152] and make a profit in these markets or in the market for Internet access services;[153] it only pre-

147. On the difference between the focus of analysis in antitrust and in the network neutrality context, see also *supra* notes 119 and 128 and accompanying text.

148. *E.g.*, Yoo, *Beyond Network Neutrality*, *supra* note 2, at 13–18. One puzzling aspect of the network neutrality debate is that some opponents of network neutrality, such as Yoo, admit that broadband markets are not competitive and that promoting competition would be desirable. *E.g., id.* Yoo believes that allowing networks to discriminate will promote competition. On the other hand, some opponents, and, again, Yoo, insist that the markets are actually somewhat competitive or will soon be competitive, and thus, there is no case for regulation. *Id.* at 60–61; Yoo, *Economics of Congestion*, *supra* note 2, at 1899–1900.

149. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 48–51.

150. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 33–37, Yoo, *Economics of Congestion*, *supra* note 2, at 1904.

151. Van Schewick, *supra* note 18, at 388–89.

152. Frischmann & Lemley, *supra* note 12, at 296 n.146; Tim Wu, *The Broadband Debate: A User's Guide*, 3 J. TELECOMM. & HIGH TECH. L. 69, 89 (2004).

153. Proponents of network neutrality regulation disagree whether price discrimination should be allowed under a network neutrality regime or whether certain types of price discrimination should be ruled out. *See, e.g.*, Wu, *supra* note 66, at 151–54 (arguing against price discrimina-

vents them from making additional profits by discriminating against their rivals. On the other hand, new wireless technologies may reduce the level of profits needed to provide efficient incentives by reducing the costs of broadband infrastructure.[154] Ultimately, the level of profits needed to guarantee efficient incentives is unknown, making it difficult to assess the extent of the problem.

Second, Yoo argues that network neutrality rules reduce entry by removing new entrants into the market for last-mile broadband access of their strategic allies, because in the absence of network neutrality rules providers of excluded applications would finance new networks.[155] There are two problems with this argument: First, it disregards the different capital requirements associated with entry into these markets.[156] As a result, only some of the excluded providers of complementary products would have the financial means to finance new networks. Second, forcing established providers of complementary products to finance their own networks does not really solve the problem that network neutrality regulation is designed to address: Once the provider of a complementary product becomes affiliated with a network owner, it experiences the same incentive to discriminate as other vertically integrated network owners. Taken together with the first argument, this implies that newcomers or users that cannot finance their own networks will still be subject to discrimination. Given that these actors have traditionally been a very important source of innovation in Internet applications and content[157] and that application-level

tion, if it is based on discrimination between applications) on the one hand and JONATHAN E. NUECHTERLEIN & PHILIP J. WEISER, DIGITAL CROSSROADS: AMERICAN TELECOMMUNICATIONS POLICY IN THE INTERNET AGE 177 (2005) on the other hand. *See also* Lessig, *Testimony*, *supra* note 19 at 2–3 & n.2 (arguing against "access tiering," that is, "any policy by network owners to condition content or service providers' right to provide content or service to the network upon the payment of some fee . . . . [which is] independent of basic Internet access fees." However, he supports "customer-tiering," that is, price discrimination, so long as it is not based on "discriminat[ion] among content or application providers."). Which of these solutions is implemented under a network neutrality regime clearly influences the amount of profit that network providers can expect to make. We do not enter the fray in this article.

154. Van Schewick, *supra* note 18, at 388–89.

155. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 48–51; Yoo, *Economics of Congestion*, *supra* note 2, at 1894–95.

156. Because of the end-to-end architecture of the Internet, entrants into the market for Internet applications need only programming skills and access to an end host. *See* VAN SCHEWICK, *supra* note 7 (manuscript at 172–73, 227–28) (describing the relationship between the end-to-end architecture of the Internet and the costs of entry into this market). Similarly, entrants into the market for content need only access to a Web server. *See id.* (manuscript at 228). By contrast, as Yoo has described in detail, the market for last-mile broadband networks is characterized by considerable barriers to entry. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 27–30.

