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Lawrence J. Spiwak, President

28 February 2007

Federal Trade Commission
Office of the Secretary
Room H-135 (Annex B)
600 Pennsylvania Avenue, NW
Washington, DC 20580

RE: Broadband Connectivity Competition Policy Workshop – Comment, Project No. V070000

To Whom It May Concern:

On behalf of the Phoenix Center, I would like to thank you for inviting our Chief Economist, Dr. George Ford, to participate in the FTC's public workshop entitled "Broadband Connectivity Competition Policy" held this past February 13-14, 2007. To this end, I am attaching for your reference four of our recent papers on the unintended consequences of certain types of network neutrality rules. They are:

- PHOENIX CENTER POLICY PAPER NO. 24, *Network Neutrality and Industry Structure* (April 2006) *and being republished in* 29 HASTINGS COMMUNICATIONS AND ENTERTAINMENT LAW JOURNAL (Winter 2007) (demonstrating risk that network neutrality rules that promote "commoditization" of broadband Internet access services could deter entry and result in an even more concentrated market);

- PHOENIX CENTER POLICY BULLETIN NO. 16, *The Efficiency Risk of Network Neutrality Rules* (May 2006) (reviewing studies which show that a "stupid network" mandated by network neutrality proposals could cost consumers $300-$400 per month more than a managed, "intelligent" broadband network);

- PHOENIX CENTER POLICY PAPER NO. 25, *The Burden of Network Neutrality Mandates on Rural Broadband Deployment* (July 2006) (showing that imposing a network neutrality regulatory mandate could dampen deployment of broadband networks in rural areas six times more than it would dampen deployment in urban areas); and

- PHOENIX CENTER POLICY PAPER NO. 28, *Network Neutrality and Foreclosing Market Exchange: A Transaction Cost Analysis* (forthcoming March 2007) (demonstrating that, under plausible conditions, rules that prohibit efficient commercial transactions between content and broadband service providers could, in fact, be bad for *all* participants: consumers would pay higher prices, the profits of the broadband service provider would decline, and the sales of Internet content providers would also decline).

In addition, just to make sure the record is complete, we are attaching two critiques of POLICY PAPER NO. 24 authored by Dr. Taylor Roycroft, as well as our two responses to Dr. Roycroft.

We hope you will find these papers useful in your analysis of this important policy debate. As with all of our work (and critiques thereof), these papers are available free on the Phoenix Center's web page: www.phoenix-center.org. In the mean time, please do not hesitate to contact us if you have any additional questions or comments about our current and forthcoming research.

Sincerely,

Lawrence J. Spiwak
President

PHOENIX CENTER POLICY PAPER SERIES

Phoenix Center Policy Paper Number 24:

Network Neutrality and Industry Structure

George S. Ford, PhD
Thomas M. Koutsky, Esq.
Lawrence J. Spiwak, Esq.

(April 2006)

Phoenix Center Policy Paper No. 24
Network Neutrality and Industry Structure

George S. Ford, PhD†
Thomas M. Koutsky, Esq.*
Lawrence J. Spiwak, Esq.‡

Abstract: 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. While we argue neither for nor against the need for Network Neutrality legislation in this POLICY PAPER, our analysis shows that policymakers should avoid Network Neutrality mandates that have the intent or effect of "commoditizing" broadband access services since such a policy approach is likely to deter facilities-based competition, reduce the expansion and deployment of advanced communications networks, and increase prices. 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.

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‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies. The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center, its Adjunct Fellows, or any of its individual Editorial Advisory Board members. We are indebted to Randy Beard, Adjunct Fellow, for his assistance in formulating the economic model presented in this paper.

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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 POLICY PAPER, our analysis shows that policymakers should avoid mandates that may "commoditize" broadband access services since 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 concentrated industry structures, including monopoly.[2] Our economic model indicates that by deterring entry, Network Neutrality rules encouraging 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.

As we discussed in POLICY PAPER NO. 21, economic forces inherent to communications networks tend to promote concentrated equilibrium industry structures (i.e., few firms).[4] Consequently, policymakers should always consider

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

[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*, THE MOTLEY FOOL (Sept. 7, 2004) (available at: 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 loss profit to firms and the fixed costs of the entrant.

[4] George S. Ford, Thomas M. Koutsky and 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 and analysis and citations therein).

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 POLICY PAPER, Network Neutrality rules that encourage commoditization of broadband service *exacerbate* this tendency toward concentration in an industry that 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 words, Network Neutrality rules that promote even higher levels of concentration may be a cure that worsens the disease. In considering various Network Neutrality proposals, therefore, 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 POLICY PAPER is focused. We do not attempt in this POLICY PAPER to address the incentive to discriminate of a broadband Internet access service provider 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.

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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) (available at: http://commerce.senate.gov/pdf/cerf-020706.pdf) ("Cerf Testimony") at 7 ("[t]he best long-term answer to this problem is significantly more broadband competition.").

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 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 POLICY 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]

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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, CS Docket 02-52 (Aug. 22, 2003).

7 John Windhausen, Jr., *Good Fences Make Bad Broadband,* Public Knowledge White Paper (Feb. 6, 2006) (available at: http://static.publicknowledge.org/pdf/pk-net-neutrality-whitep-20060206.pdf) at 40-42 (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 provider.").

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.

While this POLICY 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, 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 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, one 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 rejects a market solution and instead foresees a rate-of-return

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[10] Christopher S. Yoo, *Promoting Broadband Through Network Diversity* (Feb. 6, 2006) (available at: http://law.vanderbilt.edu/faculty/Yoo%20-%20Network%20Diversity%202-6-06.pdf) at 3.

[11] *Id.* at 4.

[12] Wu, *supra* note 6, 2 J. ON TELECOMM. & HIGH TECH. L. at 149.

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 appropriate framework for broadband Internet access stands as one example where policymakers attempt to navigate this tightrope.[14] Each of the FCC's four broadband Internet access principles contains the same deliberately italicized preamble—that principle is *"to encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet."* Moreover, the FCC Policy Statement includes as a principle the idea that "consumers are entitled to competition among network providers."[15] 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

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13 Isenberg and 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 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.

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

monopoly and thus 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.

In markets with fixed and/or sunk costs, differentiation can be an important driver of market structure.[16] 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

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16 *See, e.g.*, A. Shaked and J. Sutton, *Product Differentiation and Industrial Structure*, 36 JOURNAL OF INDUSTRIAL ECONOMICS 131-146 (1987); J. Sutton, SUNK COST AND MARKET STRUCTURE (1995); G. S. Ford, T. M. Koutsky and L. J. Spiwak, Competition After Unbundling: Entry, Industry Structure and Convergence, PHOENIX CENTER POLICY PAPER NO. 21 (July 2005) (available at: http://www.phoenix-center.org/pcpp/PCPP21Final.pdf.)

allows for entry and gives consumers the benefits of not only price competition but of increased choice and innovation.[17]

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 becomes 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

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

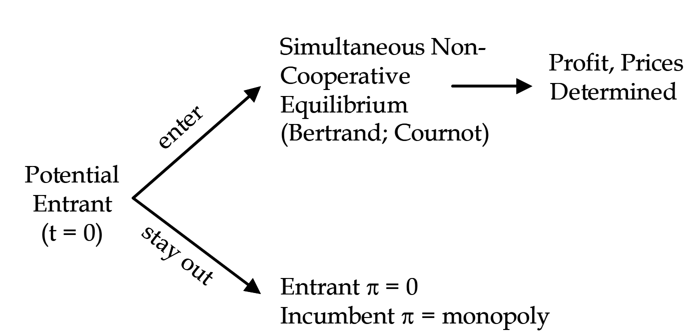
> [W]here firms in the market produce a product whose differences are either nonexistent or so minor that the only dimension of competition between firms is price[,] it is relatively easy for firms to agree to establish an anticompetitive price. Where firms compete in many dimensions (for example, price, 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 (1990) at 279 ("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 (1995) at ¶ 404a (product complexity, differentiation, or variety "multiplies avenues of rivalry and hence the decisions that must be coordinated, because 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 (1993) at 116-7 ("[p]roduct differentiation reduces the incremental profit to be gains 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.").

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 resulting from Network Neutrality mandates.

In our economic model, price competition can be either Cournot competition in quantities or Bertrand competition in prices.[18] 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.

Figure 1. Timeline



We use the following demand system,

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

[18] 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.

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 production differentiation parameter where $0 \le \theta \le 1$. 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 inverse 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.[19] Notice that if $p_i = p_j$, then

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

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.[20] 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.[21] 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.

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[19] With homogeneous goods, the demand elasticities are infinite at the rival's price.

[20] 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.

[21] 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.

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.[22] 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 $\theta \rightarrow 1$ (homogeneous goods competition), and converge to monopoly price as $\theta \rightarrow 0$ (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)

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

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22 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.

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

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

$$p_m^* = \frac{\alpha + c}{2}; \quad (5)$$

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

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

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

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

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

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

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

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.[23] 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 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 is suitably severe enough so that firms do not enter the market.

> *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.

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23 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 (2004) at 51. *See also* N. Mankiw and M.D. Whinston, *Free Entry and Social Inefficiency*, 17 RAND JOURNAL OF ECONOMICS 48-58 (1986). With even 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).

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′. π(duopoly, $\theta < 1$) + $S_F > E$;

3′′. W(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/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.[24] As shown above, if entry is deterred, then Network Neutrality rules of the type evaluated here are unambiguously bad for consumers. Moreover, adopting strict Network Neutrality rules that

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[24] 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.

mandate a bandwidth-as-commodity pricing regime on the industry could codify and potentially even exacerbate the very highly-concentrated industry structure with which Network Neutrality supporters are concerned.[25]

Our analysis in this POLICY PAPER is, admittedly, focused, as 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. Accordingly, while proponents of Network Neutrality have called competition the "best long-term solution" to the problem they seek to resolve,[26] our model shows that the cure promised by commoditizing Internet access might in fact exacerbate the very problem that it is attempting to address.

Our analysis also reveals that even under conditions where firms have no incentive to discriminate (or simply choose not to act on such incentives) to 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, social welfare. Thus, Network Neutrality legislation or regulation should not be viewed by policymakers as costless simply by virtue of the absence of anticompetitive discriminatory actions by network firms.

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[25] 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.

[26] *Id*.

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THE EFFICIENCY RISK OF NETWORK NEUTRALITY RULES

Abstract: In this POLICY BULLETIN, we evaluate Network Neutrality proposals from the standpoint of consumer welfare and economic efficiency by presenting a cost/benefit analysis framework for examining the effect on consumers of Network Neutrality proposals that would limit operators from injecting intelligence into broadband Internet access networks. For a Network Neutrality proposal to be justified, the purported benefits of that proposal must exceed the costs, including the inefficiency in network design as well as the risk of increased industry concentration and market power. Publicly available cost studies show that if IP video services increase in popularity, the cost of providing a residential subscriber a "stupid" network that is video-capable could reach $300 to $400 per month more than an "intelligent" network, which would certainly put broadband out of the reach of many Americans. We also present a simple model which shows that voluntary investments in network efficiency always improve consumer and social welfare—even if, as some Network Neutrality proponents contend, stupid networks are otherwise preferred by consumers.

I. Background

Some proponents of Network Neutrality argue that only a "stupid," or commodity-priced, broadband Internet will preserve the current free-wheeling nature of competition for Internet applications and services. But building and operating a communications network, like all forms of engineering, involves trade-offs. While the current Internet infrastructure may appear to be an "open" and somehow passive conduit of bitstreams, the Internet is, in fact, anything but passive. Routers, perhaps the core infrastructure of the Internet, are highly intelligent devices that pick and choose which route, among many, is least congested and thus capable of delivering the bits the fastest. IP multicasting capabilities, which operate pursuant to complex protocols, make efficient video transmission over IP networks possible.[1] Of course, there are a host of other types of network "intelligence" that have been (and can be) integrated into the network in order to improve network efficiency and quality.

From a consumer and social perspective, whether or not increasing intelligence along with increasing bandwidth (the "smart" network) or just expanding bandwidth (the "stupid" network) is preferred depends on the relative costs of these alternatives at some specified level of quality. Bandwidth is by no means free, and the per-household cost of bandwidth sufficient to support future Internet services (e.g., multiple streams of video services) has not been a significant part of the Network Neutrality debate. Moreover, in the case of wireless broadband providers, spectrum is closely controlled by the government and, therefore, capacity cannot be increased without bound. As such, Network Neutrality proposals that would limit or effectively restrict the injection of intelligence into broadband Internet access networks could present a significant risk to Internet users and the economy.

In this POLICY BULLETIN, we provide a cost/benefit analysis framework for evaluating various Network Neutrality proposals from a consumer and social welfare perspective. The general and specific applications of this framework build off the analysis that we presented in PUBLIC POLICY PAPER NO. 24, in which we showed that Network Neutrality proposals that seek to commoditize the market for broadband Internet access services would harm consumers by increasing industry concentration.[2]

Our discussion in Section II shows that not only do Network Neutrality proposals present potential harms from increased industry concentration, but that these proposals also risk consumer and social welfare harm due to the loss in efficiency by preventing network owners from making investments to improve the management of their networks. The general cost/benefit framework set forth in Section II.A shows that for a Network Neutrality proposal to be justified, the purported benefits that the proposal would create must exceed the costs of producing those benefits, including differences in the incremental network costs and market power. The cost and benefits of investing in network intelligence are evaluated using a more specific economic model in Section II.B. This model shows that all voluntary investments in network efficiency improve consumer and social welfare even if, as some Network Neutrality proponents contend, stupid networks are (for some reason) preferred by consumers. In fact, we

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[1] F. Fluckinger, UNDERSTANDING NETWORKED MULTIMEDIA (1995) at ch. 9.

[2] George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, *Network Neutrality and Industry Structure*, PHOENIX CENTER POLICY PAPER NO. 24 (April 2006) (available at: http://www.phoenix-center.org/pcpp/PCPP24Final.pdf).

show that, at least from a consumer and social welfare perspective, firms actually have too little and not too much incentive to invest in network intelligence that increases network efficiency.

Our cost/benefit analysis framework in Section II is simply that—a framework that lays out the important factors to consider but does not provide specific calculations for any particular Network Neutrality proposal. In Section III, we review some of the publicly available evidence in order to provide the reader with some guidance as to how large these consumer and social welfare losses may be if network owners were prevented from injecting "intelligence" into the Internet. Significantly, some studies show that a mandated "stupid" network could increase the per-subscriber cost of providing service by $300 to $400 per month if IP video or other high bandwidth applications continue to grow in popularity. Because American consumers are sensitive to price for broadband services, actions that increase the cost of these networks could have a significant effect on broadband penetration.

The purpose of the BULLETIN is to raise the level of debate by exposing some of the trade-offs inherent to Network Neutrality requirements. Importantly, we neither discount nor dismiss possible vertical leveraging about which Network Neutrality proponents claim concern and its potential to harm consumers. Our cost/benefit framework can encompass such concerns. Our specific model does not address these concerns, not because we seek to minimize them but to show that regardless of possible consumer harm from vertical leveraging, investments in network intelligence will still improve consumer and social welfare in the market for broadband Internet access. Any harm from potential increases in market power from these investments would need to be balanced against these unquestionable consumer and social benefits.

II. Economic Analysis of Investments and Welfare

In this section, we first present a simple cost/benefit framework for analyzing Network Neutrality proposals. The framework starts with the basic premise that governmental intervention to ensure Network Neutrality, like any other market intervention, is justified only if the benefits of such rules exceed the consumer and social costs of those rules.[3]

Although our framework is a highly stylized, we believe that it provides a palette from which to analyze the costs and benefits of any particular proposed approach, so that the policymaker may better understand the relevant tradeoffs between "intelligent" and "stupid" networks. Our initial analysis focuses only upon consumers, in that we consider only the value and price that consumers will place upon "intelligent" versus "stupid" networks. As a result,

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[3] Office of Management and Budget, Circular A-4 (Sept. 17, 2003) (available at: www.whitehouse.gov/omb/circulars/a004/a-4.pdf).

we ignore whether or not the economic conditions are such that a network of either type is more or less likely to be constructed. If a "stupid" network, for example, costs $1,000 per subscriber month to operate, then the welfare consequences of its mandate are somewhat obvious since such a network will not be constructed.

In Section II.B, we provide a more specific model of investment in network intelligence. In this model, we consider under what conditions a firm will invest in network intelligence if such investment also has the potential to reduce the marginal value of the service sold by the firm. This setup is a good match for the current debate. Proponents of government-mandated "stupid" networks contend that they are more valuable to consumers, and our model allows that to be the case. Opponents contend that the "stupid" network is more expensive to build, and we allow that to be the case. What we find is interesting: Under these conditions, the monopolist's incentive to invest in intelligence to reduce costs is aligned with both consumer and social welfare in that any voluntary investment in network efficiency increases not only profits but increases consumer welfare. Thus, viewing investments in intelligence as "anti-consumer" is misguided. In fact, our model shows that, if anything, firms invest too little in intelligence from a social welfare perspective because society benefits more from the investment than does the operator alone.

A. *A Cost-Benefit Test for "Smart" v. "Stupid" Networks*

We contemplate two competing network architectures: (1) "intelligent;" or (2) "stupid"—*i.e.,* a passive Internet in which the network passes information without regard to the nature of or importance of the content of that information. In the "stupid" network, the only solution to network congestion that a network owner may undertake is to expand the capacity of the network until bandwidth is sufficiently voluminous so that congestion does not occur. However, bandwidth is not free, so this approach will lead to higher network costs per end user (even with density economies in the network).[4] With a "smart" network, the network owner can avoid congestion not only by increasing bandwidth, but also by increasing the intelligence of the network so congestion can be avoided by "managing" the traffic flows (or, using an entirely different architecture to deliver some content), thereby reducing unit costs of throughput. A network owner following an "intelligent" network approach will of course need to make additional investment in parts of the network, such as deploying smarter routers or caching technologies, but the network owner will, of course, consider and balance those costs against the cost of simply increasing bandwidth.

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[4] Assume a network is serving 100 customers. A circuit with capacity 100 costs $100, but a circuit with capacity 200 costs $150, so that there are economies of density. While the capacity costs decline in size ($1 per unit versus $1.33 per unit), the average cost per end user rises from $1 to $1.50. Thus, the presence of scale or density economies does not solve the problem we analyze here.

If increasing bandwidth is in fact the cheapest method of addressing network congestion, then the owner/operator of both a "stupid" and an "intelligent" network will make the same choice—if possible, it will add bandwidth. The two approaches to network architecture differ *only* in cases in which deploying intelligence into the network is *cheaper* than deploying more bandwidth. By definition, if a legal rule makes expanding bandwidth the only solution to congestion when intelligence may be more efficient, that legal rule has forced an inefficient network architecture on society.

Whether that inherent inefficiency in a "stupid" network harms society is, however, dependent upon several other factors. Proponents of government-mandated "stupid" networks would argue that the flexibility that a "stupid" network offers consumers makes it more valuable to consumers. At the same time, if the cost inefficiency foisted on the network is so large that prices for Internet access needed to sustain the "stupid" network are significantly higher than the "intelligent" network, these demand-side benefits might not be worth the expense. As we also discussed in POLICY PAPER NO. 24, another cost of a "stupid" network is the harm that would result from a concentrated market structure, or even monopoly.[5] Policymakers must understand these trade-offs and attempt to quantify the relative benefits and costs of alternatives in order to make sound policy. This task is not an easy one, no doubt, since each proposal has its own set of trade-offs and consequences, some intentional and obvious while others are inadvertent and veiled.

We describe this cost/benefit framework using simple equations. Say that a customer is values Internet service at R. In economic parlance, R is the reservation price (the maximum price the customer is willing to pay). This reservation price can be quite high—many Internet users derive tremendous value from Internet access and would pay prices several times higher than prevailing rates for that access. Other users consume Internet services on the margin, so an increase in price could result in them "dropping off the Net."[6] The ultimate value that a customer places on Internet access with price P is $R – P$, where P is the price for the broadband connection. For the marginal consumer, $R = P$. Since we are considering two potential network architectures, a "stupid" network (S) and an "intelligent" network (I), we can represent the net values to a representative consumer (V) of each as:

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[5] *Supra* n. 2.

