Network Neutrality and Industry Structure

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I. Introduction 150
II. Background: The Various Shades of Network Neutrality 152
III. Economic Model: Commoditization, Industry Structure, and Network Neutrality 155
A. Model 157
1. Case 1: Monopoly, $\theta = 1$ 160
2. Case 2: Monopoly, $\theta < 1$ 161
3. Case 3: Duopoly, $\theta = 1$ 161
4. Case 4: Duopoly, $\theta < 1$ 163
5. Case 5: Bertrand Duopoly, $\theta = 1$ 164
IV. Evaluation of the Results 164
A. Network Neutrality and Efficiency 165
B. Network Neutrality and Consumers 166
C. Differentiation that Increases the Marginal Value of Goods 167
D. Summary 167
V. Conclusion 168

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I. Introduction

One of the most heated debates in the current efforts to re-write the Communications Act has been whether the federal government should impose Network Neutrality requirements on broadband service providers. Although there is no consensus on precisely what "Network Neutrality" means—and thus no consensus on what rules are required to achieve it—the principle is usually couched in terms of preserving the "openness" of the Internet so that consumers can freely access third-party applications over broadband networks without the fear that the broadband network provider will deteriorate or degrade the transmission to these third-party applications and services in favor of their own applications and services. In practice, the goal of Network Neutrality is to prevent anticompetitive conduct by placing various regulatory constraints on the behavior of broadband service providers.

While preventing anticompetitive conduct sounds sensible enough, it is also possible for a Network Neutrality rule to have the intent or effect of "commoditizing" broadband transmission and Internet access services by limiting the ability of broadband service providers to differentiate their service offerings from those of rival firms. While we argue neither for nor against the need for Network Neutrality legislation in this paper, our analysis shows that policymakers should avoid mandates that may "commoditize" broadband access services because such a policy approach is likely to deter facilities-based competition, reduce the expansion and deployment of advanced communications networks, and increase prices. Moreover, given the economic characteristics of local communications networks, policies that promote commoditization of broadband access could lead to the monopoly provision of advanced broadband services in many markets. This outcome would harm consumers substantially.

Our conclusion, while based on a rather technical economic model, is actually relatively simple and intuitive. Economic theory suggests that product differentiation is an important component of competition, particularly in industries with large fixed and sunk costs. Allowing broadband firms to differentiate their products may make entry more likely, thereby leading to a less concentrated industry structure.[1] Entry with differentiation is superior to the situation in which policy-mandated bandwidth commoditization results in highly

1. This relationship is well known in economics. *See, e.g.,* J. TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION ch. 7 (1995).

concentrated industry structures, including monopoly.[2] Our economic model indicates that by deterring entry, Network Neutrality rules that encourage commoditization are clearly bad for consumers (and probably bad for society as a whole), and this result holds even if differentiation has no effect on overall demand.[3] Since differentiation is likely to have significant value to consumers and firms, our caution about such Network Neutrality rules is possibly even conservative.

Economic forces inherent to communications networks tend to promote concentrated equilibrium industry structures (i.e., few firms).[4] Consequently, policymakers should always consider how various policy proposals influence the underlying economics of entry into communications markets so that the existing entry-limiting economic conditions are not intensified by regulatory intervention. As we show in this paper, Network Neutrality rules that encourage commoditization of broadband service *exacerbate* this tendency toward concentration in an industry that is already characterized by an inherently high equilibrium industry concentration level. This effect on industry structure actually conflicts with the desires of Network Neutrality advocates, in that proponents of Network Neutrality rules often cite to the concentrated nature of the local market as justifying their concern over discrimination.[5] In other

2. The history of communications and video markets clearly indicates that the market is not conducive to competition among a large number of firms, or in some cases even few firms. In both domestic and international markets, many communications and video networks were constructed with significant government subsidies and decades of protected monopoly. It is well recognized that the financial struggles of interexchange carriers such as AT&T and MCI driven, in large part, by the commoditization of long distance services. *See, e.g.,* J. Oldham, *AT&T Enters Latest Fare War, Lowering Long-Distance Rates,* LOS ANGELES TIMES, Aug. 31, 1999; K. Taylor, *So Long, Long Distance, available at* THE MOTLEY FOOL, Sept. 7, 2004, http://www.fool.com/News/mft/2004/mft04090712.htm.

3. In our model, social welfare is impacted by network duplication costs, whereas consumer welfare is affected only by price changes. For social welfare to improve with entry, the gains to consumers must outweigh the lost profit to firms and the fixed costs of the entrant.

4. George S. Ford, Thomas M. Koutsky & Lawrence J. Spiwak, PHOENIX CENTER POLICY PAPER NO. 21: *Competition After Unbundling: Entry, Industry Structure and Convergence* (July 2005), *available at* http://www.phoenix-center.org/pcpp/PCPP21Final.pdf (analysis and citations therein. The paper also reveals that high concentration need not result in poor market performance. Indeed, high concentration may be the result of intense price competition. In the presence of sunk costs, however, monopoly is nearly always undesirable, since sunk costs protect the monopolist from the hit-and-run entry that could create pricing discipline.