157. For a detailed description of the benefits of independent application-level innovation with links to the relevant literature, see VAN SCHEWICK, *supra* note 7 (manuscript at Ch. 11).

innovation is particularly important in fostering economic growth[158] the social benefits of forcing producers of complementary products to finance networks by subjecting them to discrimination seem to be rather limited.

Third, Yoo argues that by forbidding network providers to diversify their last-mile offering, network neutrality regulation deprives network providers of an important tool to overcome barriers to entry in the form of direct network effects.[159] Yoo's argument consists of three steps: (1) direct network effects are a source of market failure in the market for last-mile broadband networks; (2) diversification would enable small networks to enter the market in spite of this problem; (3) network neutrality is harmful because it prevents diversification. This argument is not only based on an overly broad perception of network neutrality regulation[160] that goes far beyond what network neutrality proponents want to achieve. It is also based on a faulty application of the theory of direct network effects.

As a matter of fact, network neutrality regulation does not prevent network providers from diversifying their offerings. It only establishes certain limits on their ability to use their power over the network to distort the markets for applications and content. While the extent of diversity that would be allowed under a network neutrality regime is still subject of debate,[161] ways of differentiating themselves from other network providers would always remain. For example, network providers could compete on the basis of bandwidth, the amount of overprovisioning, or the exclusive offering of complementary products.

While Yoo describes the relationship between diversification and direct network effects correctly, his reasoning is based on the wrong premise. In the presence of strong network effects, competition between several incompatible technologies usually results in a single technology dominating the market.[162] In such a world, smaller networks cannot survive against large networks. If, however, consumer preferences are sufficiently heterogeneous, several competing incompatible networks may be able to coexist.[163] Under these circumstances, diversification may enable smaller networks to enter (and remain in) the market in spite of barriers to entry in the form of network effects. The

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158. This is because of the character of the Internet as a general-purpose technology. For a short explanation, see discussion *infra* note 168 and accompanying text. For a detailed explanation, see VAN SCHEWICK, *supra* note 7 (manuscript at 346–49); Frischmann, *supra* note 7, at 1004–22; van Schewick, *supra* note 18, at 385–86.

159. Yoo, *Beyond Network Neutrality*, *supra* note 2, at 27–33; Yoo, *Economics of Congestion*, *supra* note 2, at 1904.

160. *See generally* van Schewick, *supra* note 18, at 333–34 & nn.9–11 (describing the differences between the overly broad notion of network neutrality used by Yoo and the narrower notion of network neutrality used by network neutrality proponents with references to the literature).

161. For example, network neutrality proponents disagree on whether the use of Quality of Service technology should be allowed under a network neutrality regime.

162. *E.g.*, Katz & Shapiro, *supra* note 59, at 105–06.

163. *E.g.*, Katz & Shapiro, *supra* note 59, at 106.

applicability of this theory is limited to cases in which network effects actually form a barrier to entry, that is, if there is competition between several incompatible technologies. By contrast, if the competing technologies are compatible, network effects are not a problem for new entrants: As the benefits of an additional user accrue to the overall network consisting of the users of all compatible technologies, the size of the new entrant's network is not an issue.[164]

Yoo argues that network effects in the market for Internet access services constitute a barrier to entry into that market that network diversity may be able to ameliorate; however, direct network effects are not currently a problem in the market for Internet access services. Under the current regime of universal Internet Protocol connectivity, competition between networks in today's Internet is a form of competition between compatible technologies.[165] A new user who joins a particular network provider's network gains access to the customers of every other network provider who also implements the Internet Protocol. As a result, network effects, or the size of the particular network provider's network, are not an issue. Network effects do not form a barrier to entry into the market for Internet access services; put differently, Yoo presents the concept of network diversity as the solution to a problem that does not exist.

The above arguments suggest that the impact of network neutrality regulation on competition in the market for last-mile broadband networks is not as bad as Yoo makes it seem. While network neutrality regulation may reduce network providers' incentives to deploy broadband networks,[166] it remains unclear whether any potential reductions are large enough to create a problem for public policy. That is, discrimination by network owners might increase network owners' returns and their incentives to build and maintain broadband networks, but the magnitude of such increases is not known (or even knowable). Not surprisingly, Yoo offers no empirical evidence or even speculative suggestions as to *how much* incentives to invest in infrastructure would improve.