[6] Studies have shown that the demand for broadband access is elastic, and sometimes highly elastic, so even moderate price increases should be expected to have a sizeable effect on subscription. *See, e.g.*, A. Goolsbee, *The Value of Broadband and the Deadweight Loss of Taxing New Technology,* (University of Chicago, 2000); H. Varian *The Demand for Bandwidth: Evidence from the INDEX Project,* (University of California, Berkeley 2002); P. Rappoport, D. Kridel, L. Taylor, K. Duffy-Deno, & J. Alleman *Residential Demand for Access to the Internet*, in Madden, G., ed., THE INTERNATIONAL HANDBOOK OF TELECOMMUNICATIONS ECONOMICS: VOLUME II (2002); *see also* Mohan, Suruchi, 1994, *Oracle, Bell South Pilot Service*, COMPUTERWORLD (July 4, 2006) at 4.

$$V_S = R_S - P_S; \tag{1}$$

$$V_I = R_I - P_I. \tag{2}$$

The representative consumer prefers the network architecture that provides the largest ultimate benefits. The "stupid" network is preferred instead of the "intelligent" network if:

$$R_S - R_I > P_S - P_I, \tag{3}$$

implying that the additional benefit from the "stupid" network exceeds the increase in price for that network (if there is any). For example, if a consumer values stupidity by $10 more than a "smart" network, but a "stupid" network costs $20 more, then the "intelligent" network generates greater net benefit and is thus the preferred outcome. Consumers make decisions like this every day—they will opt to pay a little more for a product if they receive greater net utility for that product over a rival product. Of course, if the "stupid" network is cheaper than the "smart" one ($P_S < P_I$), and the "stupid" network is preferred ($R_S > R_I$), then the "stupid" network is more desirable.

In Section III of this paper, we review publicly available evidence on the cost (rather than price) of a "stupid" network. That analysis can be made more informative by assuming that P, the price for access to these networks, will be a function of costs and the competitiveness of the market:

$$P_S = M_S \cdot C_S \tag{4}$$

$$P_I = M_I \cdot C_I \tag{5}$$

where C is incremental cost and M is a markup factor (both unique to each network architecture). From Policy Paper No. 24 (and economic theory), we can assume that the value of M depends on the value of N, where N is the number of firms in the market, and that $M \geq 1$ (the service is profitable). The fewer the firms, the higher the markup ($\mathrm{d}M/\mathrm{d}N < 0$).

We can then re-write the consumer's cost/benefit analysis by substituting Equations (4) and (5) into (3):

$$R_S - R_I > (M_S \cdot C_S) - (M_I \cdot C_I). \tag{6}$$

Interpretation of Equation (6) is only a little different from that of Equation (3). Here, the "stupid" network is preferred only when the increase in the willingness to pay for a "stupid" network exceeds the margin-adjusted difference in cost. In Equation (6), we allow both the margin and cost to differ by network type. We can see from Equation (6) the relevant factors for evaluating the consumer's preference for a given network architecture:

(a) Is one architecture more desirable to consumers than another, and by how much?

(b) Does architecture affect industry structure and thus margins, and by how much?

(c) Is one network more costly than another, and by how much?

Some simple comparative statics along these lines are as follows. If consumers place only a small value premium on the "stupid" network, then consumers are less likely to prefer a "stupid" network, *other things constant*. If Network Neutrality increases industry concentration, as we posited in POLICY PAPER NO. 24, then margins will rise ($M_S > M_I$) and this will reduce the consumer's preference for a "stupid" network, other things constant. If the cost of the "stupid" network is lower (higher) than the cost of the "intelligent" network, then consumers are more (less) likely to value the "stupid" network, other things constant. Of course, we can devise many different comparisons like these and allow multiple factors to change simultaneously. Thus, Equation 6 only indicates some of the important factors to consider as tradeoffs; this analysis provides a framework only, not dispositive answers.

Unfortunately, there are very few constraints we can place on the relationship in Equation (6) to improve the predictive power of the analysis. Based on our analysis in POLICY PAPER NO. 24, we feel it is appropriate to assume that $M_S \geq M_I$ (industry structure is, if anything, more concentrated when the network is "stupid", so markups are, if anything, larger). Network Neutrality advocates would argue that $R_S \geq R_I$, but this need not be the case if quality is not constant across the networks. For example, streaming video may be of exceedingly low quality over the "stupid" network with inadequate capacity, so that $R_I > R_S$. Likewise, in the presence of network congestion, prioritizing voice traffic may render a higher value for the intelligent network than the "stupid" network, other things constant. Assuming that the quality of two networks is identical, we might expect $R_S = R_I$, so that the better network is determined solely by relative prices.[7] Proponents of government-mandated "stupid" networks may argue that $R_S \geq R_I$ even if network quality is equal in a static sense, because a "stupid" network is of higher quality in a dynamic sense. We are unaware of any compelling evidence to support this ranking, but as we show in the next section, it may not matter under certain conditions.

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[7] If consumers view them as having the same quality, there is no reason to believe reservation prices would differ (by definition in a static sense).

B. *Application of the General Cost/Benefit Framework: Voluntary Investments in Intelligence are Welfare Improving*

The cost/benefit analysis described above and summarized in Equation (6) sketches out the factors that should be considered when comparing "stupid" and "intelligent" network architectures. In essence, the social and consumer preference for network architecture depends on consumer valuations of the architecture, the costs of the architecture, and the profit margins of firms (which may be affected by industry structure). In this simple layout, unambiguous guidance is precluded; the analysis merely provides guidance on what to think about. However, it is possible to construct a more specific economic model that provides some insight on investments in network intelligence, even if a more "stupid" network is preferred by consumers. Specifically, we consider what happens to social and consumer welfare when a firm voluntarily makes an investment in network intelligence that reduces unit bandwidth cost and somehow also reduces the value of the service to consumers. This setup goes to the heart of the Network Neutrality issue: we allow the "stupid" network to be preferred by consumers, but we also allow it to be more costly to operate.[8]

We begin with a simple linear demand curve:

$$Q = A - P \tag{7}$$

where Q is quantity sold, P is the price, and A is the intercept of the demand curve. The slope of the demand curve is assumed to be -1 without loss of generality. Let unit bandwidth cost be C. Now, assume some investment K in network intelligence lowers incremental cost by reducing the capacity demands of the network (the change in cost is ΔC, which is negative). Also assume, consistent with arguments advanced by "stupid" network proponents, that the investment K also reduces A (writing the change as ΔA, which is negative). In other words, all consumers place a higher value on the "stupid" network. Assuming monopoly, equilibrium values of interest include:

$$Q^* = (A - C)/2\,; \tag{8}$$

$$P^* = (A + C)/2\,; \tag{9}$$

$$\pi^* = (A - C/2)^2\,; \tag{10}$$

[8] Of course, any conclusions we draw are based on these assumptions. We address the relative cost issue in more detail in Section III.

$$CS^* = \pi^*/2: \quad (11)$$

$$W^* = 3\pi^*/2 \quad (12)$$

where π is profit, *CS* is consumer surplus, *W* is social welfare ($\pi + CS$), and the * symbol indicates equilibrium values. Worth mentioning is that both consumer surplus and total welfare are proportionate to profits, so increases in profits increase welfare (the firm is a monopoly, so there is no market power consequence of investment).

We now turn to the question of when a firm voluntarily makes some investment *K* that reduces incremental cost and demand. The firm makes the investment *K* if and only if:

$$(\Delta A - \Delta C) > \frac{2K}{(A-C)}, \quad (13)$$

since profits do not rise if this condition is not met. The interpretation of Equation (13) is intuitive. Since the left-hand side of (13) must be positive, it must be the case that ΔC is more negative (a larger reduction) than ΔA for the investment to be profitable. Thus, the decline in cost must exceed the decline in consumer marginal value for the investment to be profitable.

Policymakers are often more interested in social or consumer welfare than firm profits. Social welfare rises with *K* if and only if:

$$(\Delta A - \Delta C) > \frac{4K}{3(A-C)}. \quad (14)$$

Observe that while the left-hand sides of Equations (13) and (14) are identical, the right-hand side of (13) is larger than (14) (that is, $2 > 4/3$). Thus, satisfying Equation (14) is easier than satisfying Equation (13). So, if a voluntary investment in reducing costs is made by the firm, then the investment must also improve social welfare, even if it reduces the value of the service. Since consumer surplus is proportional to profits by Equation (11), consumer surplus also rises with the voluntary investment.

A comparison of Equations (13) and (14) reveals that the hurdle for beneficial investment to the firm is higher than the hurdle for beneficial investment for consumers and society. Thus, the model indicates that, if anything, the firm's incentive to invest in cost-reducing intelligence is *too low* from a consumer and social perspective. As such, policymakers should be more concerned with the prospect for too little and not too much investment in cost-reducing network intelligence.

This proof that voluntary investments in network intelligence are welfare improving even if such investments reduce demand for Internet services is based on a specific formulation of demand, costs, and market structure. It is not obvious to us that reasonable alternative formulations would not find a similar result, but there may be some differences.[9] Despite the possibility of conflicting results, this simple proof remains important. We have provided theoretical evidence that voluntary investments in network intelligence to reduce costs will not be made if they reduce consumer and social welfare, even if, as some Network Neutrality proponents contend, they reduce the marginal value of the service. Thus, absent anticompetitive consequences, consumers are better off if firms can make voluntary investments in network intelligence.

III. Analysis of Publicly Available Industry Broadband Cost Models

As we described above, when comparing the social desirability of "stupid" and "intelligent" networks, the factors to consider are not limited to arguments about relative gross values. Rather, a complete analysis requires consideration of the prices consumers must pay for Internet access (where prices are margin-adjusted costs). As also noted above, several studies have shown that American consumers are very sensitive to price for broadband services.[10] As a result, actions that would increase the cost of these networks could have a significant effect on broadband penetration. In this section, we review some publicly available engineering and financial models, and these models show that a government policy to mandate "stupid" networks could increase the cost of providing broadband services to households by hundreds of dollars per month.

Perhaps the most important fact to consider in evaluating the current and future architecture of the Internet is the rapidly changing demands for services provided over it. Evidence indicates that the average consumer demand on the Internet will rise substantially over the next few years. In the "stupid" (unmanaged) network, higher bandwidth demands by consumers could be met only with increases in the capacity of the network.[11] An important question, therefore, is how much more expensive a "stupid" network would be for Internet consumers not only today but in the future, and how significantly this expense can be reduced through network management.

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[9] It is always possible to posit some particularly odd and unrealistic formulation of demand or cost to prove just about anything.

[10] S*upra* n. 6.

[11] Advances in compression technologies, reductions in transmission costs, caching, and other technological advancements could reduce the need for and cost of bandwidth expansion.

In recent months, there have been a few attempts by the industry and Wall Street to estimate the cost of operating a "stupid" network. These publicly available studies contemplate a world where end-users are streaming multiple video entertainment signals at once, either in standard or high-definition formats. These cost calculations assume that a "stupid" network will adopt a "neutral" unicast-only technology, where the video content of each subscriber must transit the Internet backbone separately and independently of video content viewed by other subscribers. With simultaneous usage, the capacity demands on the Internet for video content in this architecture would be substantially larger than the email/browsing content that dominates the Internet today.

A. *Kafka Analysis*

In a recent presentation entitled *Drivers for Next Generation Networks*, BellSouth Chief Architect Hank Kafka discusses, in part, the bandwidth demands of the future Internet that is expected to deliver video services.[12] Kafka states that today the "key factor" for Internet networks is "access speed," or Megabits/second. In the future, however, the key factor will be the quantity of content delivered (measured, say, in Gigabytes per month). In this future Internet, network providers must pay careful attention to scheduling (i.e., busy hour) and the distance between content and consumer.

Today, Kafka suggests that the average busy-hour usage rate of a consumer is less than 50 Kbps, where access line speeds are generally on the order of 1.5 to 6 Mbps. On average, a consumer will download approximately two Gigabytes per month. Kafka estimates that this typical usage level amounts to about $1.00 in monthly bandwidth usage costs.

Table 1. Cost Estimates of the "Stupid" Network, Kafka Analysis

BH Capacity Utilization	*Access Speed*	*Avg Busy Hr Usage*	*Quantity (Gbytes/month)*	*Cost of Quantity*
Today's Internet	1.5 to 6 Mbps	< 50 Kbps	2	$1.00
SDTV, 5 movies/month	1.5 to 6 Mbps	190 Kbps	9	$4.50
SDTV, All Viewing	12 Mbps	1.3 Mbps	224	$112
HDTV, All Viewing	24 Mbps	6.7 Mbps	1120	$560

Source: H. Kafka, *Drivers for Next Generation Networks* (2006). All Viewing implies 8 hours, 11 minutes per day of viewing.

In a future with HDTV channels delivered over the Internet, however, the access speed would need to be 24 Mbps, with average busy-hour usage of 6.7 Mbps and monthly downloads of 1,112 Gigabytes (1.1 Terabytes). Obviously, in this scenario, the demands on the Internet

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12 H. Kafka, BellSouth Chief Architect, *Drivers for Next Generation Networks* (March 7, 2006) (available at: http://www.ofcnfoec.org/materials/2006KafkaPlenary.pdf).

network are significantly different than they are now, and Mr. Kafka concludes that video services "can overwhelm current Internet core technology." Kafka "guesstimates" that if video service is provided using technology that delivers one copy of the stream to each customer, without any intelligent replication or caching in the network, the average cost of Internet transit bandwidth for a typical customer would be $560 month.

Of course, we would not expect much demand for Internet service at a price reflecting a cost of $560 per month, and at that price the United States' world ranking in broadband subscription would certainly not increase. In fact, such a network would not be constructed and Internet consumers would not use it to access IP video (or quality video, at least). Kafka offers several potential solutions to keep Internet access affordable, including "new content distribution technologies/models," "network management/traffic control," "new business models for Internet services," "massive amounts of cheaper bandwidth," and "then some." Some of these proposals (like network management and traffic control) clearly reflect the necessity for a more intelligent Internet to reduce the end-user price of accessing the Internet of the future. Certainly, Kafka's presentation reveals that network owners and operators will need to devote considerable attention to the bandwidth demands that video will place upon the Internet and that "intelligent" investments will be needed to reduce costs substantially.

B. *Clarke Analysis*

A more detailed analysis of the potential cost of an unmanaged or "stupid" network is provided in a recent study entitled *Cost of Neutral/Unmanaged IP Networks*.[13] The study's author is Richard N. Clarke, AT&T Director of Economic Analysis. The study considers primarily the cost of delivering high bandwidth video-like services (say, a television show in HDTV) in real time using unicasting technology.

The study considers the cost of serving four types of customers, where the customers are differentiated temporally (current, future) and in their bandwidth demands (low, high). For a "Modest Future Video Usage," the study assumes receipt of two simultaneously streamed standard definition television channels ("SDTV"), whereas "Typical Future Video Usage" is the simultaneous streaming of one HDTV and three SDTV channels or two HDTV channels. The cost results are summarized in Table 2 below. Bandwidth demands in the busy hour are provided.

Costs are divided into four categories. "Outside Plant Costs" include the "last mile" link to the final user including drop, distribution and feeder plant, home optical terminals and so forth.

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13 Richard N. Clarke, *Costs of Neutral/Unmanaged IP Networks* (May 2006) (available on the Social Sciences Research Network at: http://ssrn.com/abstract=903433).

In this model, the last mile is fiber using PON ("passive optical network") architecture (e.g., Verizon's FiOS network is a PON). "WC+Cluster Costs" include optical line termination equipment located at a wire center and the facilities used to connect local wirecenters (including routers, interoffice fiber, etc). "Backbone" costs are special access links from a hub wire center to the Internet backbone point-of-presence plus IP transit costs. Operating costs are assumed to be constant across demand levels.

Table 2. Cost Estimates of a Neutral/Unmanaged IP Network

BH Capacity Utilization	*Busy-Hour Download*	*Outside Plant Costs*	*WC+Cluster Cost*	*Operating Cost*	*Backbone Cost*	*Total Cost*
Current Typical Usage	45 Kbps	$30.64	$2.77	$12.00	$1.30	$46.71
Current Power Usage	450 Kbps	$30.64	$3.07	$12.00	$8.84	$54.55
Modest Future Video Usage	5.5 Mbps	$30.64	$11.32	$12.00	$86.14	$140.09
Typical Future Video Usage	21.5 Mbps	$31.62	$86.49	$12.00	$336.15	$466.26

Source: Clarke, *Cost of Neutral/Unmanaged IP Networks* (2006).

From Table 2, we see the key drivers of the cost of the "stupid" network are wire center and backbone costs, and most of these usage-driven cost increases reflect the need to expand the capacity of transmission facilities and associated equipment.

This study echoes Kafka's analysis and suggests that in the future, when video streaming or other high bandwidth real time services become a more significant component of consumer demand, the cost of a "stupid" network will be very high. For "Typical" video usage as defined in the study, the monthly cost of serving a household is $466.[14] This estimate appears consistent with that in the Kafka analysis ($560). These estimates are static and do not take into account possible future developments, such as lower bandwidth costs or improvements in compression technology, which would reduce the bandwidth needed to transmit high-quality video. But the cost figures are striking and show that relying on such technological improvements may be a risky gamble, because if they fail to transpire, the price for broadband services could skyrocket to several hundred dollars a month, or, more likely, consumers get stuck with the capabilities of today's network.

C. *The "Managed Network"*

While the estimates of these studies are important to the Network Neutrality debate, neither of these analyses provides estimates of cost of a managed network that would provide the same level of video service contemplated in the analysis. Since prices typically exceed costs, we can

[14] A rough approximation of monthly costs can be computed for any given Kbps using the formula: $42.06 + 0.01962 \cdot \text{Kbps}$. The equation is based on the least-squares coefficients using the figures reported in Table 1.

make some comparisons to the expected prices for services capable of delivering the services considered by these cost analyses. For example, the usage pattern of a "typical" customer in the Clarke study appears equivalent to AT&T IPTV service per-customer capacity (one HDTV and three SDTV channels).[15] While the price for AT&T's IPTV service is not yet formally determined, public statements indicate a price, including some content, of about $100 per month.[16] Similarly, Verizon's FiOS video service is priced under $100 including video content.[17] And, the traditional cable television network, the ultimate managed network (in a tie with the circuit-switched network), can deliver excellent broadband speeds and HDTV without difficulty and at a price substantially less than $500. Many large cable operators are now offering a triple play bundle of services for about $100.[18] So, it appears possible for network management to keep the cost of video-heavy Internet connections at affordable levels.

D. *Bernsten Research*

A recent report by financial analysis firm Bernstein Research, entitled *The "Dumb Pipe" Paradox (Part I)* is authored by Craig Moffett and Amelia Wong, purports to analyze the cost of building and operating a "dumb pipe" network.[19] The Bernstein Research report is the only study of which we are aware that suggests that operator of a "dumb pipe" would be more profitable than one also offering related, vertical services such as video.

Bernstein Research focuses on the cable network and concludes that if a cable firm was to sell its network as a "dumb pipe" and allow another entity to sell the programming, the cable firm would be more profitable. In essence, the argument is that if the cable firm becomes a "dumb pipe" that "revenues would fall significantly" but that "[o]perating expenses would fall even more significantly." This argument is (at best) a puzzling one.

In Bernstein Research's view, the cable industry sells two products: programming and transmission, and Bernstein Research posits that the total profits for transmission service would

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15 J. T. Stankey, *Lightspeed/Cost Initiatives*, presentation at AT&T Analyst Meeting (Jan. 31, 2006) (available at: http://library.corporate-ir.net/library/11/113/113088/items/181347/analyst06_color.pdf).

16 J. Roper, *CEO Out to Transform SBC Into a Diversified Global Giant*, HOUSTON CHRONICLE (April 20, 2006) (according to AT&T CEO Ed Whitacre, "we would offer voice service, we'd offer long-distance service, we'd offer broadband, we'd offer wireless service, and we'd offer video so the customer would get everything they needed in one package in a bundle for $100 to $110 a month.")

17 M. Morrison, *Battling For The Eyes Of Texas*, BUSINESSWEEK (March 20, 2006) ("Verizon is charging about $100 a month for a package of TV, Internet, and phone services in Keller, competitive with cable and satellite offerings in town.")

18 A. Breznick, *Comcast Joins Cable's Triple-Play Parade*, CABLE DIGITAL NEWS (March 1, 2006).

19 C. Moffett and A. Wong, *The "Dumb Pipe" Paradox (Part I)*, BERNSTEIN RESEARCH (Feb. 27, 2006).

be higher if no programming were sold. In other words, the report assumes that the sale of video programming takes away profits from the "dumb pipe" component of the cable industry. Of course, if programming and the "dumb pipe" were divested from one another, the entity now responsible for selling programming would be a money-losing venture. Exactly who would sell cable programming under these circumstances? Clearly, if it were profitable for another firm to sell cable programming profitably, the cable industry could increase its profits by contracting with this more efficient seller of programming, much in the way that certain areas of department stores, like jewelry counters, are run by separate firms. Yet, we are unaware of any occurrences of this arrangement in the cable industry. In our opinion, the Bernstein report lacks credibility from an economic or financial perspective.