5. Prepared Statement of Vinton C. Cerf, Vice President and Chief Internet Evangelist, Google Inc., U.S. Senate Committee on Commerce, Science, and Transportation (Feb. 7, 2006) at 7 (on file with author), *available at*:

words, Network Neutrality rules that promote even higher levels of concentration may be a cure that worsens the disease. Therefore, in considering various Network Neutrality proposals, policymakers should be aware of the need to balance concerns about discrimination with the danger that commoditizing the market for broadband Internet access services may lead to the monopoly provision of broadband Internet access service in many markets. The result would be lower broadband penetration rates due to higher broadband prices and would certainly impede the expansion and technological advancement of broadband networks in the United States.

Our analysis in this paper is focused. We do not attempt to address the incentive to discriminate against broadband Internet access service providers, or model the value to consumers and firms of network-based differentiation and innovation. Nor do we attempt to examine comprehensively the myriad of Network Neutrality proposals, many of which might not present this risk of commoditization. Our analysis only considers the particular risk that (effectively) mandated commoditization would have on competition and entry. Our findings reveal that Network Neutrality rules may be socially inefficient even if firms never engage in anticompetitive behavior and even if consumers place no value on network differentiation and innovation. If consumers and firms do value network differentiation and innovation, and we certainly expect they do, then our findings would be substantially strengthened. Network Neutrality rules, then, are not innocuous simply because firms might adhere to their intended purpose (nondiscrimination) even without the imposition of such rules.

After a brief background section, we present an economic model in Section III that compares consumer and social welfare across market scenarios that differ in the degree of product differentiation and competition. Aspects of this economic model are quite technical, but we summarize the primary findings of the model in Section IV. Those not interested in the technical details can jump ahead.

II. Background: The Various Shades of Network Neutrality

Network Neutrality proposals exist on a continuum. Some Network Neutrality proposals focus almost exclusively on

http://commerce.senate.gov/pdf/cerf-020706.pdf ("Cerf Testimony") ("[t]he best long-term answer to this problem is significantly more broadband competition.").

nondiscrimination,[6] while others include prohibitions on certain forms of exclusive arrangements for broadband transmission services.[7] No doubt, the rules crafted to handle these particular flavors of Network Neutrality may unintentionally promote commoditization, but some Network Neutrality advocates unabashedly assert that the commoditization of local broadband Internet access should be the goal of policymakers. For example, David Isenberg, who first coined the term "Stupid Network," explicitly calls for the government to create a "commodity network," where broadband transport is divested entirely from higher level services.[8] Our analysis in this paper reveals an important problem with this approach: this type of forced commoditization could deter entry, possibly resulting in monopolization of broadband access and slow deployment and improvements in broadband infrastructure.[9]

While this paper is (to our knowledge) the first formal economic analysis of this particular concern regarding Network Neutrality, we are not the first to recognize the potential undesirable market power consequences of Network Neutrality-driven commoditization. For example, Professor Christopher S. Yoo recently opined that if "improving the competitiveness of the last mile becomes the central goal of broadband policy, it becomes clear that network neutrality is potentially problematic and counterproductive."[10] The problem, Professor Yoo argues, is that:

> network neutrality can reinforce the sources of market failure in telecommunications markets by exacerbating the impact of up-front, fixed costs and by network economic effects. Conversely,

6. *See, e.g.,* Tim Wu, *Network Neutrality, Broadband Discrimination,* 2 J. ON TELECOMM. & HIGH TECH. L. 141 (2005) (which focuses exclusively on "restrictions on the use of an Internet connection"); Letter from Tim Wu, University of Virginia Law School, and Lawrence Lessig, Stanford Law School, to Marlene H. Dortch, Secretary, Federal Communications Commission, in CS Docket 02-52 (Aug. 22, 2003) (on file with author).

7. John Windhausen, Jr., *Good Fences Make Bad Broadband,* Public Knowledge White Paper (Feb. 6, 2006) at 40-42, *available at*: http://static.publicknowledge.org/pdf/pk-net-neutrality-whitep-20060206.pdf (noting that "a properly tailored Net Neutrality rule" would allow differentiated tiers, provided that those tiers "not offer *exclusive access* to the higher bandwidth levels to providers selected by the network operator.").

8. D. Isenberg and D. Weinberger, *The Paradox of the Best Network*, available at: www.netparadox.com ("Just as the Internet separates transport from service, the incumbent telephone companies should be separated into transport companies and service companies."); D. Isenberg, *The Rise of the Stupid Network*, COMPUTER TELEPHONY, Aug. 1997, at 16-26.

9. Isenberg and Weinberger, *id.*, appear fully aware that their "commodity network" is unlikely to be financially viable without government intervention.