If, however, there is a problem and incentives to invest in infrastructure are suboptimal, it is far from clear whether refraining from network neutrality regulation is the solution. By focusing only on the potential negative impact of network neutrality regulation on the market for last-mile broadband networks, Yoo neglects the values that are fostered by a network neutrality regime: network neutrality guarantees unfettered application-level innovation, which is

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164. SHAPIRO & VARIAN, *supra* note 61, at 173–260; Katz & Shapiro, *supra* note 59, at 110.

165. Van Schewick, *supra* note 18, at 363.

166. In other words, there is a trade-off: while network neutrality rules protect incentives to innovate in the markets for complementary products such as applications and content, they reduce incentives to invest in the market for last-mile broadband access. This trade-off is recognized by network neutrality proponents as well. *See* Wu, *Testimony*, *supra* note 19, at 4–5; van Schewick, *supra* note 18, at 382–89. Network neutrality proponents and opponents disagree on the extent of the problem in the market for last-mile broadband access and on the correct resolution of the trade-off.

critically important for economic growth. In addition, by implementing a nondiscriminatory access regime, network neutrality regulation fosters the production of a wide range of public and nonmarket goods, which, because of the positive externalities associated with them, may create enormous social value.

As a general purpose technology, the Internet has the potential to contribute disproportionately to economic growth.[167] The literature on general purpose technologies shows that the existence of the Internet as such is not sufficient to positively affect economic growth. Instead, the rate with which a general purpose technology can contribute to economic growth is limited by the rate with which new uses of the technology in various sectors of the economy and society can be identified and realized. Thus, with respect to the Internet, the rate with which the Internet can contribute to economic growth is limited by the rate with which new applications and new content can be identified and realized; in other words, it is limited by the rate of application-level innovation. Measures that reduce application-level innovation have the potential to significantly limit economic growth. Measures that increase application-level innovation have the potential to significantly increase economic growth.[168] Thus, by increasing application-level innovation, network neutrality regulation has the potential to significantly increase economic growth.

As an infrastructure resource, the Internet serves as an input to the production of a wide range of private, public and nonmarket goods. The positive externalities associated with the various productive activities that users engage in and the positive spillovers associated with the public and nonmarket goods they produce have the potential to create significant social value. These positive externalities are often diffuse and accrue to society as a whole. As a result, productive users will not internalize these externalities; their demand for infrastructure access will not accurately reflect the beneficial impact of their activities for society. Network providers do not internalize these externalities, either; their decisions on which users and uses to admit to their networks will neglect society's interest in these types of productive uses. Under these circumstances, a nondiscriminatory access regime has the advantage of providing a rather blunt broad subsidy for users and uses that produce positive externalities associated with public and nonmarket goods by freeing them from market-driven restrictions on access and use, while avoiding the difficulties associated with directing targeted government subsidies to those user-producers. Thus, a nondiscriminatory access regime serves an important role in fostering the type of productive downstream activities that, because of the positive spillovers asso-

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167. General purpose technologies are generic technologies that can usefully be applied in a large number of sectors throughout the economy. Research on general purpose technologies shows that in the past, general purpose technologies have contributed disproportionately to economic growth. *See* VAN SCHEWICK cited *supra* note 18, at 383–86.

168. For a detailed explanation of the relationship between general purpose technologies, economic growth, and application-level innovation, see VAN SCHEWICK, *supra* note 7 (manuscript at 346–49); van Schewick, *supra* note 18, at 383–86.

ciated with them, have enormous social value, but may get lost under a discriminatory access regime driven by network providers' private commercial interests.[169]

In resolving the trade-off between these conflicting values, Yoo also neglects that there are alternative ways of improving incentives to deploy infrastructure that do not entail discrimination on the basis of content or application and would not be as detrimental to application-level innovation or the Internet-based production of public and nonmarket goods as refraining from network neutrality regulation.[170] Some viable options include direct subsidization of infrastructure expansion, tax incentives to support the same, cooperative research and development projects, and joint ventures.. In addition to improving incentives for private provision of infrastructure, government provision of infrastructure is another viable option for the last mile. In fact, municipal provision of broadband access to the Internet has gained significant momentum in recent years.[171] Thus, it is possible to solve the problem of infrastructure deployment through alternative means that do not have similarly harmful effects for application-level innovation.[172] Similarly, while Yoo may be correct in arguing that a chain of vertically related markets is only as competitive as its weakest link, this does not necessarily justify distorting competition in a more competitive market to ameliorate the problem.