E. *Other Commentary*

While we are unaware of any other documented analyses of the cost of managed versus unmanaged networks, there have been unsupported commentary on the issue by notable persons. For example, consider the testimony of Gary R. Bachula, Vice President of Internet2, a consortium of colleges and universities:

> [A]ll of our research and practical experience supported the conclusion that it was far more cost effective to simply provide more bandwidth. With enough bandwidth in the network, there is no congestion and video bits do not need preferential treatment. All of the bits arrive fast enough, even if intermingled. . . . We would argue that rather than introduce additional complexity into the network fabric, and additional costs to implement these prioritizing techniques, the telecom providers should focus on providing Americans with an abundance of bandwidth—that the quality problems will take care of themselves.[20]

Bachula did not provide this research to the Senate Committee, so we are not in a position to review it.[21] But the implication that expanding bandwidth is always cheaper than designing intelligence into the network seems plainly overstated, as Internet protocols are evolving to include quality of service provisions and Internet backbones and the electronics that run them

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[20] Testimony of Gary R. Bachula, Vice President, Internet2, Before the United States Senate, Committee on Commerce, Science and Transportation (Feb. 7, 2006) (available at: http://commerce.senate.gov/pdf/bachula-020706.pdf) at 2-3.

[21] We are, however, concerned that Mr. Bachula may be conflating backbone management needs with institutional network management needs. Internet2 is a backbone network that is likely engineered to handle (and not question) the loads offered to it and paid-for by its member institutions. This backbone network may have far less need for management than the last mile networks that institutions use to distribute connectivity to their end users. It is in these networks where capacity is typically greatly oversubscribed.

are highly intelligent. If presented with a proposal that asserts that an involuntary investment in more "dumb" bandwidth investment is the universal answer to every engineering challenge that the Internet presents, then a policymaker should at least demand to see the materials that support that assertion.

IV. Conclusion

The debate over Network Neutrality proposals needs to focus on balancing the competing concerns over the potential for anticompetitive vertical leveraging against the very real consumer and social harm that "stupid network" proposals would engender. In this POLICY BULLETIN, we present a general cost/benefit analysis framework for examining Network Neutrality proposals that would limit firms from injecting intelligence into Internet local access and backbone networks. We show that such Network Neutrality proposals risk significant consumer and social welfare harm because of the loss in efficiency by preventing network owners from making investments that would reduce network cost by improving the management of their broadband Internet access networks. Our review of publicly available evidence shows that if IP video services increase in popularity, the cost of providing a residential subscriber a "stupid" network capable of addressing those bandwidth demands could reach $300 to $400 per month more than an "intelligent" network. Increasing the cost of broadband to this degree would destroy the business case to build a network that would offer affordable, residential broadband services to American consumers.

Our theoretical analysis also suggests that the need for regulatory control of network design may be unwarranted. We show that under a simple theoretical framework, a firm will invest in network intelligence to reduce costs only when the investment improves both consumer and social welfare, even if the investment reduces the marginal value of the service sold. In fact, policymakers should be more concerned whether too little, and not too much, investment is being made in network efficiency, since the incentive for the firm to invest in network intelligence is below that of society in general. While this theoretical analysis ignores investments made strictly for anticompetitive purposes, it reveals that any general distrust of network investments in intelligence is misguided.

It is important to note that this POLICY BULLETIN simply provides a cost-benefit framework to analyze "stupid" networks from a consumer welfare and economic efficiency standpoint. We do not formally model anticompetitive behavior. This paper highlights the trade-off that would be inherent in any government mandate to build "stupid" networks and illustrates that the consumer welfare benefits that would result from stamping out vertical leveraging would need to be enormous to offset the sizeable efficiency losses we observe in our review of the evidence. Ignoring these efficiency losses would not simply be "stupid"—it would be crazy.

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Phoenix Center Policy Paper Number 25:

The Burden of Network Neutrality Mandates on Rural Broadband Deployment

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(July 2006)

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The Burden of Network Neutrality Mandates on Rural Broadband Deployment

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Abstract: The purpose of this POLICY PAPER is to examine empirically the relative impact that a regulatory mandate like network neutrality would have on high-cost areas and to compare that relative burden to lower-cost urban areas. We find areas that are, on average, high-cost could be disproportionately affected by imposition of these mandates, even if the cost of complying with that mandate does not vary by geography. Using publicly available network cost models and data, we show that under plausible conditions, while network neutrality mandates negatively impact broadband deployment in all geographic areas regardless of average cost characteristics, such rules could disproportionately impact broadband deployment in high-cost areas. Moreover, our analysis that suggests the differential reduction in service availability for high-cost rural areas is six times as much as in lower cost, more urbanized markets.

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‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies. The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center, its Adjunct Fellows, or any of its individual Editorial Advisory Board members. We are indebted to Randy Beard, Adjunct Fellow, for his assistance in formulating the economic model we present in this paper.

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I. Introduction

By all accounts, the deployment of broadband services to all corners of America and "network neutrality" have become two key issues in the current debate over rewriting the nation's communications laws. But no analysis has been performed on the impact that a "network neutrality" regulatory mandate would have on the incentives and ability of firms to deploy broadband services in high-cost areas. We show in this POLICY PAPER that while network neutrality regulation would materially impact broadband deployment generally, such regulation could disproportionately and negatively impact broadband deployment by a sizeable amount in areas that are, on average, high-cost areas (such as rural markets)—at a magnitude of six times the impact relative to areas with lower costs (or more urbanized markets) under plausible conditions and assumptions.

It is critical for policymakers to understand this relatively large impact that network neutrality mandates could have on households in high-cost areas, as the nation's leaders from both the Democrats[1] and the Republicans[2] have called for broadband services to be available throughout the country.

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1 For example, Senator Byron Dorgan has long championed broadband deployment to rural areas, noting that "Ensuring that all Americans have the technological capability is essential in this digital age. It is not only an issue of fairness, but it is also an issue of economic survival. *** No longer must economic growth be defined by geographic fiat." Statement by Senator Byron Dorgan (D-ND) on the introduction of S 2307, the Rural Broadband Enhancement Act (March 28, 2000) (available at: http://www.techlawjournal.com/cong106/broadband/20000328dor.htm). Similarly, FCC Commissioner Michael J. Copps has said that "access to broadband is absolutely essential if

(Footnote Continued. . . .)

Indeed, billions of dollars are spent annually to subsidize the availability of communications services in high-cost areas of the country. Since 1998, the federal universal service fund has spent $21.85 billion to support the construction and maintenance of telephone networks to high-cost areas of the country, and disbursements for high-cost support in 2006 are expected to top $4.2 billion. Given this level of commitment (and requests from the high-tech industry that more should be spent to subsidize 100 Mbps broadband networks),[3] policymakers should clearly seek to avoid implementing public policies that would disproportionately affect the availability of communications services in rural America.[4] Policies that reduce broadband generally should likewise be scrutinized, since such policies will not improve the relative economic strength of the United States.[5]

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every area of this country is going to be able to compete for high-quality jobs and investment." Remarks of FCC Commissioner Michael J. Copps, "Disruptive Technology … Disruptive Regulation," (Feb. 24, 2004) (available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-244356A1.pdf) at 4, 6 ("we need to develop a real national plan for broadband deployment").

2 President Bush has called for universal and affordable broadband service to be ubiquitous throughout the country by 2007, White House, *A Generation of American Innovation* (April 2004) (available at: http://www.whitehouse.gov/infocus/technology/economic_policy200404/innovation.pdf), and FCC Chairman Kevin J. Martin has called "the deployment of new packetized networks throughout the nation" to be "one of the Commission's core priorities". Statement of Chairman Kevin J. Martin, *In the Matter of Petition of SBC Communications Inc. for Forbearance from the Application of Title II Common Carrier Regulation to IP Platform Services,* WC Docket No. 04-29 (May 5, 2005). Section 706 of the Communications Act of 1934, as amended, 47 U.S.C. § 11157 nt. directs the Commission to encourage the deployment of advanced telecommunications capability to all Americans.

3 *See, e.g.*, TECHNET, *A National Imperative: Universal Availability of Broadband by 2010* (2002) (available at: http://www.technet.org/news/newsreleases/2002-01-15.64.pdf); *see also* Computer Systems Policy Project, *A Vision for 21st Century Wired & Wireless Broadband: Building the Foundation of the Networked World* (available at: http://www.cspp.org/reports/networkedworld.pdf); Semiconductor Industry Association, *Removing Barriers to Broadband Deployment* (available at: http://sia-online.org/downloads/Broadband_Combined.pdf). Microsoft and Google, two large advocates of network neutrality policies, are members of TechNet.

4 Of course, there are high-cost components of nearly any defined geographic market and it is these households that are harmed by cost-increasing regulations. Relative harm across markets essentially relates to the proportion of "high-cost households" in a given market.

5 There are varying reports as to the exact ranking of the United States for broadband penetration compared to other countries. For example, according to the OECD, the United States ranks 12th in broadband penetration among member countries as of December 2005 (see

(Footnote Continued. . . .)

The challenge of bringing broadband service to all corners of America is dominated by one unchangeable fact: it is very costly to deploy and operate broadband networks and this is particularly the case in sparsely-populated areas. Network Neutrality mandates would, almost by definition, make broadband networks either more costly to build or less valuable (or both). As we described in POLICY BULLETIN NO. 16, the potential size of these increased costs, according to some estimates, is staggering, and can be has high as several hundred dollars per month.[6] The revenue-reducing capability of such rules for the network operators is another important component of the neutrality debate because some network neutrality proposals would essentially prohibit network owners from collecting from certain users of the networks (content companies like Google or Microsoft), even if such charges would be the most efficient means of charging for access to the network. Increasing the cost of designing and operating broadband networks or reducing their revenue potential would certainly have a negative impact on the economics of deploying broadband everywhere.

But the extent of that impact on households in high-cost areas, and comparing that relative burden to homes in lower cost, more urbanized areas, is an empirical question that we seek to answer in this POLICY PAPER. Our analysis estimates the relative impact that a regulatory mandate like network neutrality would have in areas that have different cost characteristics. We find that areas that can be described as high-cost areas (on average) would be disproportionately affected by imposition of these mandates, even if the cost of complying with that mandate does not vary by geography. In Section II, we present a conceptual framework for this analysis, and Section III attempts to calculate the disproportionate impact that a network neutrality mandate will have. Using publicly available network cost models and data, we show that under plausible conditions, while cost-increasing or revenue-reducing network neutrality mandates will materially impact broadband deployment in all geographic areas, such rules can be expected to disproportionately impact broadband deployment in high-cost areas and potentially by a significant

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http://www.oecd.org/document/39/0,2340,en_2649_34225_36459431_1_1_1_1,00.html); *but c.f.*, ITU January 2005 data, which lists the United States as 16th in broadband penetration (http://www.itu.int/osg/spu/newslog/ITUs+New+Broadband+Statistics+For+1+January+2005.aspx.

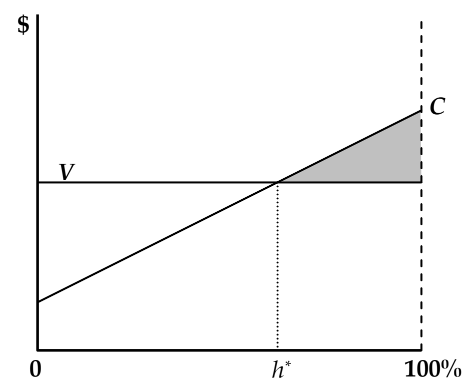
[6] G. Ford, T. Koutsky and L. Spiwak, *The Efficiency Risk of Network Neutrality Rules*, PHOENIX CENTER POLICY BULLETIN NO. 16 (May 2006) (available at: http://www.phoenix-center.org/PolicyBulletin/PCPB16Final.pdf).

amount. Our particular analysis indicates the differential impact is about six times as much as in lower cost, more urbanized areas.

II. Conceptual Framework

In this POLICY PAPER, we set out to explore the impact that increased costs (or reduced value) of a broadband network caused by network neutrality mandates could have on the eventual deployment of such network in certain areas, particularly high-cost areas. We demonstrate in this section how an increase in costs of building or operating a network could have a disproportionate impact on deployment decisions in particular areas even if the cost change from the regulatory mandate is identical across all areas.

Figure 1. Network Deployment



We can, in general, represent the effect an increase in costs has upon broadband deployment with some simple graphics. In Figure 1, we illustrate the economics of deployment. For the figure, we assume the broadband service provider must expend a fixed costs *C* to build network to a particular household (while *C* is incremental to each house, it is a fixed capital expense in that it is spent only once and is required to provide service). The cost of building a wireline broadband network in the United States varies widely and to a large extent is driven by population density. The line labeled *C* in Figure 1 demonstrates this relationship—the vertical axis measures the costs to build out to a household and the horizontal axis is the percentage of households passed, where households are ranked by the fixed cost of constructing the network to *each* house.[7] Since the homes are sorted by C, the C curve slopes upward, with the lowest cost households on the far left and the highest cost households on the far right.

The horizontal line labeled V is the expected value of the household to the broadband network operator. The value might be considered the net revenues (or gross profits) that a firm expects to generate from each particular household that it passes. It is important to note that V represents the "value" of the network to the network service provider—effectively the present value of gross profits that the firm can realize from building and operating the network.[8] For our purposes, we assume that the value of a broadband network for residential consumers is essentially unrelated to the underlying capital cost of constructing network. This assumption seems reasonable, since there is little reason to think that consumers in high-cost areas are willing to pay substantially more (or less) for voice, video and high-speed broadband data services than consumers in lower cost areas. As a result, the V curve is flat.[9]

The network firm will build a network to a household as long as the expected value meets or exceeds the fixed costs of serving household i (where $V \geq C_i$). This equilibrium occurs where the C and V lines intersect, rendering the equilibrium percentage of households passed of h^*. Households to the right of h^* are too costly for the private sector to serve given expected benefits V. The shaded area in Figure 1 essentially represents a type of "gap" or "shortfall"—the

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7 In other words, the curve labeled C is the fixed capital cost for the household h and not the sum of fixed capital costs at h. For simplicity, we illustrate the distribution of the per-household fixed capital costs as linear across all households (with total households being H). We have normalized households by dividing by total households H so that the horizontal axis is measured on the unit interval (i.e., the lowest value is 0 and the highest value is 1 or 100%).

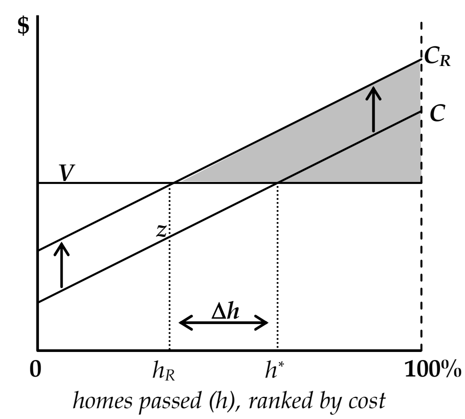
8 As a result, in this conceptual framework, V only represents the net revenues from the network that the network service provider can actually collect from users of the network. It is not a statement of the complete "social" value of the network or the value that consumers would place upon the network. In analyzing a firm's build-out decision it is, of course, obvious that only the "value captured by the firm" is relevant to the firm's decisions.

9 There may be differences in demand due to income, but, on average, there is no consistent relationship between costs and income. G. Ford, T. Koutsky and L. Spiwak, *The Impact of Video Service Regulation on the Construction of Broadband Networks to Low-Income Households*, PHOENIX CENTER POLICY PAPER NO. 23 (September 2005) and the ADDENDUM (February 2006) and citations therein (available at: http://www.phoenix-center.org/pcpp/PCPP23Final.pdf and http://www.phoenix-center.org/PolicyBulletin/NewJerseyTestimonyFinal.pdf).

portion of the service area where the cost of building a network is greater than the private value of the network that can be captured as revenues by the network provider. Policymakers that seek to promote the broadest penetration level for broadband network should favor policies that seek to minimize the size of this triangle as much as possible (or utilize other regulatory tools such as subsidies to mitigate the adverse impact of this shortfall).

Now, consider the effect of increasing the capital cost of deploying network through, say, network neutrality regulations. An increase in costs lowers the equilibrium penetration of broadband network. Figure 2 demonstrates this effect. If regulation increases the cost of the network deployment (by ΔC, with Δ meaning "a change in"), then the C curve shifts upward to C_R (the latter being cost with "Regulation") as illustrated in Figure 2. Now, the profit maximizing network operator builds to only h_R homes, reducing deployment by Δh homes. So, Figure 2 shows how increasing the cost of network deployment through regulation reduces the equilibrium number of homes passed.

Figure 2. Network Deployment with Cost Increase from Regulatory Mandate



For ease of presentation, in Figure 2 we treat the effect of this regulatory mandate as an increase in capital cost to deploy network. But the same effect would be observed if the regulatory mandate effectively increased the incremental (or operating) cost of or reduced the revenue that the provider could collect from the network (by shifting the V curve to intersect C at z).

It is important to see that not only has the cost hike decreased broadband penetration from h^* to h_R, but the size of the shortfall shaded area has increased significantly. The "shortfall" between the cost of the network and the value of that network has increased, a development that would certainly make the goal of achieving universal access to broadband more costly to achieve.

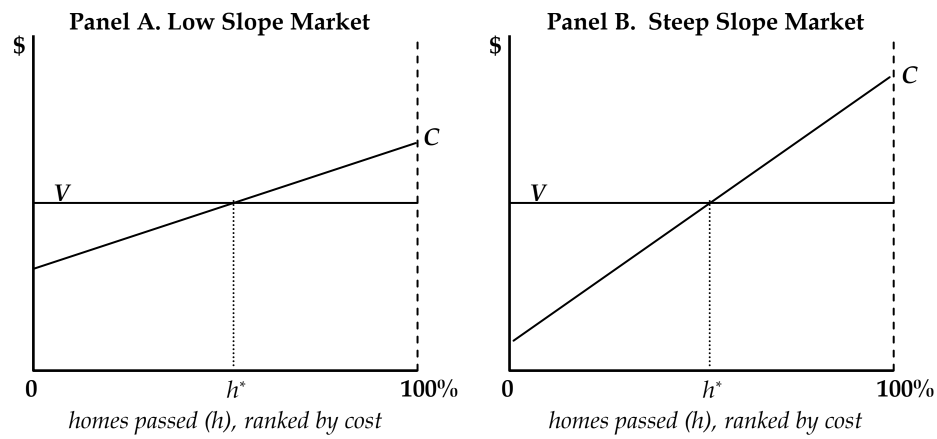
Thus far, the conceptual argument is straightforward and intuitive, but our interest lies in the relative effect that cost increases has upon a particular category of households—those that are in high-cost areas (or areas with higher average cost of service). In particular, while our previous analysis clearly shows that a cost increase from a regulatory mandate decreases overall broadband deployment regardless of the level of cost, our focus in this paper is on whether that mandate would affect deployment disproportionately in areas that are, on average, high-cost compared to lower-cost markets.

We show now how the extent to which an increase in costs may differentially affect deployment across different areas. To do so, we illustrate the cost curves for two markets in Figure 3. In Panel A, we have a market in which the costs of deployment do not vary widely across homes so that the slope of the curve *C* is low (the curve is relatively flat). Panel B of this figure shows a market in which the costs of deployment vary widely across homes so that the slope of *C* is high (or relatively steep).[10] The two cost curves are drawn so that the point where the *V* curve intersects the *C* curves at the same household penetration point, h^*, and the two markets have the same *average* cost of deployment.

---

10 The market of Panel B might be an area in which there is a densely populated urban core but some extremely high-cost households on the fringes (such as a smattering of mountaintop homes in Southern California). This distribution of homes would render a non-linear curve, however, which begins as a relatively flat curve and then rises sharply as homes passed approaches 100%.

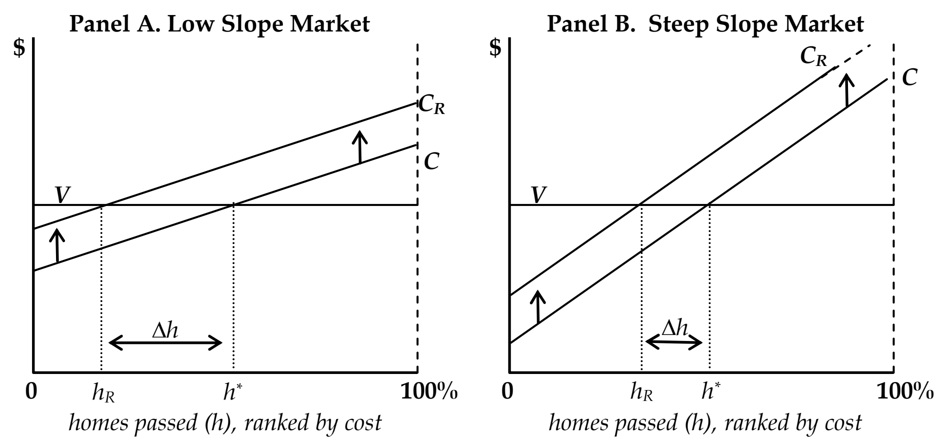
Figure 3. Differences in Network Deployment with Cost Changes



While both markets start with the same equilibrium level of network construction and same average cost per home, the impact of a regulatory mandate differs between markets. In particular, the market with the low slope (Figure 3, Panel A) will see a substantial decrease in households passed compared to the other market shown with a relatively steep cost curve.