10. Christopher S. Yoo, *Promoting Broadband Through Network Diversity*, Feb. 6, 2006, at 3, *available at*: http://www.ncta.com/DocumentBinary.aspx?id=286.

> economic theory shows how allowing network owners to differentiate the service they offer can allow smaller producers to survive despite having lower sales volumes and higher per-unit costs by differentiating their offerings to appeal to a subsegment of the larger market.[11]

Equally as important, even avowed Network Neutrality proponents agree that a "commoditization" approach may have significant consequences. For example, Professor Tim Wu argues that

> the concept of network neutrality is not as simple as some IP [Internet Protocol] partisans have suggested. . . . Network design is an exercise in tradeoffs. . . IP's neutrality is actually a tradeoff between upward (application) and downward (connection) neutrality. If it is upward, or application neutrality that consumers care about, principles of downward neutrality may be a necessary sacrifice.[12]

Similarly, Isenberg and Weinberger, two of the staunchest advocates of Network Neutrality, notes that "the best [i.e., stupid] network is the hardest to make money running." As a solution, Isenberg and Weinberger reject a market solution and instead foresee a rate-of-return regulated and sometimes subsidized network as the "best" future for domestic broadband service.[13]

Our analysis highlights the need to balance Network Neutrality principles against the effect that the imposition and enforcement of those principles might have on the prospects for increasing concentration in the broadband Internet access market. The Federal Communications Commission's 2005 Policy Statement on the regulatory framework for broadband Internet access stands as one example where policymakers attempt to walk this tightrope.[14] Each of the FCC's four broadband Internet access principles contains the

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11. *Id.* at 4.

12. Wu, *supra* note 6, 2 J. ON TELECOMM. & HIGH TECH. L. at 147-148.

13. Isenberg & Weinberger, *supra* note 8 ("the best network is the hardest to make money running. So who builds it? Who runs it? Who fixes it when it breaks? And who develops the next generations of faster, simpler infrastructure?"; "The transport companies would be have [sic] government incentives (e.g., assured return on investment), to make fiber, pole attachment, and right of way available to all service providers.").

14. *Appropriate Framework for Broadband Access to the Internet over Wireline Facilities,* Policy Statement, FCC 05-151 (rel. Sept. 23, 2005) ("FCC Policy Statement"). The FCC Policy Statement states that, "*to encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet:*" (1) consumers are entitled to access the lawful Internet content of their choice; (2) consumers are entitled to run applications and services of their choice, subject to the needs of law enforcement; (3) consumers are entitled to connect their choice of legal devices that do not harm the network; and (4) consumers are entitled to competition among network providers, application and service providers, and content providers (emphasis in original). Although the Commission did not adopt rules in this regard, it has said that it will incorporate these principles into its ongoing policymaking activities.

same deliberately italicized preamble—that principle is *"to encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet."*[15] Moreover, the FCC Policy Statement includes as a principle the idea that "consumers are entitled to competition among network providers."[16] The stated basis for this principle is the Preamble of the Telecommunications Act of 1996, which describes the Act's intent "to promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies."

With these phrases, the FCC Policy Statement appears to recognize the need to balance these rival considerations. In that balancing act, the FCC perhaps recognized that Network Neutrality rules that promote commoditization may lead to high industry concentration or monopoly and thus are incompatible with the legislative mandate to "promote competition," "secure lower prices and higher quality services," or "encourage the rapid deployment of new telecommunications technologies." The development of Network Neutrality principles by policymakers must necessarily be nuanced and flexible because of these competing concerns, particularly given the economic characteristics of local broadband networks.

III. Economic Model: Commoditization, Industry Structure, and Network Neutrality

In our formal economic treatment of the issue, we simplify the various Network Neutrality proposals by focusing on one important consequence (intentional or otherwise) of some of these proposals. Our particular concern is with regard to Network Neutrality rules that would effectively "commoditize" broadband access to the Internet by limiting the ability of a network firm to offer products that are somehow differentiated from other networks (or, at least, perceived to be). This restriction on network differentiation can manifest itself in several ways. For example, rules may require broadband providers to offer access services separate and apart from affiliated content (i.e., privacy, security, packet prioritization, VoIP services) or limit the manner in which they can charge for various ancillary services.

15. Preamble, Telecommunications Act of 1996, P.L. 104-104, 100 Stat. 56 (1996).
16. FCC Policy Statement, *supra* note 14, at n. 14.