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169. For a detailed exposition of the importance of nondiscriminatory access for infrastructure resources that serve as an input to the production of public and nonmarket good, see Frischmann, *supra* note 7, at 978 (in general), *id.* at 1020–22 (in the context of the Internet). *See also supra* note 52.

170. Frischmann, *supra* note 7, at 1021; Frischmann & Lemley, *supra* note 12, at 139 n.147; van Schewick, *supra* note 18, at 388–89. For a specific proposal along these lines, see ATKINSON & WEISER, *supra* note 132, at 14 (suggesting "Congress should allow companies investing in broadband networks to expense new broadband investments in the first year" and "Congress should extend the current temporary moratorium on federal, state and local broadband-specific taxes and make it contingent upon broadband providers providing the level of open, un-managed Internet service as defined by the FCC.").

171. For a compilation of sources on municipal broadband efforts, see Cybertelecom Web site, http://www.cybertelecom.org/broadband/muni.htm (last visited Oct. 28, 2007).

172. Wu, *Testimony*, *supra* note 19, at 5 ("Taxing innovation is hardly the only, and probably the most expensive way to encourage [broadband] infrastructure deployment."); van Schewick, *supra* note 18, at 388–89.

In his article on network neutrality and the economics of congestion, Professor Yoo contends that the network neutrality debate has been framed too narrowly and that a wider view that takes account of the fact that the Internet is subject to congestion is needed.[173] We agree with this view. We believe, however, that it is Yoo who adopts too narrow a frame. Apart from his foray into the economics of congestion, Yoo focuses mainly on competition policy.[174] He generally employs antitrust economics as a backdrop for the various economic arguments he makes.[175] His analysis of network neutrality is grounded on the view that the "central goal of broadband policy" is "improving the competitiveness of the last mile."[176] This is too narrow a frame. There are many related normative commitments at stake in the network neutrality debate, including market values such as promoting allocative and productive efficiency, innovation, and economic growth but also various nonmarket values such as education and increased participation in cultural and political processes.[177,178] As has become apparent above, network neutrality regulation

173. Yoo, Economics *of Congestion, supra* note 2, at 1851–54, 1885–87.

174. *E.g.*, *id.*, at 1851–55, 1885–95, 1899–1900.

175. *See id.*

176. Yoo, *Beyond Network Neutrality, supra* note 2, at 9; Yoo, *Economics of Congestion, supra* note 2, at 1895 (noting, "[i]n the case of the Internet, ... [t]he central policy focus should be on how to encourage greater entry by new last-mile providers."). For an explanation of this view, see Yoo, *Beyond Network Neutrality, supra* note 2, at 8–9, 15–18.

177. *See* Brett Frischmann, *Cultural Environmentalism and the Wealth of Networks*, U. CHI. L. REV. (forthcoming 2007) (reviewing YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM (2006)), (on the range of normative commitments at stake). In his recent book, Benkler persuasively argues that "commons based peer production" is economically viable as a production system and that preserving and encouraging this system of production is justified by a range of normative commitments. BENKLER *supra*, at 60–63.