Figure 4 shows how a regulatory change that increases the costs of building or operating the network by the same amount for all households passed alters homes passed in two different markets that are alike in many ways (average cost and penetration) except for the slopes of their *C* curves. To illustrate the cost increase, the *C* curves in Figure 4 have been increased to C_R. As we illustrated in Figure 2, this increase in cost will decrease deployment in both markets, but Figure 4 shows that the market in Panel A sees a much more substantial decrease in network construction in response to an identical change in costs across markets.

Figure 4. Impact of Cost Change



This analysis reveals that a fixed increase in costs, which applies to all households equally, can affect deployment in areas differently (but always reduces deployment). The reason for this differential impact is the slope of the cost curve (*C*) in each particular market at the point where *V* intersects that curve (for these linear curves, the slope is constant). As Figure 4 reveals, if the *C* curve is relatively flat at the intersection with *V* (a small slope), then even a tiny change in fixed costs will have a substantial impact on homes passed. Alternately, if the curve is steep at *V* (the slope is large), then the percentage of homes passed is not as sensitive to changes in costs. As shown in this example, the relative deployment response is not a function of average cost or initial penetration (which are assumed identical in the figures), but is driven solely by the slope of the *C* curve. Thus, if we know the slope of the curve at and around some point, then we can make estimates of the relative responses of network deployment to changes in costs across a variety of markets.

This analysis indicates that deployment response is not directly related to the average cost of provision (since average costs are identical in Figures 3 and 4), but rather the response is related to the shape of the cost distribution. Markets, however defined, that have large proportions of high-cost households will typically have a flatter cost distribution (such as market A in Figure 3 and 4). More urbanized markets will have a very flat cost distribution over much of the range, but as penetration approaches 100% the distribution curve becomes very steep (since there are typically some high-cost customers in every market). Thus, systematic differences in deployment responses between low- and high-cost markets depends not on whether they are low- or high-cost *per se*, but on the systematic relationship between the slope of the cost distributions and average cost. So, we have a question that cannot be answered by theory but is empirical in nature.

This linkage between response and the slope of *C* is important because it indicates a very useful tool of empirical analysis. If we can calculate these slopes for particular markets, then we can make certain predictions about the extent to which a regulatory policy might disproportionately impact deployment in that particular market and compare that impact on other markets with different characteristics. It is possible, for example, to analyze whether a regulatory mandate might disproportionately affect deployment in certain areas, such as high-cost areas, or urban areas, or states, or even by the service area of a particular local telephone company.

To develop this tool, however, we need granular, cost data that allows us to calculate the slopes of these cost curves. Complicating this analysis is the fact that, unlike our figures, the actual network cost curves in markets are highly non-linear; as a result, the slope in unique at each point along the curve. Fortunately, publicly-available network cost models have been created that do in fact estimate the fixed costs of building networks in various markets throughout the country. In Section III, we demonstrate how we can use this data to analyze and effectively calculate the slopes of these cost curves around some point *V*. With this data, we also calculate an index of the relative burden between low-cost and high-cost markets. While all increases in costs should be expected to reduce deployment, this analysis will show whether the burden of an increase cost would fall on high-cost areas well beyond what an equal impact on markets would render.

III. Simulation Data and Methodology

In recent years, for the purpose of distributing subsidies and setting unbundled element rates, the Federal Communications Commission and industry have developed and utilized cost models that effectively estimate the costs of building a communications network in the United States. For some models, cost estimates provided all the way down to the "Census Block Group" level, which are relatively small geographic areas established by the United States Census. In 1990, there were about 230,000 Census Block Groups ("CBG") in the United States, so the network cost analysis is fairly granular. We can utilize this data and these models to estimate the slope of the fixed cost curves (*C*) that we describe in Section II above. With this information, we can determine whether or not, on average, areas with higher average costs are disproportionately and negatively affected by network neutrality rules (or any other regulatory mandate).

A. *Data*

To conduct the empirical analysis, we first collected the CBG loop cost estimates (*L*) for a large number of local exchange carriers using the HAI cost model.[11] Our sample was constructed by choosing states randomly and including all carriers in the state with data available. The result of this procedure is significant diversity in geography and costs. In our sample, there are about 95 million access lines and about half of all CBGs are represented.[12]

Once the data is collected, we calculate a cost index (*u*) for each CBG by dividing the CBG loop cost by the sample mean loop cost. The distribution of *u* is an index that measures the *C* values illustrated in Figures 1 and 2, though in reality the distribution of costs is nonlinear rather than linear as illustrated in those figures. We then use the average of this index for each carrier in each state as a measure of relative costs across markets. For each market, we have an average cost index of $\bar{u}$ (or "u bar"). In summarizing our results, we will use this cost index ($\bar{u}$) as the descriptor of each carrier/market. If the cost index $\bar{u}$ is large, then the market is considered a "high cost" market, on average. If $\bar{u}$ is low, then the market is a relatively "low cost" market, on average. The mean of $\bar{u}$ is 1.00 and the $\bar{u}$ series has a range of 0.46 to 2.10, so we have in our sample a wide range of average costs.

B. *Results*

As we discuss in Section II above, to assess the impact of Network Neutrality regulations on different markets, our task is to measure and compare the deployment response to a particular cost change (what is Δh in response to ΔC?). To make this calculation, we must first compute h_U, which is equilibrium number

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11 HAI Cost Model Version 5.0, which was the last version of this model to provide nationwide estimates of costs. We use the HAI model because it provides cost estimates down to the CBG level, whereas the FCC's Synthesis Model results are provided at the Wire Center level only. The two models produce highly comparable estimates of relative loop costs, with the two series having a very high correlation coefficient. *See* PHOENIX CENTER POLICY BULLETIN NO. 9: *Federalism in Telecommunications Regulation: Effectiveness and Accuracy of State Commission Implementation of TELRIC in Local Telecoms Markets* (9 March 2004) (available at: http://www.phoenix-center.org/PCPB9Final.pdf. States included in the analysis are: AZ, CA, CO, FL, NY, GA, IA, LA, MD, MO, MS, MT, NC, NE, OH, SC, TX, VA, and WV.

12 In the 1990 Census, there were 229,466 Census Block Groups defined. Our sample includes 112,990 Census Block Groups.

of homes passed in the Unregulated environment in each market that we study. To make this calculation, we need to assume some value (*V*) for the network, and *V* must be on the same scale as our cost index $\bar{u}$ (with the mean of $\bar{u}$ being 1.00).

We initially set *V* equal to 1.6 and do so because it is this value that produces an average homes passed rate of 50% (with a homes passed penetration rate ranging from a minimum of 26% to a maximum of 62%).[13] Clearly, an average penetration of 50% (and maximum of 62%) is low when discussing broadband network deployment, but setting *V* equal to 1.6 allows us to establish a *lower* bound response differential to cost changes. As shown in sensitivity analysis, larger values of *V* only strengthen the relationship found at $V = 1.6$. Nothing prohibits considering values of *V* less then 1.6, except as *V* gets smaller the ratio of value to costs gets so small that the network is barely deployed even in an unregulated market.

After computing h_U for the 51 markets in our sample using these inputs, we then compute homes passed in the regulated environment (h_R) by raising the capital cost of deployment in all markets by the same small, fixed amount (ΔC) as we did in the conceptual analysis in the previous section. So that ΔC is constant across markets, we set ΔC equal to 5% of *V* (since *V* is equal across and constant in all markets) and then compute h_R. (This calculation again illustrates that changes in *C* can be equivalent to changes in *V*).

With both h_U and h_R computed, we can then determine whether or not there is any relationship between the change in household penetration (Δh, or the difference between h_U and h_R) and the average cost index ($\bar{u}$). Essentially, this comparison will determine whether high-cost (often rural) markets are more or less affected by network neutrality regulations than their low-cost counterparts. We define $\Delta h = h_U - h_R$, which is always a non-negative number (h_U will equal or exceed h_R in all circumstances).[14] Higher values of Δh imply larger percentage-point reductions in the homes passed rate in a given market.

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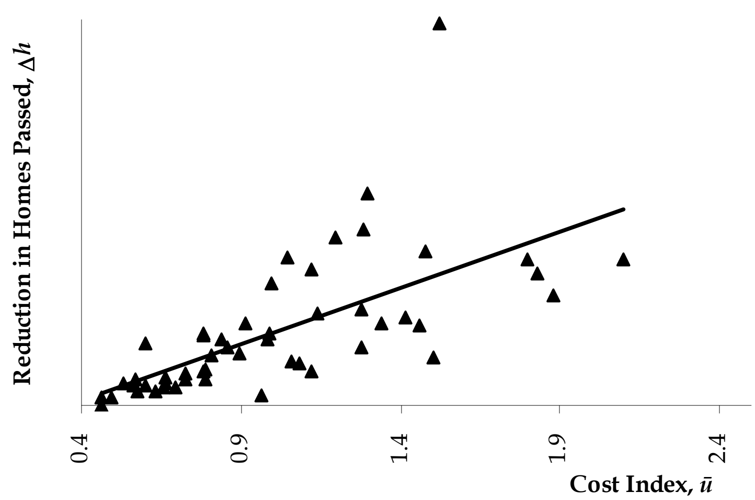
[13] This assumption implies that a network company would have gross margin of about $1.60 for $100 in network investment. Press stories indicate that AT&T is spending about $250 per line to upgrade to IPTV. At V = 1.6, this assumes that the additional margin from the upgrade will be only $4 per month, which is probably lower than that expected by AT&T. Thus, setting V = 1.6 is conservative.

[14] The calculation Δh could be zero, however, if the change leads to no reduction in homes passed because $V > u$ for all households with or without regulation.

We use three different tools of statistical analysis to examine the relationship between this change in penetration (Δh) and the index of average costs ($\bar{u}$). First, Figure 5 provides the scatter plot and linear fit of the relationship between Δh and $\bar{u}$. As shown in the figure, it is typically the case that the higher are average costs in a market ($\bar{u}$), the larger is the reduction in network deployment. Thus, there is reason to believe that network neutrality regulations will disproportionately harm high-cost, rural areas.

Figure 5. Network Neutrality and Service Reduction



A second way to analyze this relationship is to compute the simple correlation coefficient between Δh and $\bar{u}$.[15] The correlation coefficient has values between -1 and 1. If the correlation coefficient is zero, then the two variables exhibit no linear relationship. As the correlation coefficient gets closer to 1 or -1, however, the two series exhibit strong positive or negative correlation. The computed correlation coefficient between the two series Δh and $\bar{u}$ is 0.66, which indicates a strong positive linear correlation. The correlation coefficient thus indicates that there is a high linear correlation between the reduction in network deployment and average costs of network, and confirms that network

[15] For an intuitive and thorough description of the correlation coefficient, *see* http://en.wikipedia.org/wiki/Correlation_coefficient.

deployment is typically (though not always) reduced more in high-cost, rural areas.

Our findings of a strong relationship between Δh and $\bar{u}$ are again confirmed by using least squares regression. The trend line in Figure 5 is based on least squares regression

$$\Delta h = \beta_0 + \beta_1 \overline{u} + \varepsilon, \qquad (1)$$

where the β are estimated parameters and ε is the disturbance term. As shown in Figure 5, the slope of the line estimated for this data is positive ($\beta_1 > 0$), indicating disproportionate harm in high-cost, rural areas from Network Neutrality regulations. The slope coefficient is statistically different from zero at better than the 1% level (t-stat = 6.12).

C. *The "Relative Burden" Index*

Our results establish that there is a strong relationship between the change in network penetration caused by a regulatory mandate and the average network cost index of a market. In other words, we can say that a regulatory mandate that increases the costs of building a broadband network will disproportionately and adversely affect broadband deployment in high-cost areas. It should not be a surprise to policymakers that an increase in network costs will decrease network deployment; what might be a surprise is the extent to which these increases costs will disproportionately affect high-cost areas, even if the costs of complying with the regulatory mandate do not vary by geography.

Finding that high-cost areas will be disproportionately affected is important enough in itself, but "by how much" is an inevitable follow-up question to this conclusion. It is possible to provide a rough estimate the extent of this disproportionate impact on rural, high-cost areas. Our estimate of disproportionate impact, which we call the "relative burden index," is intuitive from a policy perspective. The availability of broadband service in all areas of the country is a national policy goal, so it would be reasonable to assume that policymakers would want their policies to apply with equal impact across markets. That is, if policymakers choose to impose a regulatory mandate that results in lower broadband penetration, then rural markets should not be burdened with more than their "fair share" of that burden. Stated differently, the probability that a household does not have access to a modern broadband network due to network neutrality regulations should be equal in high- and low-cost areas.[16] By comparing these probabilities across markets, we can generate a meaningful measure of disparity.

The results we calculate above can be used to compute this "relative burden index." To compute this relative burden index, we first compute the share of total homes in the sample for (particular definitions of) low-cost markets ($\bar{u} \leq 0.75$) and high-cost markets ($\bar{u} \geq 1.25$), which are labeled N_{HC} and N_{LC} (where subscripts "*HC*" and "*LC*" indicate high cost or low cost). Then, we compute the share of total homes passed lost to regulation for the high-cost and low-cost markets, which we label L_{HC} and L_{LC}. The index of relative burden is

$$BURDEN = \frac{L_{HC} / N_{HC}}{L_{LC} / N_{LC}}. \tag{2}$$

The index *BURDEN* has an intuitive interpretation. If $BURDEN = 4.0$, for example, then high-cost markets bear four-times the burden from network neutrality regulations as do low-cost markets in terms of the reduction in homes passed. Put another way, if the index is 4.0, then a home in a high-cost market is four-times more likely not to have access to the network than if the home was in a low-cost market based on the imposition of network neutrality mandates. An index of 4.0 would be found, for example, if the percentage of total homes in high-cost markets is 10% and in low-cost markets is 40%, yet the high-cost and low-cost markets each contain 20% of the homes not passed due to network neutrality regulations [= (0.2/0.1)/(0.2/0.4)]. Thus, high-cost markets have 20% of the homes lost to regulation but only 10% of the homes, whereas the low-cost markets have only 20% of the homes lost to regulation but 40% of total homes. The impact in high-cost markets is, then, four times larger than low-cost markets.

Our calculations above permit us to calculate *BURDEN* for the network neutrality mandate as follows:

$$BURDEN = \frac{L_{HC} / N_{HC}}{L_{LC} / N_{LC}} = \frac{0.227 / 0.068}{0.382 / 0.722} = 6.31 .$$

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16 This statement is true regardless of the initial level of homes passed, since the percentage change in homes passed is computed using total homes.

Thus, network neutrality regulation burdens high-cost markets more than low-cost markets by a factor of 6.31. Moreover, *BURDEN* rises if we use more extreme definitions of "low" and "high" cost. If we define high-cost markets as those with $\bar{u} \geq 1.5$ (markets with average cost more than 50% of the mean) and reduce the low-cost market boundary to $\bar{u} \leq 0.50$ (markets with average cost only 50% of the mean), then *BURDEN* = 16.93. *BURDEN* is consistently above 1.00 for any sensible definition of low- and high-cost. Even if we define low- and high-cost as being below or above the mean cost, then *BURDEN* = 4.47.

The disparate burden that a network neutrality mandate would impose on high-cost markets is substantial. Even though the costs of complying with a regulatory mandate may not vary by geography, broadband deployment in high-cost areas will be disproportionately affected by that mandate. The disparate burden increases significantly in even high-cost markets.

D. *Sensitivity Analysis*

We have made a number of assumptions in our analysis, but our findings are robust to alternative assumptions.[17] One area where a sensitivity analysis is particularly warranted is the estimated value of a household in terms of gross profits, which form the basis for the *V* curve. In Table 1, we present five different values of *V* (including 1.6) to evaluate the role the selection of *V* plays in our findings. As revealed in the table, the disproportionate harm to high-cost areas rises as *V* rises.[18]

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[17] As long as the actual *C* curve for deployment is proportional to our variable *u*, the disproportionate impact on rural areas remains, though its size may differ.

[18] Of course, as *V* gets smaller than 1.6, the relatively harm declines. When *V* is 0.8, the effect across markets is roughly equal (and inverted for values below 0.8). However, at *V* = 0.8, the average penetration of the service is only 34%, and as low as 12% in high-cost areas. It is little surprise that the deployment effect becomes small in high-cost areas when deployment is almost non-existent even in the unregulated state. As a technical matter, the relationship of *V* to Δh suggests that low-cost markets typically have very flat *C* curves in the lower cost segments of their markets with sharply rising C curves as penetration approaches 100%. In contrast, the C curves of high-cost markets typically rise even in the lower cost areas but do not rise very steeply as penetration approaches 100%.

Table 1. Sensitivity Analysis

V	Correlation Coefficient	t-stat(β_1)	Relative Burden (*BURDEN*)
1.6	0.66	6.12*	6.31
1.8	0.68	6.41*	6.08
2.0	0.68	6.42*	7.66
2.2	0.83	10.28*	8.93
2.4	0.82	10.06*	9.37

* Statistically different from zero at the 5% level or better.

One interpretation of the rising burden in *V* is that the more valuable the service (or, the higher the penetration in an unregulated environment), the greater will be the relative harm to high-cost markets for some given cost change. Since broadband is considered to a high-value service (indeed, the triple play is a $100+ bundle of services), our analysis suggests that the impact on high-cost areas from network neutrality regulations could be substantial.

E. *Caveats*

As with any theoretical or empirical analysis, the conclusions reported here are based in large part on the underlying assumptions of the model. We have assumed that the cost of deploying a modern broadband network is correlated with the forward-looking cost of deploying telephone network. We believe this assumption is reasonable, particularly in the case of fiber deployment. It is certainly possible to imagine networks (particularly hypothetical networks) which do not exhibit the expected cost properties with respect to household density, and in such cases our findings may change. Nevertheless, under the plausible framework we have set forth here, the results are robust.

IV. Conclusion

Increasing the costs of building or operating a broadband network by a regulatory mandate unquestionably will result in lower broadband network construction across the board. But our analysis shows that this decline in construction will not be evenly spread across the country as a whole—in fact, deployment in high-cost areas will be harmed disproportionately by any such cost-increasing mandate.

Using publicly available data and cost models, we show in this POLICY PAPER that a regulatory mandate like network neutrality could result in at least a six-fold relative reduction in broadband deployment in high-cost rural areas than in low-cost urban areas (under plausible conditions). In a very real way, the burden that a network neutrality mandate would create would be disproportionately (but not exclusively) borne on the back of rural America. These findings give credence to arguments raised by the National Grange, which has warned that network neutrality mandates could "seriously delay the benefits of new broadband deployment" in rural communities.[19]

Understanding the impact that public policy will have on broadband deployment is of crucial importance. The goal of universal broadband service has been called the "primary challenge" of the nation's telecommunications policy. Given that overarching goal, it is therefore appropriate to examine closely a public policy like network neutrality that will disproportionately and adversely affect broadband deployment in rural areas before we rush to pass legislation. We encourage further research on this important topic.

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19 National Grange, *Rural Public Interest Group Concerned About Net Neutrality Debate in Light of Congressional Hearing*, (May 25, 2006) (available at: http://www.nationalgrange.org/PressRoom/pr/2006/Neutrality.htm).

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Phoenix Center Policy Paper Number 28:

Network Neutrality and Foreclosing Market Exchange: A Transaction Cost Analysis

George S. Ford, PhD
Thomas M. Koutsky, Esq.
Lawrence J. Spiwak, Esq.

(March 2007)

Phoenix Center Policy Paper No. 28

Network Neutrality and Foreclosing Market Exchange: A Transaction Cost Analysis

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Abstract: In this POLICY PAPER, we analyze the effects of "network neutrality" proposals that seek to mandate an inflexible set of rules that would foreclose or severely limit many market transactions. Our model reveals that under plausible conditions, rules that prohibit efficient commercial transactions between content and broadband service providers could, in fact, be bad for *all* participants: consumers would pay higher prices, the profits of the broadband service provider would decline, and the sales of Internet content providers would also decline. Moreover, rules that prohibit the market from contracting efficiently may shift sales from content providers to the broadband provider's content affiliate, a result entirely inconsistent with the stated desire of network neutrality proponents. As the model shows, these unintended consequences of such network neutrality rules are the result of shifting costs to consumers that are more efficiently borne in the exchange between content and broadband providers. While proponents of such regulation may view it as protection from alleged anticompetitive behavior by broadband service providers, such proposals also eliminate the potential for efficient, voluntary, welfare-improving market transactions.

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‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies. The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center, its Adjunct Fellows, or any of its individual Editorial Advisory Board members. As always, we are indebted to Randy Beard, Adjunct Fellow, for his assistance on earlier drafts of the paper.