In markets with fixed and/or sunk costs, differentiation can be an important driver of market structure.[17] In commoditized markets, firms have nothing to compete over but price. Differentiation, alternately, allows firms to improve consumer welfare not only by price cuts but by creating better price-quality offerings and innovative new products and services. Certainly, price competition is desirable, but when price is the only choice in a market with large fixed/sunk costs and low marginal costs (like local broadband networks), the result of permitting price-only competition is a tendency toward monopoly (the situation where entry does not occur at all, which deprives consumers of that price competition). By giving firms alternate avenues of rivalry, differentiation allows for entry and gives consumers the benefits of not only price competition but of increased choice and innovation.[18]

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17. *See, e.g.,* A. Shaked & J. Sutton, *Product Differentiation and Industrial Structure*, 36 JOURNAL OF INDUSTRIAL ECONOMICS, 131-146 (1987); J. SUTTON, SUNK COST AND MARKET STRUCTURE (1995); Ford, Koutsky, & Spiwak, *supra* note 4, at 23. The economic model developed in this paper is consistent with this earlier research, though we assume that market size is held constant, endogenous sunk costs are zero, and all product differentiation is horizontal in nature. While the effects of these features of the Sutton-type models are, no doubt, interesting, our model format was selected so that the welfare effects of various policies could be assessed.

18. Significantly, economic theory suggests that product differentiation often impedes oligopolistic coordination. As observed by Kaserman and Mayo:

> [W]here firms in the market produce a product whose differences are either nonexistent or so minor that the only dimension of competition between firms is price[,] it is relatively easy for firms to agree to establish an anticompetitive price. Where firms compete in many dimensions (for example, price, quality, and new service or product innovations), however, it becomes more difficult to successfully collude because firms will need to establish limits on competition in each of the relevant dimensions.

D. KASERMAN and J. MAYO, GOVERNMENT AND BUSINESS: THE ECONOMICS OF ANTITRUST AND REGULATION (1995) at 159; s*ee also,* F.M. SCHERER & DAVID ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 279 (1990) ("When products are heterogeneously differentiated, the terms of rivalry become multidimensional, and the coordination problem grows in complexity by leaps and bounds."); P. AREEDA & H. HOVENKAMP, ANTITRUST LAW: AN ANALYSIS OF ANTITRUST PRINCIPLES AND THEIR APPLICATION ¶ 404c3 (2002) (product complexity, differentiation, or variety "multiply avenues of rivalry and hence the decisions that must be coordinated. Even if firms reach a coordinated price, they may continue to compete by improving product quality."); *see also, In re Implementation of Sections 3(n) and 332 of the Communications Act, Regulatory Treatment of Mobile Services,* Second Report & Order, FCC Docket No. 94-31 (rel. March 7, 1994) at ¶ 149 ("[c]omplex pricing structures, such as are used in the cellular industry, make it difficult for a carrier to sustain collusive pricing."); *but cf.,* S. MARTIN, ADVANCED INDUSTRIAL ECONOMICS 116-7 (1993) ("[p]roduct differentiation reduces the incremental profit to be gained by departing form a joint-profit-maximizing configuration because product differentiation insulates rivals' markets and reduces the extent to which a single firm can lure rivals' customers into its own market.").

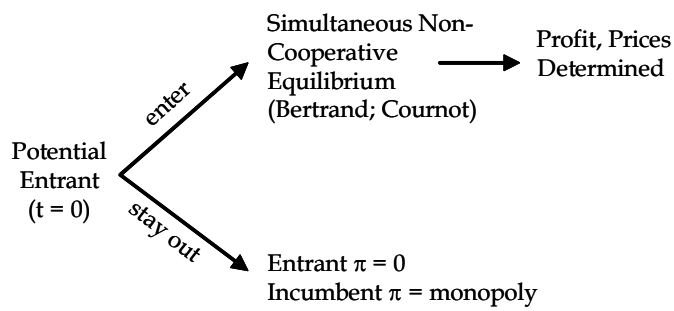
A. Model

We model Network Neutrality as requiring homogeneous goods. We consider entry by a new firm into a market initially controlled by a monopoly. We specify a demand model that allows continuity between homogeneous and differentiated goods, and that *does not allow differentiation to alter the marginal benefit of units sold*. The latter restriction is important since it ensures that our theoretical analysis is conservative. In our model, the only effect of differentiation is to make goods less-close substitutes so that firms pursue more independent pricing policies and the reaction functions become steeper. Clearly, our choice to ignore the benefits of differentiation in the theoretical model understates the undesirable consequences of Network Neutrality rules that lead to commoditization. Differentiation undoubtedly increases the marginal value of units sold, since there are many benefits that arise from differentiation. In particular, differentiation can increase consumer welfare by giving consumers more desirable price-quality combinations. Further, a key motivator of innovation is an attempt by firms to provide a better product that differentiates themselves from rivals. Thus, our analysis—by focusing on entry alone—grossly understates the negative effects of commoditization of broadband Internet access services that results from Network Neutrality mandates.

In our economic model, price competition can be either Cournot competition in quantities or Bertrand competition in prices.[19] There are sunk costs to entry and, for simplicity, constant marginal cost of service which is the same for both firms. We basically analyze a simple extensive form game with the timeline illustrated in Figure 1.

19. With Cournot competition, rival firms choose the quantity they wish to offer for sale. Each firm maximizes profit on the assumption that the quantity produced by its rivals is not affected by its own output decisions. The Cournot equilibrium asserts that prices and quantities approach competitive levels as the number of firms supplying the market increase. With Bertrand competition, rivals choose price rather than quantity. The Bertrand equilibrium (with homogeneous goods) has price equal to marginal cost with only two firms. Thus, if there are any fixed or sunk entry costs, entry will not occur. For more detail, *see* S. Martin, *id.*, at ch. 2.