178. Yoo does acknowledge that other values may be relevant to the network neutrality debate. For various reasons, they do not enter his final trade-off, though. For example, he acknowledges the existence of noneconomic motivations for network neutrality regulation. In one article, he rejects existing attempts to invoke noneconomic values to justify network neutrality based on the argument that they are not sufficiently quantified to enter an economic trade-off, Yoo, *Beyond Network Neutrality*, *supra* note 2, at 53–57 (footnote omitted) ("There is noting [sic] incoherent about imposing regulation to promote values other than economic welfare. The problems with this approach are more practical than conceptual. Unless protecting the widest possible diversity of sources is a virtue in and of itself that trumps all other values, such a theory must provide a basis for quantifying the noneconomic benefits and for determining when those benefits justify the economic costs."). In his article on network neutrality and the economics of congestion, he justifies his focus on economic justifications by arguing that this is the approach used by network neutrality proponents. Yoo, *Economics of Congestion*, *supra* note 2, at 1851 n.13 ("Since network neutrality proponents defend their proposals almost exclusively in terms of the economic benefits of innovation, this Article discusses the issues solely in economic terms. I therefore set aside for another day any discussion of noneconomic issues, such as network neutrality's implications for democratic deliberation or the First Amendment."). Yoo discusses network neutrality proponents' concerns about application-level innovation, but concludes that there is no problem

may have countervailing effects on some of these values. Thus, ultimately, the decision for or against network neutrality may require a trade-off. This makes it even more important to identify and take account of the various values at stake.[179]

In this paper, we have addressed various weaknesses in Yoo's arguments from within the economic framework he employs. We have also shown how concerns about application-level innovation, broadly defined, and the positive externalities associated with productive uses of the Internet infrastructure further complicate the picture and provide theoretical support for network neutrality regulation.

By freeing providers of complementary products from the threat of discrimination, network neutrality regulation increases application-level innovation. Measures that increase application-level innovation have the potential to significantly increase economic growth.

While concerns about application-level innovation have played a central role in the network neutrality debate from the beginning, the importance of network neutrality for the production of a wide variety of public and nonmarket goods has not been similarly acknowledged. As an infrastructure resource, the Internet generates significant value as an input into a wide variety of productive activities engaged in by users. The Internet has had a transformative impact on many different social systems, spurring widespread systematic change not only in many different industries but also in many different nonindustrial sectors of our society:[180] It is transforming commerce, community, culture, education, government, health, politics, and science—all information- and communications-intensive systems. The Internet spurs this transformation by empowering people to participate and engage in socially valuable, productive activities. These activities produce significant external benefits that accrue to society as a whole and are not captured or necessarily even appreciated by the participants.[181] As network providers cannot capture these externalities,

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for application-level innovation that network neutrality regulation would need to solve. *Id.* at 1887–95. We have discussed specific problems with his arguments *supra* Part III.; it is worth reiterating that network neutrality proponents' concern about application-level innovation leads to a focus of analysis that is different from a traditional antitrust analysis. *See supra* text accompanying notes 119, 128, and 147. This suggests that Yoo's choice of antitrust economics as the primary theoretical approach may make it more difficult for him to capture the problems for application-level innovation that an absence of network neutrality rules may create. While he discusses concerns about application-level innovation, Yoo does not address the concerns about discrimination that result from the infrastructural nature of the Internet.

179. We do not claim to have completely identified and discussed all values at stake in the debate, either. In particular, the relationship between network neutrality and free speech has been underexplored in the academic debate so far.

180. This paragraph draws from Frischmann, *supra* note 7, at 1004–22.

181. It is worth noting that welfare can be ratcheted up in incredibly small increments and still lead to significant social surplus. As participants educate themselves, interact, and socialize, for example, the magnitude of positive externalities may be quite small. Diffusion of small-scale positive externalities, however, can lead to a significant social surplus when the externality-producing activity is widespread, as it is on the Internet.

either, their decisions will not take account of society's interest in these uses. As a result, shifting from an Internet infrastructure commons that does not distinguish between users and uses to an Internet infrastructure in which network providers decide which users and uses to admit risks preferencing certain end-user activities (that is, those that generate observable benefits that can easily be appropriated by network providers) over others (that is, those that generate positive externalities). The social opportunity costs of allowing network owners' to dismantle the Internet's infrastructure commons may be tremendous but incredibly difficult to measure precisely because so much of the value generated by Internet users is not fully captured in market transactions. It would be a real tragedy to forsake the social value—the comedy—of the Internet commons.