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I. Introduction

New Internet applications, in particularly streaming video, are creating a rapid and explosive growth in the bandwidth demands on the Internet, and ensuring that firms build, operate and maintain adequate Internet infrastructure to meet this challenge is perhaps the central challenge of telecommunications policy today.[1] Since, in the United States, local broadband networks and the Internet backbones are built, operated and maintained by the private sector, satisfying the growing demands of consumers is the responsibility of broadband and content firms. And, like any other private enterprise, decisions about allocating societal resources to these endeavors is trusted to market forces, the essence of which is the pricing mechanism. Relying on market forces for the development of the Internet was the result of a conscious decision by policymakers in the early 1990s when the Internet was privatized: policymakers knew that commercial demands upon the Internet would flood the largely publicly-financed and procured Internet backbone, and these policymakers decided to entrust network infrastructure decisions and, importantly, network

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[1] *See, e.g.*, REUTERS, *Google and Cable Firms Warn of Risks from Web TV* (Feb. 7, 2007); Bret Swanson, *The Coming Exaflood*, WALL STREET JOURNAL (Jan. 20, 2007; Page A11); Phil Kerpen, *Information Super Traffic Jam*, FORBES.COM (Jan. 31, 2007).

access pricing and peering policies, to the free market.[2] As a result, network operators, content providers, and consumers are today free to contract with one another over the price, terms and quality of the services they obtain and provide over the Internet.

But now many policymakers and commentators, under the guise of "network neutrality" legislation, want to change course and regulate these commercial interactions directly by imposing a rigid pricing structure on Internet services. Far from being "neutral," these proposals would instead mandate an inflexible and potentially harmful set of rules that would govern all market transactions for Internet services in a way that would severely limit the scope of some market transactions and foreclose others altogether.

For example, the Internet Freedom Preservation Act introduced in the 110th Congress would prohibit broadband service providers from charging Internet content and application providers for specialized bandwidth prioritization services that might be necessary to provide high-quality video or voice multimedia applications to consumers.[3] In this proposed legislation, a broadband service provider could only charge its consumers directly for these types of network improvements, and even then only through tiers of "defined levels of bandwidth" or rates that reflect only "the actual quantity of data flow over a user's connection."[4] This legislative proposal would virtually eliminate the flexibility of content providers, broadband service providers, and consumers from entering into voluntary, welfare-enhancing agreements that are prevalent in other areas of the communications industry.

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2 Even in 1995, economists Jeffrey K. MacKie-Mason and Hal R. Varian noted that "with growing demand for multimedia, we need to think about how to allocate multiple service qualities in an integrated network. . . The multimedia genie is out of the bottle. . . . [T]he Internet is going to have to find new ways to allocate bandwidth." Noting that "[d]ifferent kinds of traffic requires different treatment from the network," MacKie-Mason and Varian proposed that private industry have the freedom to price bandwidth on a dynamic basis so that bandwidth be allocated properly and that network firms would continue to invest in sufficient infrastructure. *See* J. K. MacKie-Mason and H. R. Varian, *Some FAQs about Usage-Based Pricing*, 28 COMPUTER NETWORKS AND ISDN SYSTEMS 257 (1995), *also printed in* JOURNAL OF ELECTRONIC PUBLISHING (2004) (available at: http://www.press.umich.edu/jep/works/mackiemason.usage.html).

3 Internet Freedom Preservation Act, S. 215, 110th Cong. (2007).

4 *Id.* at § 2.

In this PAPER, we explore the potential impact that imposing this type of regulatory structure on the Internet would have on content providers, broadband service providers, and consumers. We show that to the extent these proposals alter the behavior of firms and consumers, network and service enhancements by a broadband service provider suitable to support particular Internet content and applications would become even more costly. Our analysis borrows concepts from the field of transaction cost economics to demonstrate the impact that such a policy would have on the pricing of Internet content and broadband services. We show that, under simple and plausible conditions, prohibiting commercial transactions between content and broadband service providers could be bad for *all* participants: consumers would pay higher prices, the profits of the broadband service provider would decline, and the sales of Internet content providers (like Google and Amazon.com) would also decline. In fact, rules that prohibit the market from contracting efficiently may shift sales from content providers to the broadband provider's content affiliate, a result entirely inconsistent with the stated desired of network neutrality proponents. While proponents of such rules may view them as protection from anticompetitive behavior by broadband service providers, such proposals also eliminate the potential for efficient, voluntary, welfare-improving market transactions.

We stress that this PAPER is neither a general treatment nor condemnation of network neutrality regulation. Presumably, the purpose of Internet regulation is to improve—not to reduce—economic performance. Nevertheless, regulation often has unintended consequences, and the role of this PAPER is to reveal the potential defects in an outright prohibition on market exchange. Hopefully, our analysis raises the level of the Internet regulation debate in order to focus it on the *actual effects* that governmental intervention would have on market performance.

II. Conceptual Analysis

The Internet is often described as a "layered" network—content providers stand at the "top" and consumers at the "bottom," while networks are poised in the "middle," serving as the intermediary, conduit, or platform through which content is provided to consumers. Like any other private sector endeavor, neither the content provider nor the broadband network firm offers its services for free—both classes of firms seek to earn a profit via prices for the services they offer. As exhibited in Figure 1, in this stylized construction, many different market transactions might take place: between the consumer and the broadband network provider, between the consumer and content provider, between the content provider and the broadband network, between consumers and consumers, and so forth.

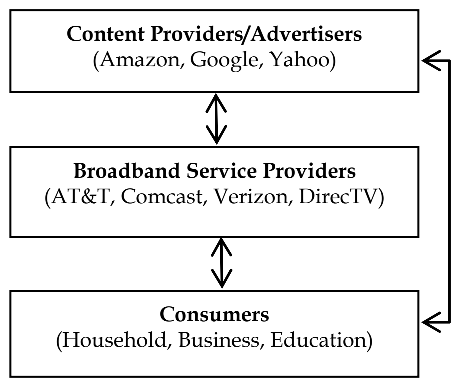

Figure 1. Transactions in the Layered Internet

While services generally flow from the "top" of the figure to consumers at the bottom, dollars do not necessarily flow from the "bottom" straight to the "top."[5] Payments for services rendered can be made in a whole variety of ways. Consumers purchase broadband access, and in some cases related services (virus protection, website hosting, and so forth), from broadband service providers. Consumers also purchase services from content providers including subscription services, banking services, books, medicines, and nearly any other product or service imaginable. At the same time, for many content firms, the Internet is their major means of delivering product to their customers. Through services like auction sites and classifieds, thousands of consumer-to-consumer transactions occur daily. As a result, content providers routinely purchase services from Internet backbone service providers, including interconnection and transit services.

From the perspective of economic theory, much can be learned about the past, present, and future nature of these transactions from concepts like

[5] We include advertisers in the group of content providers because, to a consumer, advertising is essentially content on a web page or service that subsidizes the provision of other content to consumers. Consumers pay for this content with their eyeballs.

transaction cost economics and the relatively new theory of multi-sided markets. Transaction cost economics was developed largely to explain why and when particular types of market exchange would predominate in different industries. A core hypothesis of transaction cost economics is that firms will individually and collectively seek out relationships that on the whole minimize transaction costs (in an effort to maximize profits).[6] Transaction cost economics plays an important role in modern economic policy. As observed by Mayo and Kaserman,

> The basic insight [of transaction cost economics] that observed firm behavior can often be explained in terms of attempts to reduce the costs of conducting market exchange has been an important factor in improving our public policy toward business over the past two decades, particularly in the field of antitrust. Market activities that were previously viewed with considerable suspicion or even outright hostility (for example, vertical integration, tying arrangements, and territorial restrictions) have gradually come to receive more hospitable treatment as our understanding of the efficiency motives behind these activities has improved. Allowing firms to pursue actions that reduce costs (whether they are costs of producing products or costs of conducting exchange) enhances overall economic performance.[7]

Transaction cost economics can be used to explain a variety of phenomenon, from the organization of firms, to the way contracts are written, and the very way goods and services are priced.

Multi-sided markets theory explores the industry structure and pricing behavior in markets in which particular "platforms" have different sets of consumers that wish to engage in transactions. The core insight of multi-sided markets theory is that the value of a platform depends on the number of participants on both sides of the platform. The primary contribution of the

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[6] The classics in this area of economics include O. E. Williamson, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985) and R. Coase, *The Nature of the Firm*, 4 ECONOMICA 386-405 (1937).

[7] J. Mayo and D. Kaserman, GOVERNMENT AND BUSINESS (1995) at 28.

theory thus far is to point out the sometimes complex pricing problems faced by intermediaries attempting to gather participants on both sides of the platform.[8]

From a policy perspective, the key insight of multi-sided market analysis is that pricing schemes in these "platform" industries can be highly complicated and even surprising.[9] The pricing schemes used to recover the costs of building and operating a "platform," such as broadband service, may include prices to some or all sets of customers of the platform.[10] The economics of such multi-sided markets indicates that pricing schemes are often complex and varied, and, importantly, that common notions of equity or fairness might actually be inefficient and costly to maintain. For example, in multi-sided markets, optimal individual price components may not be cost-based, below-cost pricing need not be predatory, and competition does not necessarily force prices to cost.[11]

Because network neutrality rules essentially seek to regulate these vertical commercial relationships between content firms and broadband providers, it is important to examine how those rules would impact the ultimate provision of goods and services at each level (or "side") of the industry. Particularly important to the network neutrality debate is that a high price on one side of the market generally requires a low price on the other side, since attracting members to the other side becomes more profitable. Thus, a positive price to content may allow for a reduction in price to consumers, thereby increasing broadband

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[8] For a readable survey of many of the insights of two-sided markets, *see* J. Wright, *One-Sided Logic in Two-Sided Markets*, 3 THE REVIEW OF NETWORK ECONOMICS 42-63 (2004); *see also* J. Rochet and J. Tirole, *Platform Competition in Two-Sided Markets*, 1 JOURNAL OF THE EUROPEAN ECONOMIC ASSOCIATION 990-1026 (2003); M. Armstrong, *Competition in Two-Sided Markets*, RAND JOURNAL OF ECONOMICS (Forthcoming); D. S. Evans, *The Antitrust Economics of Two-sided Markets*, AEI-Brookings Joint Center for Regulatory Studies, Related Publication 02-13 (Sep. 2002); J. Rochet and J. Tirole, *Two-Sided Markets: A Progress Report* (Nov. 2005) (available at: http://idei.fr/doc/wp/2005/2sided_markets.pdf).

[9] Useful examples including dating services (women and men), credit cards (stores and consumers), television networks (advertisers and viewers) and videogame platforms (games and users). The pricing schemes vary widely across these markets.

[10] For an Internet-related discussion of two-sided markets, *see,* e.g., R. W. Hahn and S. Wallsten, *The Economics of Net Neutrality*. AEI-BROOKINGS JOINT CENTER WORKING PAPER, Related Publication 06-13 (2006).

[11] *Id*.

subscription.[12] Put very simply, if a content or broadband provider's advertising price is a function of its number of its subscribers, then it may make sense to lower the price to subscribers to attract more of them.

Many proposals to regulate the Internet actually attempt to effectively foreclose potentially efficiency-enhancing market transactions—i.e., those between the content provider and broadband service provider.[13] By preventing market exchanges between these two entities, policymakers would effectively force the broadband service provider to charge only consumers for the services it provides, even if those transactions are far more inefficient than transactions between content and network providers. Effectively barring one form of market exchange between content providers and broadband service providers is not dissimilar from prohibiting cable television operators from accepting payments from content providers or advertisers, as doing so would no doubt lead to higher consumer cable rates, less content, and possibly less-efficient industry structure.

One can understand how such rules would increase transactions costs if one considers the impact they might have if applied to another industry, such as the sale of books by online retailer Amazon.com. As discussed above, because firms and consumers will act in order to minimize transaction costs, certain ancillary yet important services (like shipping a book form Amazon.com via UPS) are often bundled with the sale of a final product because it is more *efficient* for those services to be procured by the firm selling the product rather than obtained individually by the consumer. While the average consumer may make a handful of on-line purchases a month, Amazon.com no doubt has warehouses with pre-existing bulk shipping arrangements with shippers like the U.S. Postal Service or UPS because it ships thousands of packages a day. Society is better off because when Amazon.com offers its customers shipping, it is far more efficient for

12 Rochet and Tirole, *Two-Sided Markets: A Progress Report, supra* n. 8 at 25 ("A factor that is conducive to high price on one side, to the extent that it raises the platform's margin on that side, tends also to call for a low price on the other side as attracting members on that other side becomes more profitable").

13 *See* Internet Freedom Preservation Act, *supra* note 3. Similar legislation was proposed in the 109th Congress. *See* Internet Freedom Preservation Act, S. 2917, 109th Cong., § 2 (2006); Network Neutrality Act of 1996, H.R. 5273, 109th Cong. §§4(a)(6), (a)(7) (prohibiting "surcharges" based on content and prohibiting any "surcharge or other consideration" for "prioritization or quality of service"); Internet Non-Discrimination Act of 2006, S. 2360, §4(a)(3) (prohibiting broadband service operator from "access[ing] a charge to any application or service provider not on the network of such operator for the delivery of traffic to any subscriber to the network of such operator").

Amazon.com to bundle shipping with its book sales than to force consumers to contract directly for shipping with the Post Office or UPS for each and every purchase. It is also economically desirable for Amazon.com to offer more than simply the most basic parcel post shipping option itself, rather than forcing customers to coordinate outside shipping arrangements between shipping firms and Amazon.com if "next day" shipment is desired. Similarly, a firm that is in the business of streaming video to consumers is likely to be in a far better position to understand, plan for and ultimately procure special broadband network services necessary to deliver a video program to a consumer, who simply may want to push a button on a remote control and watch a baseball game.

One can begin to see similar types of arrangements emerging for bandwidth-intensive Internet applications like streaming video (though not in the way most content providers fear). Most notably, ESPN is offering its online video "ESPN360" product only to customers of broadband service providers *who pay ESPN to distribute this content*.[14] The popular social networking site Facebook has struck a deal with Comcast to make video "Facebook Diaries" available on Comcast's Ziddio website and Comcast On-Demand customers.[15] Even firms with similar products are experimenting with different models of providing online broadband content. For example, Major League Baseball currently charges customers directly for online streaming of out-of-market baseball games, a service that costs $89.95 for the full season which also includes searchable video and condensed games. In contrast, the National Hockey League as an exclusive relationship with Comcast so that Comcast Hi-Speed customers can watch online streams of National Hockey League games for free.[16] These different models of delivering bandwidth-intensive content to subscribers may or may not be commercially sustainable, but it is clear that firms are certainly experimenting with different business models.

In this environment, it dangerous to assume that one particular method of delivering and paying for these services is the "correct" one and foreclose all

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14 S. Nassauer, "*ESPN Charges Net Providers for Right to Offer Broadband Web Site*, WALL STREET JOURNAL (Aug. 1, 2006).

15 REUTERS, *Facebook Moves into TV with Comcast's Ziddio*, (Feb. 6, 2007) (available at: http://today.reuters.com/news/articleinvesting.aspx?view=CN&storyID=2007-02-07T013402Z_01_N06266968_RTRIDST_0_COMCAST-FACEBOOK.XML&rpc=66&type=qcna).

16 M. Reardon, *Comcast to Stream NHL Games*, CNET.COM NEWS (Oct. 5, 2005).

others. As we show below, foreclosing upstream content providers from directly contracting with broadband network firms to deliver their products could have an impact upon the price and availability of new online services and applications. If rules analogous to some "network neutrality" proposals were imposed on Amazon.com's book sales, then the Postal Service, UPS (and other shippers) would be prohibited from negotiating that bulk arrangement with Amazon.com.[17] Instead, every customer that wanted to purchase a book from Amazon.com would need to contact a shipper separately and apart from that purchase to arrange for shipping.[18] Seen in this light, it does not take long to understand how foreclosing or limiting content provider-broadband provider contracts could throw sand into the gears of online commerce.

In this PAPER, we consider the effect of these limitations on exchange by using a simple transaction cost framework. More specifically, we contemplate the role of transaction costs for a service provided by a broadband service provider that can be "ordered" by either consumers *or* content providers, but where the transaction costs are not identical. In this setting, impeding commercial transactions on one side of the market could lead to undesirable outcomes both "upstream" and "downstream." Even in the absence of transaction costs, however, overall economic efficiency and market performance could be negatively impacted by a rule that forecloses market exchange. While we focus on transaction cost economics here, we suspect that other theoretical treatments may provide additional insights outside the scope of our model.

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[17] Such bulk shipping arrangements can have substantial value to consumers. For example, in 2005, Amazon.com boasted that because of "Amazon.com, UPS and the U.S. Postal Service practicing a little wizardry of their own," Amazon.com was able to ship copies of HARRY POTTER AND THE HALF-BLOOD PRINCE for delivery to customers on the book's July 16, 2006 launch date, a service that included guaranteed Saturday delivery for the same price as standard shipping. Interestingly, Amazon.com only undertook this "wizardry" for purchases through selected outlets—orders for the book placed through "third-party seller arrangements" did not receive the same treatment. BUSINESSWIRE, *Amazon Receives An Unprecedented 1.5 Million Advance Orders for "Harry Potter and the Half-Blood Prince at Its Web Site Worldwide; Executed Largest Single-Product Delivery Event in Company's History* (Jul. 16, 2005).

[18] This option may allow the consumer to pick which shipper it prefers, rather than use the shipper chosen by Amazon.com, but few would argue that prohibiting Amazon.com from arranging its own shipping services (and thus obtaining better prices) is good policy. Indeed, Amazon.com currently subsidizes shipping to its customers—in 2005, it spent $239 million more on shipping its products than it charged consumers for that service, approximately 2.8% of its net sales. Amazon.com, Inc., SEC Form 10-K (Feb. 17, 2006) at 35.

III. Theoretical Model

In the theoretical analysis that follows, we present an economic model which shows that imposing this type of arrangements on the Internet could be bad for all participants under plausible circumstances; the profits of the broadband provider decline (and, consequently, investment in the network), the sales of the content providers decline (and, given the cost structure of content, the number of providers), and consumers pay higher prices.

A. *Basic Setup*

Our theoretical model has the following basic setup. We assume that the market consists of a sector of application and content providers (*A)*, a broadband network provider (*B*), and a large number of consumers (*N)*. For modeling convenience alone, we assume that there is a monopoly broadband service provider. While we recognize this assumption is not an accurate reflection of the broadband market, we note that had we allowed for competition among broadband providers in our model our general findings would not be altered. We further assume that all customers of the content provided by sector *A* must buy broadband access (service *X*) from *B* at price P_X. Customers with broadband access can then purchase an additional service *S* (say, a sporting event in high-definition) from either *A* or *B*. Purchasing service *S* requires the broadband network provider *B* to modify its network in some way to accommodate the delivery of the service (such as traffic prioritization or some other form of caching or dynamic bandwidth adjustment). This upgrade service is denoted with the letter *Z*.

Each of the services involved—broadband access (*X*), the content service (*S*), and the network upgrade needed to deliver the content to the consumer (*Z*)—have a cost, and those costs are represented in our model by C_X, C_S, and C_Z. Because we are most interested in the impact of transaction costs on the equilibrium, we assume that the cost of the content service (C_S) is the same regardless of whether the service is provided by the upstream content provider *A* or the broadband firm *B*.

Finally, we represent the transaction cost that the consumer incurs in contacting either firm about acquiring service as *t*, and we assume that these costs are the same regardless as to whether the consumer must contact the broadband firm or the content firm. This assumption is not critical as long as entering into more contacts is in general more costly than administering fewer contacts.

On the demand side, there are three demand curves: (1) the demand for access X; (2) the demand for service S sold by the broadband network firm B; and (3) the demand for service S sold by the content firm A. The demand for Z (the network upgrade) is purely derived from the demand for S (that is, each unit of S requires one unit of Z and Z has no utility value of itself). Demand, of course, depends on the full price of purchase, and the full price is the money price of the service plus the transaction cost. The relevant money prices for our analysis include:

P_X = money price for service X purchased from firm B (broadband access);

P_S^A = money price of service S purchased from a firm in content sector A;

P_S^B = money price of service S purchased from firm B;

P_Z^A = money price charged to sector A for upgrade Z;[19]

P_Z^N = money price charged N for upgrade Z.

Initially, and for simplicity, assume that sector A sets the price for its service at marginal cost.[20] We denote full prices (money price plus transaction costs) using the carat ("^") symbol, so that $\hat{P}_S^A$ is the full price of service S from firm A. Sservice S cannot be purchased without service B. We assume, for simplicity, that $\hat{P}_X = P_X$ (this does not affect the analysis).

The three demand curves are

$$Q_X(\hat{P}_S^A, \hat{P}_S^B, P_X); \quad (1)$$

$$Q_S^A(\hat{P}_S^A, \hat{P}_S^B, P_X); \quad (2)$$

$$Q_S^B(\hat{P}_S^A, \hat{P}_S^B, P_X); \quad (3)$$

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[19] This price is then passed through to their customers on a 1:1 basis, since the upstream is competitive.

[20] We discuss the impact of relaxing this assumption (by allowing a markup) later in the text.

where we assume: (a) higher broadband prices reduce all quantities sold ($\partial Q_i^f / \partial P_X < 0$) where *f* is either *A* or *B*, and since there are only two then –*f* represents "not *f*"; (b) the demand curves for *S* slope downward ($\partial Q_S^f / \partial P_S^f < 0$); (c) and *A* and *B* are competitors ($\partial Q_S^f / \partial P_S^{-f} > 0$). These assumptions are not controversial.