Figure 1. Timeline



We use the following inverse demand system,

$$p_i = \alpha - \beta\left(\frac{q_i}{1+\theta} + \frac{\theta q_j}{1+\theta}\right) \qquad i \neq j \tag{1}$$

where p_i is the price of good i (sold by firm i); α and β are positive demand parameters; q_i is the output of firm/good i; and θ is a product differentiation parameter where $0 \leq \theta \leq 1$. Note that p_i is continuous on θ, and if $\theta = 0$ we have the pure monopoly case; $\theta = 1$ we have identical goods; and for intermediate cases we have $0 < \theta < 1$.
The direct demand relationships are

$$q_i = \frac{1}{\beta}\left[\alpha - \left(\frac{1}{1-\theta}\right)p_i + \left(\frac{\theta}{1-\theta}\right)p_j\right] \tag{2}$$

which are undefined at $\theta = 1$, unsurprisingly.[20] Notice that if $p_i = p_j$, then

$$q_i = \frac{1}{\beta}(\alpha - p_i). \tag{3}$$

20. With homogeneous goods, the demand elasticities are infinite at the rival's price.

This demand system has many desirable properties. First, the market remains the same size despite entry. In essence, we can view the monopoly as merely having two markets of equal size prior to entry, where an entrant takes one of the markets after entry. This property is key since in this model differentiation *per se* has no benefit to consumers.[21] As we discuss above, this is an unrealistic but conservative assumption of the analysis, in part because differentiation might serve to expand the market by providing consumers more desirable price-quantity options. Thus, in this system, any effect from differentiation solely influences prices and competition, not consumer willingness to pay. By design, this specification renders highly conservative theoretical predictions, since we normally expect competition among differentiated goods to increase the size of the market.[22] However, this design allows us to speak separately about the role of consumer valuation of variety and its pure competitive effect. We relax this assumption later in the text.

Other desirable properties of the demand relationships are technical in nature. For example, this specification provides for closed form expressions for profits, surplus, and prices.[23] Additionally, the model has unique, symmetric equilibria whenever entry occurs, and these equilibria seem sensible. For example, prices under differentiation converge to simple Cournot price as $\theta = 1$ (homogeneous goods competition), and converge to monopoly price as $\theta = 0$ (homogeneous good with no substitutes).

In order to evaluate the effects of Network Neutrality rules that promote homogeneity, we need to solve the model for prices, quantities, and welfare in five specific cases:

Monopoly, $\theta = 1$ (one variety)
Monopoly, $\theta < 1$ (two varieties)
Oligopoly, $\theta = 1$ (simple Cournot competition)
Oligopoly, $\theta < 1$ (differentiated Cournot competition)
Oligopoly/Competitive, $\theta = 1$ (simple Bertrand competition)

21. Regardless of θ, the consumer buys both goods in equal quantities whenever their prices are equal, regardless of what the common price may be. Thus, this model is a representative consumer model.

22. The analysis is theoretically conservative in that if differentiation increased value, then we could simply pick an increase in value that makes Network Neutrality rules undesirable.

23. That is, all these values can be expressed analytically in terms of a bounded number of well-known operations. Expressions that are not closed-form can only be evaluated numerically.

Note that we evaluate both Cournot competition in quantities and Bertrand competition in prices. If we evaluated Bertrand competition alone, then the case against Network Neutrality would be significantly stronger. So, again, our analysis is theoretically conservative.

Finally, we assume that c is the common marginal unit cost to both firms; E is the sunk entry cost of a potential entrant; and F is the fixed costs (also sunk) of incumbents, which we normalize to zero for strategic analysis.

1. Case 1: Monopoly, $\theta = 1$

In the case of monopoly, the objective profit function for the firm is

$$\pi = 2(p - c)\frac{1}{\beta}(\alpha - p). \tag{4}$$

The equilibrium values (denoted with an *) of price and quantity are

$$p_m^* = \frac{\alpha + c}{2}; \tag{5}$$

$$q_m^* = \frac{\alpha - c}{2\beta}. \tag{6}$$

Producer surplus (profit, π), consumer surplus (CS) and social welfare (W) are

$$\pi_m^* = \frac{(\alpha - c)^2}{2\beta}; \tag{7}$$

$$CS = \frac{(\alpha - c)^2}{4\beta}; \tag{8}$$

$$W = \pi + CS = \frac{3}{8}\frac{(\alpha - c)^2}{\beta}. \tag{9}$$

These values are important in that they serve as a comparison point for alternative market structures.

2. Case 2: Monopoly, $\theta < 1$

As mentioned above, the demand system is designed so that we essentially have a monopolist that sells in two markets. Since we wish to compare duopoly to monopoly with either identical or differentiated goods/services, we must first evaluate whether there is any welfare improvement resulting from the monopolist differentiating its products.