B. *Determination of Full Prices With and Without Net Neutrality*

In our analysis, we wish to evaluate the implications of a network neutrality rule that blocks direct exchange between the application and content provider *A* and the broadband provider *B*. Thus, if the consumer wants to purchase a movie (service *S)* from *A* that requires a network upgrade (*Z*), then it is the consumer that must contact the broadband service provider *B* to request the necessary network upgrade *Z*. As described above, requiring the consumer to make two contacts to purchase *S* is an element of some Internet regulatory proposals that foreclose content and broadband providers from voluntary contractual agreements. Without the network neutrality rule, the content firm *A* can contact *B* directly to arrange for this upgrade. We assume that $P_S^A = C_S$ and that there is no transaction costs for *A* to contact *B* for the upgrade.[21] On the other hand, under network neutrality regulation, the consumer incurs transaction cost *t* to contact *B* if the consumer wants to purchase *S* from *A*. An example of this type of transaction would be a consumer requiring a short-term bandwidth expansion in order to watch a particular sporting event in high definition format and in real time. Thus, the effect of network neutrality regulation is to impose an additional cost of *t* that no one collects from the customer who buys service *S* from *A*.

We assume in this analysis that the transaction cost of a consumer contacting the broadband provider exceeds that of the content provider contacting the broadband provider. In the absence of any Internet regulations that preclude voluntary transactions on one side of the market, consumers, the broadband provider, and content providers will engage in transactions that minimize transaction costs. As a result, the contract foreclosure is only relevant to the extent it changes the patterns of behavior. Prohibitions or limitations on particular transactions only matter when such transactions are more efficient.

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21 Alternately, we could normalize the transaction cost for *A* contacting *B* to zero, but the notation is simplified by our choice. This assumption has no meaningful effect on the results as long as transactions costs for *N* are greater than those for *A*.

Our goal in this PAPER is to examine the impact this increase would have upon consumers, content providers, and broadband service providers, when an efficient transaction is precluded or limited by law on one side of a multi-sided market.

Without regulation, the full price of purchasing *S* from firm *B*, given *X*, is:

$$\hat{P}_S^B = P_Z^N + P_S^B + t \tag{4}$$

where the full price is the price of the upgrade *Z*, the price of the service *S*, and the transaction cost of the order *t*. The full price to purchase from *A* is:

$$\hat{P}_S^A = P_S^A + t = C_S + P_Z^A + t\,. \tag{5}$$

In the presence of regulation, the full price of purchasing *S* from firm *B* is:

$$\hat{P}_S^B = P_Z^N + P_S^B + t \tag{6}$$

whereas the full price of purchasing from a firm in sector *A* is:

$$\hat{P}_S^A = P_S^A + P_Z^N + 2t = C_S + P_Z^N + 2t\,. \tag{7}$$

The difference between Equations (5) and (7) is that two transactions are required by the consumer to purchase *S* when there is regulation.

There are many prices in our model, and solving for all the optimal prices would be tedious. Fortunately, since we are only interested in the effects of Internet regulation, most of the effects of the regulation can be determined by evaluating the profit functions alone. Going forward, we assume that rather than choosing P_Z^N and P_S^B independently, let firm *B* just select P_Z^N and $P_S^B + P_Z^N$ (the latter being a "bundled" price for *S* and *Z*). So, we define P_S^B as $P_S^B + P_Z^N$ henceforth.

Given the setup above, we can write the profit function with Internet regulation ("*R*" for regulated) as

$$\begin{aligned}\pi_R = {} & Q_X(C_S + P_Z^N + 2t, P_S^B + t, P_X)(P_X - C_X) \\ & + Q_S^A(C_S + P_Z^N + 2t, P_S^B + t, P_X)(P_Z^N - C_Z) \\ & + Q_S^B(C_S + P_Z^N + 2t, P_S^B + t, P_X)(P_S^B - C_S - C_Z)\end{aligned} \tag{8}$$

and without Internet regulation ("U" for unregulated)

$$\begin{aligned}\pi_U = {} & Q_X(C_S + P_Z^A + t, P_S^B + t, P_X)(P_X - C_X) \\ & + Q_S^A(C_S + P_Z^A + t, P_S^B + t, P_X)(P_Z^A - C_Z) \\ & + Q_S^B(C_S + P_Z^A + t, P_S^B + t, P_X)(P_S^B - C_S - C_Z)\end{aligned} \tag{9}$$

where a symmetry with respect to P_Z^A and P_Z^N is apparent in Equations (8) and (9), a consequence of the pricing behavior of A. Again, note that in Equations (8) and (9) we defined P_S^B as $P_S^B + P_Z^N$.

Rewriting Equations (8) and (9) in terms of full prices, we have

$$\begin{aligned}\pi_R = {} & Q_X(\hat{P}_S^A, \hat{P}_S^B, P_X)(P_X - C_X) \\ & + Q_S^A(\hat{P}_S^A, \hat{P}_S^B, P_X)(\hat{P}_S^A - C_S - 2t - C_Z) \\ & + Q_S^B(\hat{P}_S^A, \hat{P}_S^B, P_X)(\hat{P}_S^B - C_S - t - C_Z)\end{aligned} \tag{8'}$$

and without network neutrality regulation

$$\begin{aligned}\pi_U = {} & Q_X(\hat{P}_S^A, \hat{P}_S^B, P_X)(P_X - C_X) \\ & + Q_S^A(\hat{P}_S^A, \hat{P}_S^B, P_X)(\hat{P}_S^A - C_S - t - C_Z) \\ & + Q_S^B(\hat{P}_S^A, \hat{P}_S^B, P_X)(\hat{P}_S^B - C_S - t - C_Z).\end{aligned} \tag{9'}$$

These profit expressions reveal all the results needed for our evaluation of Internet regulation of the type described here.

C. *Theoretical Results*

The profit expressions above allow us to make some general statements about the effects of a prohibition on contractual arrangements between broadband and content providers. We are particularly interested in three effects:

- First, how would such a mandate affect the profit of the broadband provider? If profits are lower, then one would reasonably expect that investment into the broadband network business would shrink as a result of that mandate.

- Second, how would this mandate affect the overall price of the online service *S* to consumers? This question is important because increasing the price for the new online service over what it could have been in a world without regulation affects both consumers (obviously) and the health of the content service industry as a whole. If a network neutrality mandate decreases the profits of broadband providers and increases the price of online services, then everybody loses—the broadband network firms, the content providers, and consumers.

- Third, we are interested in the price for broadband service itself. If prices rise, then broadband subscription will be lower than it would be without this type of Internet regulation.

We do not consider in the model any alleged benefits of foreclosure. Such benefits might include, for instance, the removal of any prospect or potential for discriminatory or anticompetitive behavior by the broadband service provider. However, we have not seen any cohesive or coherent model that estimates these benefits of foreclosing such transactions outside of unsupported assertions. As a result, while we do not rule out the possibility that the harms to efficiency that we discuss in this paper might be counterbalanced by these other benefits, policymakers should expect and demand a thorough accounting and quantification of those asserted benefits from Internet regulation.

1. *Broadband Provider Profits*

Our first question involves the relative profits of the broadband provider *B* across the two regulatory regimes. From Equations (8′) and (9′), it is easy to show that Internet regulation reduces the profits of firm *B*.

Theorem 1. Firm *B*'s profits are larger without than with Internet regulation $\left(\pi_U > \pi_R \;\; \forall \;\; \hat{P}_S^A, \hat{P}_S^B, P_X\right)$.

Proof. From Equation (8′) and (9′), we see that $\pi_U - \pi_R = t \cdot Q_S^A \geq 0$.

Thus, the model shows that Internet regulation as conceived in this model reduces the profits of the broadband provider. As a consequence, we might expect less investment in broadband infrastructure with Internet regulation of the type considered here, to the extent that regulation reduces the return on investments.

2. *Impact on Prices*

Next, we turn to the question of full prices across regulatory regimes. Let $\hat{P}_{S,U}^{A}$, $\hat{P}_{S,U}^{B}$, and $P_{X,U}$ be the full prices in the unregulated environment and let $\hat{P}_{S,R}^{A}$, $\hat{P}_{S,R}^{B}$, and $P_{X,R}$ be the full prices with Internet regulation. These prices will obviously differ, but the important issue is how they differ.

Theorem 2. If π_U and π_R are globally concave, then

$$\hat{P}_{S,U}^{A} < \hat{P}_{S,R}^{A}$$

$$\hat{P}_{S,U}^{B} > \hat{P}_{S,R}^{B}$$

$$P_{X,U} < P_{X,R} .$$

Proof. From Equation (8′) and (9′), we see that $\pi_R = \pi_U - t \cdot Q_S^A\left(\hat{P}_S^A, \hat{P}_S^B, P_X\right)$. At $\hat{P}_{S,R}^{A}$, we get

$$\frac{\partial \pi_R}{\partial \hat{P}_S^A} = \frac{\partial \pi_U}{\partial \hat{P}_S^A} - t\frac{\partial Q_S^A}{\partial \hat{P}_S^A} = 0 ,$$

implying

$$\frac{\partial \pi_U}{\partial \hat{P}_S^A} < 0 \;\; at \;\; \hat{P}_{S,R}^{A} ,$$

so that,

$$\hat{P}_{S,R}^{A} > \hat{P}_{S,U}^{A} .$$

Proofs for $\hat{P}_S^B$ and $\hat{P}_X$ follow the same logic.

3. *Summary*

We have the following results on prices: First, Internet regulation (of the sort envisioned here) would increase the full price for service *S* sold by firm *A*. Thus, the online content providers *A* will sell less of these services. Advocates of network neutrality routinely argue that their proposals will increase the supply of online services and applications.[22] This analysis shows that those arguments need not be correct: Internet regulation of the type found in S. 215 could work against content providers and actually dampen demand for their services *when its effect is to impose a transaction cost on consumers*. Since the content providers typically face very high fixed costs relative to marginal costs, a reduction in sales will reduce the number of content generating firms.[23] Second, Internet regulation reduces the full price for service *S* sold by firm *B*, thereby transferring purchases from unaffiliated content providers to the access provider. Obviously, this result conflicts with the purported goals of this type of Internet regulation and must be netted out of any alleged benefits of the regulation.

Finally, Internet regulation of this sort may increase the full price of broadband access and consequently reduce the amount of broadband purchased.[24] Importantly, this broadband access price increase will affect *all* broadband customers—not simply those that might be interested in purchasing new, bandwidth-intensive services. This impact is important because the consumption of broadband services declines as prices rise, so Internet regulation that has the effect modeled here could decrease the overall penetration of broadband subscriptions in the United States. Based on available information, even a relatively small price increase of 5% would reduce subscription by about 4 million households, reducing the rank of the United States from 12 to 14 among OECD countries.[25] Therefore, while leading network neutrality proponents

[22] J. Windhausen, Jr. *Good Fences Make Bad Broadband: Preserving an Open Internet through Net Neutrality,* PUBLIC KNOWLEDGE WHITE PAPER (Feb. 6, 2006) at 30-33 (available at: http://www.publicknowledge.org/pdf/pk-net-neutrality-whitep-20060206.pdf); Statement of Rep. Ed Markey, Voice on the Net Conference (Sep. 12, 2006) (available at: http://markey.house.gov/index.php?option=com_content&task=view&id=2116&Itemid=46) ("The question to ask is whether Larry Page and Sergey Brin could have afforded to pay circa 1998, whether Chief Yahoo Jerry Yang could have afforded to pay a broadband behemoth circa 1995, whether Marc Andreesen could have afforded to pay anyone, anything, circa 1994 when he was inventing the Mosaic browser, which later became Netscape.").

[23] G.S. Ford, T.M. Koutsky and L.J. Spiwak, *Competition after Unbundling: Entry, Industry Structure and Convergence,* PHOENIX CENTER POLICY PAPER NO. 21 (Jul. 2005), *and forthcoming* 59 FEDERAL COMMUNICATIONS BAR JOURNAL (Mar. 2007).

[24] In general, if t rises, then P_X falls, but the total effect is a higher full price. Proof is available upon request.

[25] According to June 2006 OECD data, the United States has 56.5 million broadband subscriptions. Econometric studies estimate the own-price demand elasticity for broadband service in the United States to be about -1.5. Thus, a 5% increase in the full price of broadband service will reduce the number of connections by about 4 million (assuming constant elasticity of

(Footnote Continued. . . .)

lament middling broadband subscription rate in the United States when compared to the rest of the world,[26] a prohibition or limitation on contractual agreements between content and broadband providers that increases prices may exacerbate that condition.

4. *Other Considerations and Caveats*

There are a few additional comments to be made on our analysis. In our model we assumed that the content market was competitive so that firms price their services at marginal/incremental cost. If the content market was imperfectly competitive—so that price exceeded marginal cost—then the broadband firm would have the usual incentive to vertically integrate to eliminate double marginalization. This action would be beneficial to consumers, however, since the goal of the downstream firm's action in response to double marginalization is to lower price in the upstream market.[27] Thus, the incentive to

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demand). Subtracting the 4 million from the 56.5 million subscribers, the reduction in subscribers would move the U.S. from 12th to 14th. For elasticity estimates, *see* P. Rappoport, D. J. Kridel, L. D. Taylor, J. Alleman, *Forecasting the Demand for Internet Services*, THE INTERNATIONAL HANDBOOK OF TELECOMMUNICATIONS ECONOMICS VOLUME II, G. Madden (ed.) (2002) and R. Crandall, J. Sidak, and H. Singer, *The Empirical Case Against Asymmetric Regulation of Broadband Internet Access*, 17 BERKELEY TECHNOLOGY LAW JOURNAL 953-987 (2002). Larger demand elasticities are reported by A. Goolsbee, *Subsidies, the Value of Broadband and Fixed Costs,* in R. Crandall and J. Alleman, eds., BROADBAND: SHOULD WE REGULATE HIGH-SPEED INTERNET ACCESS (2000) and H. Varian, *The Demand for Bandwidth: Evidence from the INDEX Project*, in R. Crandall and J. Alleman, eds., BROADBAND: SHOULD WE REGULATE HIGH-SPEED INTERNET ACCESS (2002). The 5% difference is chosen somewhat arbitrarily, but the effect of alternative price increases is easily computed.

[26] Testimony of FCC Commissioner Michael J. Copps, Hearing on Accessing the Communications Marketplace, Committee on Commerce, Science and Transportation, United States Senate (Feb. 1, 2007) (available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-270194A1.pdf) ("Right now, your country and mine is 21st in the world when it comes to broadband digital opportunity and that's according to the International Telecommunications Union. . . . Fewer Americans with broadband means a smaller Internet marketplace and a glass ceiling over the productivity of small businesses and entrepreneurs in too much of our great land.").

[27] "Double marginalization" is economically inefficient and its elimination is regarded as a public benefit of vertical integration. If an upstream market is not robustly competitive, then prices for that upstream product will be priced above cost. A downstream firm that is not vertically integrated would therefore be required to pay above-cost prices to the imperfectly competitive upstream market. Consumers are harmed because the downstream firm will curtail its consumption of the upstream product, thus reducing overall output in the downstream as well. In this situation, the downstream firm (and society as a whole) would be better off if the downstream firm vertically integrated upward so that the input is priced at marginal cost. The lower input

(Footnote Continued. . . .)

favor an affiliated content provider is socially desirable in this case. Notably, we have not considered in this analysis other motivations to favor an upstream affiliate, such as the regulation of the broadband access price (P_X). We recognize that these incentives to vertically integrate are important to the debate.

We also have not modeled other potential impacts of implementing this particular network neutrality proposal. Most notably, the proposal would permit broadband network companies to have different priority classifications of services for content providers but would bar the network companies from charging for higher priority services. This proposal creates an obvious "commons" problem in which no rational content provider would ever seek any level of service other than the highest priority. Even apart from transaction cost implications, the impact of such a rule would appear to be deleterious to the efficient operation of an integrated, multi-service network.[28] Such transactions seem particularly likely to occur in mobile broadband applications, where content services may need to be customized for particular customer equipment, carriers, and service packages.

As is always the case, our findings are the consequence of the particular modeling assumptions of our analysis and we reiterate that our analysis is theoretical in nature. Our approach assumes that certain content services will require some modification to the broadband network to be provided with sufficient quality, and acquiring such modifications causes transaction costs. We provide no estimates of how large transaction costs may be and, in their presence, how much money and full prices change as a consequence of Internet regulation. Such quantification is precluded, in our opinion, since the analysis could apply to a wide-range of services, most of which are speculative or unpredictable at this time. As the Internet develops and newer, bandwidth intensive products are developed, it may be possible to quantify the likely consequences of regulations of this type.

Also, advocates of network neutrality frequently argue that it is important to limit the ability of a broadband provider to leverage market power into the

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price allows the downstream firm's profits and output to rise and prices fall. *See, e.g.*, Mayo and Kaserman, *supra* n. 7, at 303-7.

[28] *See* MacKie-Mason and Varian *supra* n. 2; *see also* G. Gross, *US Lawmaker: Net Neutrality a Top Issue*, MACWORLD (Feb. 1, 2007) (quoting former FCC Chief Technologist David Farber: "If you try to get quality of service for everyone, you don't get quality of service…").

content market. Yet, a network neutrality rule that requires all transactions related to broadband access and quality to be between the broadband provider and consumer (rather than between content and broadband providers) does not preclude this sort of exclusionary behavior. Indeed, this particular form of regulation does not limit the ability of a broadband provider to exclude *A* by setting a high price for the upgrade and a low price for the service (though there is no incentive to do so under the assumptions of our model since the upstream is competitive). As a result, it is somewhat unclear what potential benefits derive from the regulation to offset the costs revealed here.

Finally, this analysis is but one element of a portfolio of evidence on Internet regulations. We encourage contributors to the debate and policymakers to consider all analytical research on the need for and implications of Internet regulation.[29] As we have mentioned, the negative consequences of such regulation exposed here are (potentially significant) offsets to any alleged benefits of the regulation, perhaps making the regulation inconsistent with improvements in economic welfare.

IV. Conclusions

In this PAPER, we have presented a theoretical analysis of the effects of certain network neutrality proposals that would effectively bar, limit or prohibit market exchanges between upstream content and downstream broadband providers. Our model reveals that this form of Internet regulation is far from "neutral" and could instead be undesirable in that it reduces the profits (and presumably the investment) of broadband providers, reduces the output of competitive content providers (and, presumably their numbers), and raises prices for consumers. The reduced output of the content providers is, in part, explained by the transfer of content sales from unaffiliated content providers to the broadband provider's content affiliate, in conflict with one purported goal of Internet regulation.

Over a decade ago, the U.S. government released the Internet to private industry with very few strings attached. Policymakers did not implement price

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29 Interesting and analytically sound contributions on the topic are found in J. Farrell and P. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 7 HARVARD JOURNAL OF LAW AND TECHNOLOGY 85-134 (2003) and B. E. Hermalin and M. L. Katz, *The Economics of Product-Line Restrictions: With An Application to the Network Neutrality Debate,* COMPETITION POLICY CENTER PAPER CPC06-059 (July 2006) (available at: http://repositories.cdlib.org/iber/cpc/CPC06-059).

controls or universal service mandates or dictate the terms and conditions of the myriad number of commercial relationships between consumers, content providers, software firms, advertisers, applications providers, and network operators. Commercial relationships between all of these actors follow the same rules that the rest of the free market economy operates: firms seek to maximize profits and minimize transaction costs and scarce resources are allocated by use of the price mechanism. It is difficult to argue that this policy has failed.

While proponents of Internet regulation often claim that they are simply attempting to maintain the status quo, these proposals would instead outlaw an entire category of commercial transactions between content providers and network providers that have characterized the Internet since its inception. In 1995, MacKie-Mason and Varian wrote that "Internet transport is *already* priced, though many users seem unaware of that. . . . The reasonable question is not whether the Internet should be priced at all, but what type of pricing should be used."[30] Preventing network providers for charging content and application providers for prioritization or other quality of service network upgrades would effectively place the costs of those network upgrades upon consumers that want services that use those upgrades. Requiring consumers to enter into two contracts—one for the content and one for the network upgrade could increase transaction costs substantially and serve to increase the price of both broadband services and the price of content and applications.

It is important to note that our discussion here does not relate to all "network neutrality" proposals in general but to a particular class (currently encapsulated in S. 215 in the 110th Congress but also by prior legislative proposals) that would directly regulate and effectively prohibit contracts between Internet content providers and broadband service providers for the delivery of Internet services and applications to consumers. In our view, it is unfortunate that these proposals to impose price and contract regulation on the Internet are often "sold" to the public as rules that would keep the Internet "neutral." As other Phoenix Center research has advised, we believe that policymakers considering network neutrality proposals should engage in a cost-benefit analysis of the particular proposal before them. That research demonstrates that there are substantial risks and potential costs to imposing network neutrality mandates, and those risks and costs need to be fully understood and analyzed before legislation is passed

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30 MacKie-Mason and Varian, *supra* n. 2.

and regulation is imposed.[31] Analytics, not emotion, should be the centerpiece of the network neutrality debate.

[31] G. S. Ford, T. M. Koutsky and L. J. Spiwak, *The Burden of Network Neutrality Mandates on Rural Broadband Deployment*, PHOENIX CENTER POLICY PAPER NO. 25 (Jul. 2006) (showing that imposing a network neutrality regulatory mandate could dampen deployment of broadband networks in rural areas six times more than it would dampen deployment in urban areas); G. S. Ford, T. M. Koutsky and L J. Spiwak, *Network Neutrality and Industry Structure,* PHOENIX CENTER POLICY PAPER NO. 24 (Apr. 2006), *and forthcoming*, 29 HASTINGS COMMUNICATIONS AND ENTERTAINMENT LAW JOURNAL (Winter 2007) (demonstrating risk that network neutrality rules that promote "commoditization" of broadband Internet access services could deter entry and result in an even more concentrated market); G. S. Ford, T. M. Koutsky and L. J. Spiwak, *The Efficiency Risk of Network Neutrality Rules*, PHOENIX CENTER POLICY BULLETIN NO. 16 (May 2006) (reviewing studies which show that a "stupid network" mandated by network neutrality proposals could cost consumers $300-$400 per month more than a managed, "intelligent" broadband network).

Network Neutrality, Product Differentiation, and Social Welfare

A Response to Phoenix Center Policy Paper No. 24

A Policy White Paper Prepared by

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Summary and Overview

This paper will address the issue of network neutrality in light of a recent Phoenix Center Policy Paper by George S. Ford, Thomas M. Koutsky, and Lawrence J. Spiwak, titled "Network Neutrality and Industry Structure," (hereinafter, Ford *et al.*). The focus of the analysis presented here is an examination of Ford *et al.'s* economic model. The critique of Ford *et al.* is directed at four fatal flaws in their analysis, each of which completely undermines their conclusion that policy makers may harm social welfare by pursuing a policy of network neutrality.

- First, Ford *et al.'s* economic modeling does not address economies of scale in last-mile broadband access networks. This assumption is highly unrealistic and ignores the fact that new entrants in broadband last-mile markets are likely to face higher costs, and will likely need to charge higher prices, than incumbents.

- Second, Ford *et al.*'s economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband access providers. This assumption is entirely unreasonable—policy makers will not be able to enforce "commoditization" of broadband access as suggested by Ford *et al.* Network neutrality principles and some differentiation of last-mile broadband networks are not mutually exclusive.

- Third, the approach taken by Ford *et al.* is fatally flawed as they fail to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, services, and applications. By excluding this important consideration, Ford *et al.'s* approach is overly narrow. Any evaluation of a shift in policy must appropriately identify costs and benefits of alternative actions, and Ford *et al.'s* approach fails to acknowledge the tremendous decline in social welfare which is likely to arise should last-mile broadband access providers be allowed to engage in discrimination against providers of Internet content, applications, and services, an action which would reduce competition, product variety, and customer choice.

- Fourth, the conclusions which Ford *et al.* draw from their model depend on the existence of low levels of sunk costs associated with constructing new last-mile access networks This assumption is highly unrealistic. If sunk costs of entry are high (which they are), the proposition that network neutrality will harm social welfare is not supported by Ford *et al.'s* model.

It is notable that with regard to the issues of scale economies, product differentiation, and sunk costs, Ford *et al.* ignore positions which they have previously taken on the importance of these market characteristics on the potential for competition to emerge in last-mile networks.

This white paper then offers a brief conclusion regarding the issue of network neutrality in light of Ford *et al.'s* evaluation.

A Note on Terminology

The terms “network neutrality” or “open-access Internet,” as I use them in this white paper, should be understood to reflect outcomes resulting from many of the pro-competitive policies which have been enforced in telecommunications markets in the U.S. The ability of end-users to attach equipment of their choice, the provision of access on nondiscriminatory terms to bottleneck facilities, and the requirement that network providers interconnect are examples of these pro-competitive policies. Network neutrality is also consistent with the end-to-end network principles which have been associated with the operations of the Internet. The Internet has operated in a “neutral” environment of open standardization, interconnection, and deference to the network edge, an environment which has generated substantial benefits for consumers, firms, and society.

While the influences discussed above led to an Internet that was “neutral,” changes in policy have opened the possibility that the previous “neutral” Internet may be threatened. Whether a permanent and enforceable policy of network neutrality should be adopted is the main point of conflict as the potential for new telecommunications legislation unfolds.

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I. The growing threat to the open-access Internet

The future of the Internet is the center of an intense debate. At the foundation of the debate is a dispute as to whether or not the firms that control network infrastructure, especially last-mile broadband access facilities, should be allowed to "differentiate their product." Network differentiation, while possibly associated with relatively benign technology differences across broadband platforms, may also be associated with last-mile broadband access providers engaging in the strategic manipulation of technology, which will enable discriminatory practices that adversely affect the utilization and production of Internet content, services, and applications.[1] Those advocating for strategic "network differentiation" have gone as far as to suggest that abandonment of protocol standardization, the foundation of the Internet, could be beneficial.[2]

Consumers today face very few choices of broadband Internet access services.[3] The reason for the lack of choice of broadband access provider is the pervasive and substantial fixed and sunk costs associated with building alternative networks. However, today consumers enjoy a tremendous variety of, and competitive supply of, Internet services, content, and applications, which are accessed through a broadband (or dial-up) connection. Furthermore, producers of

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1 A more detailed discussion of issues related to the network neutrality debate is provided in another Roycroft Consulting white paper: "Network Diversity—A Misguided Policy," by Trevor R. Roycroft. Available at: www.roycroftconsulting.org/response_to_Yoo.pdf

2 See, for example: Christopher Yoo, "Promoting Broadband Through Network Diversity." http://law.vanderbilt.edu/faculty/Yoo%20-%20Network%20Diversity%202-6-06.pdf

For a response to Professor Yoo's arguments and additional discussion of network neutrality issues, see: Roycroft, *op. cit.*

3 The most recent statistics available from the FCC indicate that about 96% of consumers who use broadband do so with either a cable modem or telephone company DSL connection.

Internet content, services, and applications have an equal opportunity to serve the market and earn profits. This competition and product variety is the result of a legacy of Internet governance which encouraged nondiscriminatory access, standardized network protocols, and network interconnection. The competition and product diversity also reflects the heritage of regulatory policies which required the provision of access to the Internet on a nondiscriminatory basis. Thus, in economic terms, the overall welfare of society has been positively influenced by the regime of openness which has dominated the Internet to date.

The potential now arises, due to a series of decisions regarding the regulatory treatment of broadband Internet access facilities, such as cable modem and telephone company DSL connections, that the neutrality of network facilities may be eliminated.[4] This may result in the introduction of proprietary and non-standardized network protocols, or packet prioritization and discrimination. Abandonment of network neutrality principles will enable the owners of last-mile broadband access facilities to create "differentiated," and possibly incompatible and exclusive, networks. Alternatively, if network neutrality principles are abandoned, the owners of last-mile broadband access networks may discriminate against applications and services which do not fit with their revenue generation plans. If the owners of last-mile broadband access facilities differentiate their networks, and discriminate or place limits on consumer choice, the result will be a dramatic reduction in competition and the variety of Internet services, content, and applications which consumers currently utilize. Furthermore, a highly tilted playing field will be created, where the owners of last-mile broadband access facilities will be able to hamstring their competitors, undermining innovation and investment in what, to date, has been a highly competitive market for Internet content, applications, and services.

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[4] For further discussion, see Roycroft, *op. cit.*, pp. 3-5.

Policy makers must carefully consider the impact of any decision which might alter the current structure of the Internet, a structure which allows Internet users to access the content and applications of their choice, and has encouraged competition and substantial investment by firms which produce Internet content, services, and applications. At the heart of the arguments against network neutrality, which are typically offered by telephone and cable companies and their advocates, are claims that the Internet's true potential can only be achieved if multiple last-mile broadband access facilities are constructed. This alternative has been called "network diversity,"[5] or has been associated with calls for "differentiated last-mile networks." Thus, the focus of the policy debate, as framed by those that advocate for the ability of telephone and cable companies to differentiate their networks, and exclude and discriminate, often turns on the alleged negative impact that network neutrality will have on incentives for alternative last-mile facilities to be constructed.[6]

A recent addition to the argument that network neutrality can undermine last-mile broadband competition is a white paper by George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak titled "Network Neutrality and Industry Structure"[7] (hereinafter "Ford *et al.*"). The major policy recommendation offered by Ford *et al.* is that policymakers "should avoid network neutrality mandates that have the intent or effect of 'commoditizing' broadband access services since such a policy approach is likely to deter facilities-based competition, reduce the expansion

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5 See, for example, "Dueling Network Buzzwords: 'Neutrality''Versus 'Diversity'," National Journal's Telecom Insider, February 6, 2005. http://www.njtelecomupdate.com/lenya/telco/live/tb-MBSE1139339451850.html

6 A discussion of the prospects of last-mile broadband competition is contained in Roycroft, *op. cit.,* pp. 26-39.

7 The paper is sponsored by the Phoenix Center for Advanced Legal and Public Policy Studies. See, George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Network Neutrality and Industry Structure," April 2006. Available at: http://www.phoenix-center.org/ppapers.html

and deployment of advanced communications networks, and increase prices."[8]

"Commoditizing" broadband access means any policy which limits the network owner's ability to differentiate its network from other networks:

> 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.[9]

Ford *et al.* note that "policies that promote commoditization of broadband access could lead to the monopoly provision of advanced broadband services in many markets."[10] The authors conclude that "allowing broadband firms to differentiate their products may make entry more likely, thereby leading to a less concentrated industry structure."[11] Ford *et al.* offer support for the proposition that network neutrality may harm social welfare,[12] and their conclusions may encourage policy makers to tread on network neutrality principles.[13]

Ford *et al.* support their position with a "rather technical economic model."[14] Economists frequently rely on economic models to simplify complex market problems, and economic models

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8 Ford, *et al.* p. 1.

9 Ford, *et al.* p. 8.

10 Ford, *et al.* pp. 2-3.

11 Ford, *et al.* p. 3, footnote omitted.

12 Social welfare, as defined by economists, includes both the profits of the supply side of the market and the "consumer surplus" of the demand side of the market.

13 Ford *et al.* assert that they "argue neither for nor against the need for Network Neutrality legislation. . ." (p. 2.) It is difficult, however, to interpret their analysis, which purports to show social harm from network neutrality, while legislation on network neutrality is being debated in Congress, as a "neutral" contribution to the debate.

14 Ford *et al.*, p. 3.

have the potential to enable a clearer view of the potential impact of various policy alternatives. However, it is also true that complex economic models may be used to obfuscate and confuse.[15] It is important to examine the conclusions offered by Ford *et al.* in the context of their economic model, as absent the economic model, Ford *et al.* offer policy recommendations which have no foundation. Ford *et al.* indicate that their analysis is "focused,"[16] however, their approach is too narrow to provide any useful conclusions. As will be discussed in detail below, Ford *et al.'s* analysis is based on a highly restrictive set of assumptions, and these limiting assumptions prevent any general conclusions from being drawn from their analysis. However, it is important to examine their claims as it is all too likely that their findings will be utilized by others to support *broad arguments* against network neutrality principles.

II. Evaluation of Ford *et al.'s* economic model

Economic models have the potential to provide insight for policy makers. However, it is all too easy to abuse economic models and economic theory in policy discussions. To quote a recent observation by an economist of note on this issue:

> Economic theory is often abused in practical policy-making. There is frequently excessive focus on sophisticated theory at the expense of elementary theory; too much economic knowledge can sometimes be a dangerous thing. Too little attention is paid to the wider economic context, and to the dangers posed by political pressures. Superficially trivial distinctions between policy proposals may be economically significant, while economically irrelevant distinctions may be politically important.[17]

As will be discussed in detail below, Ford *et al.'s* analysis does not have sufficient "economic

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15 See, for example: Klemper, Paul. "Using and Abusing Economic Theory," *Journal of the European Economic Association*, April-May 2003, p. 272-300. Available at: http://www.nuff.ox.ac.uk/economics/papers/2003/W2/usingandabusing.pdf

16 Ford *et al.*, p. 4.

17 Klemper *op. cit.*

context," and as a result, they offer policy recommendations which are not supported by a reasonable application of economic theory.

My criticism of Ford *et al.'s* economic model is directed at four issues. First, Ford *et al.'s* model does not acknowledge economies of scale which are pervasive in last-mile broadband networks. Second, Ford *et al.'s* economic model assumes that policy makers are capable of eliminating all product differentiation in the provision of broadband Internet access facilities. This assumption is highly unrealistic. Third, while claiming to offer an analysis based on the evaluation of *social welfare*, they exclude important aspects of the market and develop an overly narrow "social welfare" evaluation.[18] Ford *et al.* completely ignore the impact that the elimination of network neutrality will have on the production and consumption of Internet content, applications, and services. Thus, Ford *et al.'s* model ignores the substantial harm to social welfare which would arise if telephone and cable companies act as gatekeepers and interfere with competition and consumer choice, and the ability of businesses to invest and market their services over the Internet. Fourth, Ford *et al.'s* conclusions are based on the assumption that *sunk costs* associated with entry in last-mile broadband access markets are negligible. This assumption is also highly unrealistic and further undermines the credibility of their conclusions.

A. Scale economies must be considered when evaluating broadband access network policy

One notable characteristic of Ford *et al.'s* model is the absence of *scale economies* in last-mile broadband access networks. In other words, there are no cost advantages associated with firm size, the unit cost of production for the incumbent monopoly firm producing all output

[18] Social welfare, as understood by economists, is the sum of *consumer surplus* and *producer surplus.*

is exactly the same as the unit cost for each firm when competition is introduced.[19] This is a highly unrealistic assumption. Other writers on the subject of the alleged advantages on "network diversity" have acknowledged that entrants may face higher operating costs than incumbents, and thus need to charge higher prices than the incumbent. For example, Christopher Yoo's recent white paper which also attacks network neutrality and provides a favorable evaluation of the prospects for "network diversity," acknowledges that scale economies exist, and he opines that differentiated networks could overcome their cost disadvantage by charging higher prices for their differentiated services because consumers will value the differentiated services more highly.[20] While Ford *et al.* do mention the possibility that network differentiation increases consumer valuation of the last-mile broadband network, their evaluation of this aspect of differentiation does not consider the higher costs facing an entrant due to the entrant's lack of scale economies.[21]

The absence of scale economies from Ford *et al.'s* analysis is a fatal flaw. Ironically, as will be discussed further below, Ford *et al.* have elsewhere addressed the negative impact of scale economies on the prospects of entry in last-mile markets.

B. Network neutrality and last-mile broadband differentiation are not mutually exclusive

It is important to note that network neutrality and product differentiation among last-mile broadband networks are not mutually exclusive as Ford *et al.* assert. Rather, the coexistence network neutrality and differentiation of last-mile facilities is an entirely reasonable prospect.

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19 The cost structure assumed by Ford *et al.* results in the same unit costs for the firms in question under the cases of monopoly and duopoly, as shown in their equations (7), (17), and (25).

20 Christopher Yoo, "Promoting Broadband Through Network Diversity," *op cit.*, p. 24. For a critique of Professor Yoo's argument, see, Roycroft, *op. cit.*

21 Ford *et al.*, p. 19.

Principles of network neutrality require that last-mile broadband providers do not engage in discrimination or sabotage of the offerings of competing providers of Internet content, services, and applications. However, network neutrality principles may be upheld and differentiation of last-mile access facilities may exist, especially if differentiation is associated with technical differences in the broadband platform, and is not the result in strategic manipulation of technology. Ford *et al.'s* model is flawed as it assumes that the pursuit of a network neutrality policy will prevent last-mile access providers from operating differentiated networks. It is important to keep in mind that Ford *et al.'s* economic modeling assumes that policy makers can force competing broadband networks to be *absolutely identical*.[22] This assumption is highly unrealistic, and the conclusions which Ford *et al.* draw from their model are tenuous as a result.

Technology differences in last-mile broadband facilities naturally introduce product differentiation. Ford *et al.* recognized the fact that different technological delivery platforms may have inherent differentiation in a July 2005 paper, a portion of which addressed differences between cable television and direct broadcast satellite (DBS) systems:

> A recent study by the General Accounting Office ("GAO") on competition between cable television and DBS firms illustrates the importance of product differentiation. While both terrestrial and satellite multichannel video providers offer similar products, there are some meaningful forms of differentiation between the two. The differences in the delivery technology itself (i.e., inter-modality) are not lost on consumers.[23]

Similar differentiation in technology resulting from "inter-modality" is associated with last-mile broadband facilities, and policy makers will not be able to eliminate this type of differentiation.

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22 In the notation of their model, policy makers can force the parameter $\theta = 1$. Ford *et al.* p. 18.

23 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, p. 24. Available at: http://www.phoenix-center.org/ppapers.html

For example, last-mile broadband in cable networks are a shared resource, multiple consumers share cable broadband access networks from a point very near the customer's premises. The impact of this sharing is the delivery of variable bandwidth to end users based on how many of the end user's neighbors are also requesting bandwidth. Telephone company DSL, on the other hand, provides fixed bandwidth in the access network, and essentially bypasses the potential for "network congestion in the neighborhood" which is associated with cable systems. Marketing by DSL and cable providers enable consumers' ability to recognize the fact that DSL and cable broadband access are differentiated products. Consumers are aware that with cable broadband "actual speeds may vary and are not guaranteed,"[24] and that "DSL provides a dedicated connection . . . so you don't have to share your local access connection with other users."[25]

Other technologies used for broadband Internet access have characteristics which result in differentiation. For example, fixed wireless broadband networks may offer a more scalable service, and symmetrical bandwidth.[26] Alternatively, mobile wireless broadband introduces mobility. These characteristics are product differentiation which will not be affected one iota by network neutrality requirements.

In addition, one of the main points of differentiation in last-mile access facilities is the amount of bandwidth which is offered to consumers. Coaxial cable, DSL, fiber to the home, and fixed and mobile wireless access services routinely use download and upload speeds as points of differentiation, and it is entirely unreasonable to expect that a policy of network neutrality would result in this fact changing. If network neutrality is consistent with some product differentiation

[24] Comcast broadband description. http://www.comcast.com/Benefits/CHSIDetails/Slot3PageOne.asp

[25] Verizon broadband description. http://www22.verizon.com/forhomedsl/channels/dsl/learnmore/faqs/#tech2

[26] http://www.znet.com/fixedwireless/

among last-mile providers (which it is), then none of the conclusions derived from Ford *et al.'s* economic model are valid. Their model assumes that policy makers have the ability to eliminate all product differentiation, and this is simply not the case.

C. Ford *et al.'s* modeling ignores the tremendous impact on social welfare that broadband gatekeepers will cause

Ford *et al.* argue that network neutrality can result in lower levels of social welfare.[27] The reason for this reduction in welfare is the alleged inability of consumers to take advantage of broadband access *product differentiation* when network neutrality is mandated. However, Ford *et al.* analyze only one part of the picture. Failure to maintain network neutrality may dramatically decrease the competition and product variety that consumers currently enjoy with regard to Internet services, content, and applications.[28] Thus, one major problem with Ford *et al.'s* economic model is that they ignore the fact that elimination of network neutrality principles will reduce competition, customer choice, and product variety which currently exists for Internet content, applications, and services. The introduction of discriminatory and exclusionary practices by last-mile broadband gatekeepers will likely lead to a reduction in competition, customer choice, and product variety. Thus, Ford *et al.'s* model fails to address the substantial loss in social welfare which would likely occur should telephone and cable companies become gatekeepers and discriminate against Internet services, content, and applications which were not consistent with the gatekeepers' revenue generation plans. This loss in social welfare must be accounted for in any analysis of the alleged gains in consumer welfare arising from "differentiated" last-mile networks.

However, Ford *et al.'s* oversight is even more significant as it appears that they have

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27 Ford *et al.*, p. 18.