In this case, the monopolist sells two goods (1, 2) with $0 < \theta < 1$. We can show that differentiation ($\theta < 1$) has no direct welfare effect. The objective function is

$$\begin{aligned} \max_{p_1, p_2} \quad & (p_1 - c)\frac{1}{\beta(1-\theta)}(\alpha - p_1 - \theta\alpha + \theta p_2) \\ & + (p_2 - c)\frac{1}{\beta(1-\theta)}(\alpha - p_2 - \theta\alpha + \theta p_1). \end{aligned} \tag{10}$$

The equilibrium values for price and quantity are

$$p_1^* = p_2^* = \frac{\alpha + c}{2}; \tag{11}$$

$$Q^* = \frac{(\alpha - c)^2}{2\beta}. \tag{12}$$

Since the equilibrium values in Equations (11) and (12) are identical to those in Equations (5) and (6), there is no welfare effect of changes in θ in the monopoly case. Thus, in this model, we can treat monopoly generically in our welfare comparisons.

3. Case 3: Duopoly, $\theta = 1$

Our purpose is to evaluate the welfare consequences of Network Neutrality rules that encourage commoditization of broadband service. As one point of interest, consider the case of simple Cournot competition in quantities with homogeneous products. Price is

$$P = \alpha - \frac{\beta}{2}(q_1 + q_2) \tag{13}$$

and profits for firm *i*, Good 1, are

$$\pi_i = \left(\alpha - \frac{\beta}{2}(q_1 + q_2) - c\right)q_1 \tag{14}$$

and similarly for firm *j* and Good 2. Equilibrium values for price and quantity are

$$P^* = \frac{\alpha + 2c}{3}; \tag{15}$$

$$q_i^* = \frac{2}{3}\left[\frac{\alpha - c}{\beta}\right]. \tag{16}$$

Producer surplus (profit, π), consumer surplus (CS) and social welfare (W) are

$$\pi_m^* = \frac{2}{9}\frac{(\alpha - c)^2}{\beta}; \tag{17}$$

$$CS = \frac{4}{9}\frac{(\alpha - c)^2}{\beta}; \tag{18}$$

$$W = \pi + CS = \frac{8}{9}\frac{(\alpha - c)^2}{\beta}. \tag{19}$$

Importantly, Equations (17) and thus (19) would need to be adjusted for the presence of fixed or sunk costs, meaning that the total (or social) welfare effect of entry must consider the duplication of fixed costs. Assuming that the incumbent's fixed costs are entirely sunk, Equation (19) is

$$W = \pi + CS = \frac{8}{9}\frac{(\alpha - c)^2}{\beta} - E. \tag{20}$$

Comparing (20) to (9), we see that if $E = 0$, then total welfare is higher with competition than without (*i.e.*, $^8/_9 > {}^3/_8$). If $E > 0$, then the size relationship between Equations (20) and (9) depends on the size of E. While total welfare may rise or fall, the effects on consumers of entry are unambiguous. Comparing Equations (18) and (8), we see clearly that entry improves consumer surplus.

4. Case 4: Duopoly, $\theta < 1$

At the core of this analysis is the question of the role of differentiation on entry. We consider that case now. In this instance, we have Cournot competition in quantities with differentiated goods (i.e., $\theta < 1$). Using the concept of Nash Equilibrium, we solve

$$\max_{q_1} \quad \pi_1 = \left(\alpha - \beta\left(\frac{q_1}{1+\theta} + \frac{q_2}{1+\theta}\right) - c\right)q_1; \tag{21}$$

$$\max_{q_2} \quad \pi_2 = \left(\alpha - \beta\left(\frac{q_2}{1+\theta} + \frac{q_1}{1+\theta}\right) - c\right)q_2. \tag{22}$$

The only Nash point is the symmetric point

$$q_1^* = q_2^* = \frac{(\alpha - c)}{2\beta}\frac{(1+\theta)}{(2+\theta)} \tag{23}$$

with prices of

$$p_1^* = p_2^* = \frac{\alpha + c(1+\theta)}{2+\theta}. \tag{24}$$

Notice that q^* and p^* are continuous and well-behaved in θ, with

$$\frac{\partial p_i^*}{\partial \theta} = \frac{\partial p_j^*}{\partial \theta} < 0,$$
$$\frac{\partial q_i^*}{\partial \theta} = \frac{\partial q_j^*}{\partial \theta} > 0.$$

Also, $\pi_i^* = (p_i^* - c)q_i^*$ is monotonically decreasing in θ. Equilibrium values of interest include

$$\pi_i^* = \frac{(\alpha - c)^2}{\beta}\frac{(1+\theta)}{(2+\theta)^2}; \tag{25}$$

$$\sum \pi_i^* = \frac{2(\alpha - c)^2}{\beta}\frac{(1+\theta)}{(2+\theta)^2}; \tag{26}$$

$$CS_i^* = \frac{(\alpha - c)^2}{2\beta}\frac{(1+\theta)^2}{(2+\theta)^2}; \tag{27}$$

$$\sum CS_i^* = \frac{(\alpha - c)^2}{\beta}\frac{(1+\theta)^2}{(2+\theta)^2}; \tag{28}$$

where the last is determined by the equal-price line integral. These values are used to compute the relevant conditions for welfare improving entry and differentiation in Section IV.A below.

5. Case 5: Bertrand Duopoly, $\theta = 1$

In the case of Bertrand price competition with homogenous goods, the equilibrium values are $p^* = c$ and $\pi^* = 0$ (except for fixed/sunk costs). In other words, Bertrand price competition renders price equal to marginal cost and profits equal to zero with duopoly. This solution is the familiar textbook result. Here, if there are any fixed and/or sunk costs of entry, then entry does not occur and the monopolist is unchallenged, so that the prevailing market price and quantity are given by Equations (5) and (6) and welfare components by Equation (7), (8), and (9)—the monopoly outcome.

IV. Evaluation of the Results

By comparing the market structure scenarios detailed in the previous section, we can evaluate Network Neutrality proposals based on how those rules affect potential entry, consumer welfare, and profits. Recall that our interpretation and discussion of "Network Neutrality rules" is limited to proposals that would effectively mandate homogeneity across providers of broadband service.

A. Network Neutrality and Efficiency

Using the equilibrium values from the five alternate competitive outcomes outlined in the previous section, we can summarize succinctly our findings as follows. Recall that E is the sunk entry cost of a potential entrant, and π is profit. Based on the analysis above, Network Neutrality rules that promote commoditization are socially inefficient under the following three conditions:

1. $\pi(\text{duopoly}, \theta = 1) < E$;
2. $\pi(\text{duopoly}, \theta < 1) > E$;
3. $W(\text{duopoly}, \theta < 1) - E > W(\text{monopoly})$.

These conditions are summarized as follows. Condition (1) states that a duopoly profit with homogeneous products ($\theta = 1$) is insufficient to cover sunk entry costs; as a result, in this case, entry would not occur. Condition (2) states that duopoly profit with differentiated products ($\theta < 1$) is larger than entry costs; as a result, in this case, entry would occur. Condition (3) states that the total welfare with differentiated duopoly is larger than total welfare with monopoly.[24] These three conditions imply that *Network Neutrality rules are socially inefficient if they reduce the number of firms serving the market, and the excluded firms would have been efficient entrants from a social perspective*.

We can show, based on the above logic, that Network Neutrality is inefficient from the social point of view whenever the prospects for post-entry competition are suitably severe enough so that firms do not enter the market.

24. As stated clearly by Motta:

> Since market power decreases with the number of firms in the industry, one might be tempted to conclude that the larger the number of firms the higher the welfare. This is not the case, however, when firms have to incur (recurrent or set-up) fixed costs. Indeed, the presence of fixed costs – which gives rise to scale economies – implies the existence of a trade-off. On the one hand, a higher number of firms entails more competition in the market and lower prices, which undoubtedly increases consumer surplus (and allocative efficiency). On the other hand, it also entails a duplication of fixed costs, which represents a loss in terms of (static) productive efficiency. The net effect on welfare is *a priori* ambiguous.

M. MOTTA, COMPETITION POLICY: THEORY AND PRACTICE 51 (2004). *See also* N. Mankiw & M.D. Whinston, *Free Entry and Social Inefficiency*, 17 RAND JOURNAL OF ECONOMICS 48, 48-58 (1986). With only a small amount of sunk costs, however, the possibility of welfare-reducing entry declines. *See* J. H. Nachbar, B. C. Petersen and I. Hwang, *Sunk Costs, Accommodation, and the Welfare Effects of Entry*, 46 JOURNAL OF INDUSTRIAL ECONOMICS 317-332 (1998).

Proposition. Suppose Bertrand competition occurs with entry and $\theta = 1$, but differentiated competition occurs if $\theta < 1$. If E is positive but not too large, then Network Neutrality is socially inefficient.

Proof. Under Bertrand competition, duopoly profit on entry with $\theta = 1$ is zero, so any positive sunk entry costs prevents entry. Without Network Neutrality requiring $\theta = 1$, a firm may enter with $\theta < 1$, whenever

$$\pi_i^* = \frac{(\alpha - c)^2}{\beta} \frac{(1+\theta)}{(2+\theta)^2} > E > 0. \tag{29}$$

If so, then welfare from differentiated duopoly exceeds monopoly welfare. Recalling that monopoly welfare is invariant to the degree of differentiation in this model, Network Neutrality is socially inefficient.

A review of the conditions required for Network Neutrality, interpreted as a requirement for commodity competition between firms, to be socially inefficient easily explains the proposition, and the conditions under which it can be weakened. Lacking brand identity, entry involves prices driven to incremental costs, with no hope of sunk cost recovery. This outcome is clearly socially undesirable whenever entry is then precluded, since price remains at the monopoly level. Thus, the analysis turns on the degree to which relaxation of net neutrality rules allow potential entrants to differentiate their offerings sufficiently from rivals to recover sunk entry costs. Importantly, this conclusion does not require the assumption that differentiation *per se* has any social benefit.

B. Network Neutrality and Consumers

The Conditions also provide us the situations in which consumers would be harmed by this particular Network Neutrality regime. Note that if there are no sunk cost of entry (that is, $E = 0$), then Condition (3) is always true as long as rivals offer somewhat substitutable goods or services (that is, $\theta > 0$), no matter how small that substitutability may be. In essence, this means that the gains to consumers from competition will always be larger than the reduction in profits to firms (as long as there are no fixed/sunk entry costs, or ignoring such costs). Importantly, we find that entry always improves consumer surplus, so the social desirability of entry relates only to the effect of entry on firm profits and the duplication of fixed costs. Our model shows that

consumers are always better off with more entry—so if Network Neutrality rules reduce entry, then consumers are unambiguously worse off.

C. Differentiation that Increases the Marginal Value of Goods

Thus far we have assumed that there is no benefit from differentiation *per se*. However, differentiation has value for both consumers and firms. To illustrate what affect on our conclusions a positive value from differentiation has, suppose this value is captured fully by consumers, and denote it S. This benefit from differentiation alters Condition (3), which would now read

3'. $W(\text{duopoly}, \theta < 1) - E + S > W(\text{monopoly})$.

Since S is positive, Condition (3') is easier to satisfy than Condition (3). So, if differentiation is valuable, then Network Neutrality rules that discourage entry are more likely to be inefficient.

If, alternately, both firms and consumers capture some of this benefit (S_F and S_C, respectively), we must modify (2) and (3) to read

2'. $\pi(\text{duopoly}, \theta < 1) + S_F > E$;

3''. $W(\text{duopoly}, \theta < 1) - E + S_F + S_C > E$.

Again, if differentiation increases the value of service so that S_F and S_C are positive, then Network Neutrality is more likely to be socially inefficient since Conditions (2') and (3'') are more easily satisfied than Conditions (2) and (3).

D. Summary

In summary, our economic model suggests that if one codifies an approach to Network Neutrality that causes the commoditization of broadband Internet access service, then those rules are inefficient if they reduce the number of firms that can offer that service. In a market which Network Neutrality advocates frequently describe as a "duopoly," an increase in concentration (*i.e.*, monopoly) is likely to have substantial negative effects on market outcomes. Network Neutrality rules that limit entry appear in this way to be a bad deal for consumers but remain an open question from a social welfare perspective, due to the potential cost of network duplication that entry presents. As long as the benefits to consumers from entry and competition exceed these network duplication costs, Network Neutrality rules that promote commoditization would be inefficient.

V. Conclusion

The Network Neutrality debate presents a difficult challenge for policymakers. In particular, policymakers need to be aware that Network Neutrality rules themselves can have the effect of making competition and entry in an already concentrated market *even less likely* in the future. Given the cost characteristics of communications networks (high fixed and/or sunk costs and low marginal cost), forced commoditization of broadband access can plausibly render monopoly outcomes. Our analysis suggests that Network Neutrality rules that promote commoditization of broadband access services will be inefficient and harmful if such rules deter efficient entry.[25] As shown above, if entry is deterred, then Network Neutrality rules of the type evaluated here are unambiguously bad for consumers. Accordingly, while proponents of Network Neutrality have called competition the "best long-term solution" to the problem they seek to resolve, our model shows that the cure promised by commoditizing Internet access could codify and might in fact exacerbate the highly concentrated industry structure that it is attempting to address.[26]

Our analysis in this paper is, admittedly, focused. We do not attempt to address all of the relevant issues in the Network Neutrality debate. What our analysis does show is that efforts to "commoditize" broadband networks, intentional or otherwise, in the name of "Network Neutrality" may in fact increase industry concentration, plausibly rendering monopoly. If entry is discouraged, then our analysis shows (under the conditions assumed) that consumers are unambiguously worse off.

Our analysis also reveals that even under conditions where firms have no incentive to discriminate (or simply choose not to act on such incentives) and sabotage third-party application providers, the imposition of Network Neutrality legislation or regulation is not costless. If Network Neutrality rules encourage commoditization, then such rules may alter industry structure, thereby reducing consumer and potentially even social welfare. Thus, Network Neutrality legislation or regulation should not be viewed by

25. By "efficient entry" we mean entry that increases social welfare by raising consumer surplus by more than the reduction in firm profits and the fixed costs of duplication.

26. One important Network Neutrality proponent, Vinton Cerf, has flatly stated that "[t]he best long-term answer to this problem is significantly more broadband competition." Cerf Testimony, *supra* note 5, at 7.

policymakers as costless simply by virtue of the absence of anticompetitive discriminatory actions by network firms.

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