28 For a further discussion of this issue, please see: Roycroft, *op. cit.*, pp. 5-11.

forgotten the basic economics of the evaluation of product differentiation, i.e., that the costs and benefits of differentiation must be thoroughly evaluated. The economics literature recognizes product differentiation as means through which firms can undermine price competition,[29] and the resulting reduction in price competition may harm consumers. It is notable that in another paper authored Ford *et al.* in July of 2005, they clearly recognized the importance of evaluating the benefits and costs of product differentiation, and identify issues with product differentiation which they now ignore completely:

> The effect of differentiation on prices can be significant. At the extreme, two products can become so different that they no longer are substitutes for one another – while both made by General Motors, a Hummer is not really a viable substitute product for a Chevette. *Accordingly, we should expect firms to attempt to differentiate their products as much as possible in order to soften price competition.*
>
> As to whether consumers are better off as a result of product differentiation, the answer is "it depends." Consumers usually value variety, *so while differentiation results in higher prices, the value of increased variety may offset the reduction in consumer welfare from higher prices.* So, there is a trade-off for consumers between variety and price. Differentiation is not always beneficial to consumers, and some firms may excessively differentiate in an effort to more aggressively soften price competition. *One type of differentiation that would harm consumers is differentiation through sabotage, where one firm reduces the quality of a rival's product instead of improving its own quality.* Product differentiation may also create entry barriers by forcing entry to incur increased sunk advertising costs to win customers.[30]

In this previous work Ford *et al.* recognize many important facts regarding product differentiation which they now ignore. Product differentiation may reduce competition. The reduction in competition generates higher prices. As a result, consumers may not benefit from

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29 See, for example, Tirole, J. *The Theory of Industrial Organization*, MIT Press, 1989, p. 278.

30 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added, p. 24, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

differentiation. Furthermore, firms may have the ability to differentiate their product by influencing the quality of a rival's product, an all too real prospect when considering the need for network neutrality policy.

Ford *et al.'s* current evaluation of product differentiation presents an overly simplified and unrealistic view of how a policy which abandoned network neutrality would affect consumers and firms. Ford *et al.* completely ignore the impact of the abandonment of network neutrality on current competition in markets for, and the availability of, Internet content, services, and applications of the consumer's choosing. Ford *et al.'s* analysis also ignores negative impacts on the ability of businesses operating at the network edge to innovate and invest. This aspect of network differentiation in last-mile broadband facilities will have a significant and negative impact on social welfare, but it is completely ignored by Ford *et al.'s* model. Furthermore, the very real possibility that the operators of last-mile broadband access facilities would differentiate their product by sabotaging access to Internet content, applications, and services of the user's choice is a tremendous oversight in Ford *et al.'s* current analysis of product differentiation.[31]

Ford *et al.'s* model offers a highly selective view of the impact of product differentiation on price competition. They abandon the more conventional view that product differentiation may undermine price competition, which they relied on in their July 2005 paper, and now state that product differentiation promotes price competition.[32] In summary on this issue, Ford *et al.'s* model entirely fails to support their policy recommendations as they model only a portion of the overall market, and only a portion of the potential impact of the abandonment of network

[31] For a further discussion of the potential for sabotage, see Roycroft, *op. cit.*, pp. 6-9.

[32] Ford *et al.*, pp. 8-9.

neutrality principles.

D. Ford *et al.'s* modeling incorrectly assumes that sunk costs of building alternative broadband networks are negligible

It would be reasonable to dismiss Ford *et al.'s* recommendations based on the criticism above. However, it is worthwhile to evaluate Ford *et al.'s* model on its (overly narrow) basis and determine whether the policy recommendations offered by the authors have any support at all.

1. Detailed look at Ford *et al.'s* economic model

Table 1, below, summarizes the five market scenarios evaluated by Ford *et al.* The basic logic of the approach utilized by Ford *et al.* is to develop a measure of social welfare under monopoly and no product differentiation, and to compare that level of social welfare with the level of social welfare which results from the other situations summarized in Table 1.

Table 1: Market Profiles Modeled by Ford *et al.*
Monopoly without product differentiation.
Monopoly with product differentiation.
Duopoly without product differentiation (quantity competition).
Duopoly with product differentiation (quantity competition).
Duopoly without product differentiation (price competition).

Table 2, below, summarizes Ford *et al.'s* findings with regard to the modeling.

Table 2: Summary of Ford *et al.'s* Findings	
Scenario	**Impact on Social Welfare Relative to Baseline**
Monopoly without product differentiation **(Baseline Scenario).**	---
Monopoly with product differentiation.	No change, social welfare not affected as compared to baseline.
Duopoly without product differentiation (quantity competition).	Social welfare may be higher if sunk costs of entry are not too high.
Duopoly with product differentiation (quantity competition).	Social welfare may be higher if sunk costs of entry are not too high.
Duopoly without product differentiation (price competition).	If the sunk costs of entry are greater than zero, then entry will not occur.

Ford *et al.* go on to evaluate their results:

> . . . 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. 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 social perspective.*[33]

Then, based on this exposition, Ford *et al.* conclude with a proof which purportedly supports the proposition that network neutrality is socially inefficient:

33 Ford, *et al.*, p. 17, emphasis in the original.

> *Proposition.* Suppose Bertrand competition occurs with entry and θ = 1, but differentiated competition occurs if θ < 1. *If E is positive but not too large, then Network Neutrality is socially inefficient.*
>
> *Proof.* Under Bertrand competition, duopoly profit on entry with θ = 1 is zero, so any positive sunk entry costs prevents entry. Without Network Neutrality requiring θ = 1, a firm may enter with θ < 1, whenever
>
> $$\pi_i^* = \frac{(\alpha - c)^2}{\beta}\frac{(1+\theta)}{(2+\theta)^2} > E > 0$$
>
> 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.[34]

This proof caps their exposition, and contributes to their conclusion that network neutrality is socially inefficient. Their conclusion ultimately hinges on the magnitude of the sunk costs of entry—specifically, it must be the case that sunk costs "are not too large." Sunk costs which are "not too large" is, however, an unreasonable presumption.

2. Substantial sunk entry costs make it unlikely, within the context of Ford *et al.'s* model, that network neutrality is socially inefficient

The extent of sunk costs associated with broadband access networks, like other telecommunications networks, are substantial, and these substantial sunk costs make it much less likely that Ford *et al.'s* model shows that a policy of network neutrality will have a negative impact on social welfare. Ford *et al.* have acknowledged the existence and importance of high levels of sunk costs in other recent writings:

> As consistently demonstrated by academic and Phoenix Center research, and again in this POLICY PAPER, given the *huge fixed and sunk costs* inherent to the construction and commercial operation of communications networks, the equilibrium level of concentration of terrestrial firms in local communications markets (voice, video, and data) will be relatively high. . . . *fewness arises because scale economies and sunk costs limit the number of firms that can profitably serve a market – and local communications networks are notoriously riddled with scale economies and sunk costs.* Any policymaker interested in local

[34] Ford, *et al.*, p. 18, emphasis added.

> communications markets should, therefore, start from the assumption that there will, at best be only a "few" facilities-based firms.[35]

Ford *et al.'s* previous recognition of the importance of scale economies and sunk costs has been abandoned in their approach to network neutrality. This makes their conclusion even more unrealistic. The sunk costs which are recognized by Ford *et al.* as a pervasive characteristic of terrestrial communications firms also apply to nonstandard technologies, such as wireless, fiber optics, and broadband over power lines.[36] The bottom line regarding Ford *et al.'s* modeling is this: the extremely high levels of sunk entry costs associated with the construction of communications networks, including last-mile broadband facilities, make it unlikely that network neutrality principles will decrease social welfare. In other words, even if one overlooks all of the other fatal flaws in Ford *et al.'s* approach, the reality of high levels of sunk costs of building last-mile broadband networks indicates that their model does not support the proposition that network neutrality will harm social welfare.

E. Summary of critique of Ford *et al.*

It is somewhat surprising to find Ford *et al.* now ignoring both data and economic principles with which they exhibited a high degree of familiarity as recently as July of 2005. While claiming that their economic model contains support for the proposition that network neutrality will be harmful to social welfare, the model does no such thing. Scale economies must be considered when evaluating the potential impact of entry on market outcomes. Furthermore, any social welfare analysis must tally the negative impact that cable and telephone company

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35 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

36 For a fuller discussion of the limitations of these alternative technologies, see, Roycroft, *op. cit.,* pp. 29-38.

gatekeepers will impose on consumers and firms. It is all too likely that cable and telephone companies will reduce competition in markets for Internet content, services, and applications, possibly even sabotaging sources of supply which interfere with their revenue generation plans. Ford *et al.* overlook this vital component of welfare analysis as it applies to the issue of network neutrality. Also, it is important to acknowledge the impact of substantial sunk entry costs on the prospects for competition. Again, Ford *et al.* ignore vital facts, and ultimately reach unsupported conclusions regarding alleged harms associated with network neutrality.

III. Conclusion

Ford *et al.* argue that policy makers may do harm if they attempt to enforce a policy which prevents last-mile broadband access providers from differentiating their networks, and which leads to "commoditization" of broadband access. As has been discussed above, it is unreasonable to associate network neutrality with the elimination all differentiation in last-mile networks. Furthermore, Ford *et al.'s* failure to address economies of scale and substantial sunk costs associated with last-mile broadband network also undermines the validity of their recommendations. Finally, their failure to acknowledge the impact of the abandonment of network neutrality principles on existing competition, consumer choice, and product variety associated with Internet content, services, and applications is another fatal flaw. The bottom line is that Ford *et al.'s* claims are not supported by economic theory or their model.

The Internet, operating under a regime of standardized protocols and interoperability, has resulted in expansive consumer benefits. Internet standardization is widely recognized to be beneficial to consumers, as it reduces purchase risks and expands network effects, which increase product values.[37] The standardization associated with the Internet operates at a

[37] See, for example, Carl Shapiro and Hal Varian, *Information Rules*, Harvard Business School Press, Boston, 1999, p. 233.

"wholesale level." The standardized network protocols reside in logical network layers below the "application level," which is associated with the Internet products used by consumers. Thus, due to the standardization of Internet protocols, consumers are presented with a wide variety of content, applications, and services. Due to the standardization of Internet protocols at the wholesale level, consumers enjoy highly differentiated retail products, and are able to benefit from competition, network effects, and the advantages of interoperability. This open-access environment allows the rise of niche market providers, which can tailor their Internet services to the needs of individuals, again adding to consumer benefits.[38]

History provides a laboratory for the evaluation of consumer reactions to differentiated information networks—consumers have had the opportunity to experience electronic information services operating as differentiated and non-standardized "information strip malls." Prior to the commercialization of the Internet, online service providers such as America Online, GEnie, Compuserve, Prodigy, and Delphi offered consumers the ability to utilize chat and bulletin boards, access electronic news and information, and send e-mail. However, these differentiated systems were not interconnected, and users of one online service generally could not communicate with the subscribers of other online service providers.[39] These proprietary network service providers were, of course, free to innovate in their "network cores." However, the commercialization of the Internet, with its open and non-proprietary standards, provides an object lesson in what consumers have deemed the superior approach—i.e., principles of openness which support innovation at the network edge. Once the expansive network effects and interoperability benefits associated with the Internet became available to any entity which

[38] *Id.*, p. 187.

[39] *Id.*

abided by the principles of the open-access Internet, the proprietary network model quickly withered. The proprietary services which were offered by online service providers were judged by consumers as inferior to the content, applications, and services, operating under the regime of standardized Internet protocols, which were competitively available over the Internet.

The fact that differentiation of last-mile broadband access networks, if that differentiation applies proprietary protocols or limits consumer choice, will undermine the diversity of Internet content, applications, and services should not be lost on policymakers. The Internet, through its governing principles of openness and nondiscrimination, has encouraged competition and expansive consumer benefits. Ford *et al.'s* flawed findings, if acted upon by policymakers who might undermine network neutrality principles, would endanger this success and risk replacing vibrant competition and extensive variety with two or three competing "information strip malls," tightly controlled by telephone and cable companies. Such an outcome is one that the U.S. can ill afford.

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IN RESPONSE…

May 2006

NETWORK NEUTRALITY AND SCALE ECONOMIES: A RESPONSE TO DR. ROYCROFT

I. Introduction

In PHOENIX CENTER POLICY PAPER NO. 24, *Network Neutrality and Industry Structure*,[1] we looked into one of the most heated debates in the current efforts to re-write the Communications Act—whether the federal government should impose "Network Neutrality" requirements on broadband service providers. While we argued neither for nor against the need for Network Neutrality legislation in that POLICY PAPER, our analysis showed that policymakers should avoid Network Neutrality mandates that have the intent or effect of "commoditizing" broadband access services since such a policy approach is likely to deter facilities-based competition, reduce the expansion and deployment of advanced communications networks, and increase prices. Our theoretical argument hinged on the well-known relationship between commoditization and price competition in the presence of fixed costs (*i.e.*, economies of scale). Since communications networks require significant capital expenditures (fixed costs), limiting firms to price-only competition will reduce the number of firms that can successfully serve the market.[2] An increase in the equilibrium number of broadband providers is promoted by service differentiation, since firms can compete in both price and non-price dimensions. As such, we concluded that 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 obviously harm consumers substantially.

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[1] George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, *Network Neutrality and Industry Structure*, PHOENIX CENTER POLICY PAPER NO. 24 (April 2006) (available at http://www.phoenix-center.org/pcpp/PCPP24Final.pdf).

[2] We discuss this point in detail (particularly at Sections III.3 and III.4) in George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, *Competition After Unbundling: Industry Structure and Convergence*, PHOENIX CENTER POLICY PAPER NO. 21 (July 2005) (available at http://www.phoenix-center.org/pcpp/PCPP21Final.pdf).

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Shortly thereafter, Dr. Trevor Roycroft, of Roycroft Consulting,[3] released a critical response to the paper. Upon our request, Dr. Roycroft agreed to allow the Phoenix Center to post his comments on our website.[4] In his critical review of our work, Dr. Roycroft's analysis is "an examination of [our] economic model."[5] Dr. Roycroft lists what he believes are four "fatal" flaws in our economic model:

1. the "economic modeling does not address economies of scale in last-mile broadband access networks";

2. the "economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband access providers";

3. the model "fail[s] to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, service, and applications";

4. "the conclusions … depend on the existence of low levels of sunk costs associated with constructing new last-mile access networks."

In an effort to ensure the accuracy and legitimacy of all analysis performed and released by the Phoenix Center, we have evaluated carefully Dr. Roycroft's response to see if he presents any legitimate criticisms or offers any material improvements to the analysis in POLICY PAPER NO. 24. At the Phoenix Center, we appreciate criticism and comment, since such review can be used to either affirm or improve our analysis, thereby making our work more useful for policy decisions. In some cases, comments on our work provide direction for future research. By all accounts, Dr. Roycroft's comments confirm the relevance and importance of the general theme of POLICY PAPER NO. 24.

Curiously, none of the "flaws" claimed by Dr. Roycroft are actually present in our analysis. In fact, all of the alleged errors and omissions claimed by Dr. Roycroft are dealt with squarely in our paper. For example, the very purpose of our model is to argue that because scale economies are present, service differentiation is necessary for entrants to successfully enter the market. Yet Dr. Roycroft claims we "do not address economies of scale" and that we "ignore[] the fact that new entrants … will likely need to charge higher prices [] than incumbents." As

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[3] http://www.roycroftconsulting.org.

[4] Available at: http://www.phoenix-center.org/RoycroftRespPCPP24.pdf. Dr. Roycroft, and any other interested party, is, of course, free to provide further substantive comments which we will post on the website.

[5] Roycroft critique at 1.

such, this criticism has no merit. Dr. Roycroft's other arguments, to the extent they address key issues in the Network Neutrality debate, are in fact not criticisms of our model at all and are, in fact, specifically incorporated into our analysis, either formally or informally.

II. Discussion

A. *Issue One: Economies of Scale*

Dr. Roycroft claims that our model "does not address economies of scale." Without question, this criticism is the most puzzling. In fact, economies of scale are at the core of our model. We set out to analyze how Network Neutrality rules would affect industry structure in a market that is characterized by economies of scale, and fixed and sunk costs. Consider, for example, the statement from the introduction (selectively quoted by Dr. Roycroft):

> Economic theory suggests that product differentiation is an important component of competition, particularly in industries with large fixed and sunk costs.[6]

and

> economic forces inherent to communications networks tend to promote concentrated equilibrium industry structures (i.e., few firms).[7]

and

> price competition is desirable, but when price is the only choice in a market with larger fixed/sunk costs and low marginal costs (like local broadband networks), the result of permitting price-only competition is a tendency toward monopoly.[8]

Clearly, from this dictum and many more quotes like it from our POLICY PAPER, it is apparent that economies of scale are not only "addressed," but play a key role in the analysis.

Dr. Roycroft states his analysis is focused on the economic model, and not the text of the document, which are quoted above. However, an evaluation of our economic model unequivocally shows that economies of scale play a constant and important role in our model. In Section III.A of POLICY PAPER NO. 24, we outline the supply-side mathematical framework of

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6 POLICY PAPER NO. 24 at 3.

7 *Id.*

8 *Id.* at 8.

our economic model. In these equations, we state there is some constant marginal cost c, a fixed entry costs E for the entrant, and fixed cost F for the incumbent. Whenever there is a constant marginal cost (c) and fixed costs (F), economies of scale are present.[9] By definition, then, economies of scale are present in the economic model. In fact, economies of scale are so pronounced in the model, that if complete commoditization of broadband Internet access services is mandated, the market would be a natural monopoly due to economies of scale.

Indeed, it is because of scale economies in our model that we were forced to deal with the issue of efficient entry. For industries with extreme scale economies, entry is not necessarily "efficient" because the inefficiency of higher per-unit production costs from multiple firms supply might outweigh the benefits consumers derive from multiple providers (i.e., price cuts). This concept is only relevant if scale economies are significant; there would have been no need for us to examine efficient entry if we our model did not "address" scale economies, as Dr. Roycroft charges.

As part of his criticism, Dr. Roycroft states that because of economies of scale, "new entrants in broadband last-mile markets are likely to face higher costs, and will likely need to charge higher prices, than incumbents."[10] While Dr. Roycroft appears to believe we ignore this logic, *it is in fact the very essence of our analysis*. As we state,

> 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.[11]

If firms are restricted to competition only on price, then high cost firms have no hope of survival. However, differentiated goods competition gives smaller firms a change to survive by softening price competition.[12] While Dr. Roycroft claims we ignore this point, this argument is, in fact, exactly what our paper is about.

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9 Stated simply, the cost function is $C = F + cq$, where q is output. Average cost *is* $AC = F/q + c$, which is always declining in q. As a result, scale economies are present over the entire range of output. While we could have specifies economies of scale in the form of declining marginal costs (either with zero or positive fixed costs), this alternative cost structure makes the welfare comparisons very complex. We suspect that the difference in our conclusions this change would make is to render efficient entry much more difficult, thereby implying that monopoly is the ideal market structure for broadband service provision.

10 Roycroft critique at 2.

11 POLICY PAPER NO. 24 at 19.

12 We state this condition with mathematical precision in the paper. At page 16, we list the condition $\partial p/\partial \theta < 0$ [the unnumbered equations after Equation (24)], which, in words, says that as the products or services become more differentiated (θ gets smaller), prices rise (p gets bigger).

Finally, on this point, Dr. Roycroft points to Equations (7), (17), and (25) as "evidence" that we ignore scale economies. These equations are expressions of equilibrium gross profit levels, and are thus functions only of *marginal* cost, not *average* costs. These gross profit levels must then be compared to the fixed/sunk entry costs to determine whether entry occurs, and this comparison is made in Equation (29). Dr. Roycroft copies this equation in his comment, so he should be aware of its purpose. Perhaps Dr. Roycroft missed the qualifier to the profit formulas stating "Equations (17) and (19) would need to be adjusted for the presence of fixed or sunk costs."[13] Or, perhaps we could have been clearer about this qualification and repeated it *ad infinitum*.

In summary, the primary thesis and purpose of PHOENIX CENTER POLICY PAPER NO. 24 was to study how Network Neutrality proposals would industry structure by focusing on interaction between economies of scale, product differentiation, and entry. Dr. Roycroft seems to have missed the very essence of our argument and economic model.

B. *Issue Two: Effectiveness of Public Policy in Eliminating Product Differentiation*

In his second criticism, Dr. Roycroft contends that our "economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband access providers." As with the scale economies argument, Dr. Roycroft is wrong again, and we can illustrate this with the precision of the mathematics included in the paper.

In describing our model, we describe the parameter θ (the Greek letter "Theta") as a "production differentiation parameter where $0 \leq \theta \leq 1$."[14] We also observe "if $\theta = 0$ we have the pure monopoly case; $\theta = 1$ we have identical goods; and for intermediate cases we have $0 < \theta < 1$."[15] In other words, our economic model can contemplate the full range of differentiation, from identical goods ($\theta = 1$) to completely differentiated goods ($\theta = 0$), and everything in between. Thus, Dr. Roycroft's criticism is inapplicable to our economic model. Our model does account for the fact that policies might not completely eliminate all potential for product differentiation. The fact that our model allows one to establish different degrees of permissible differentiation does not take away from our fundamental point—that policies that make differentiation less likely will lead to increased industry concentration.

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13 *Id.* at 15.

14 *Id.* at 11.

15 *Id.*

As a secondary point, Dr. Roycroft's point says more about his skepticism of policymakers than it does about our paper. Essentially, Dr. Roycroft asserts that even if a law mandated that local broadband services only be sold as a commodity "bitstream" service, that policy would be a failure because "policy makers will not be able to enforce 'commoditization' of broadband access."[16] He bases this assumption on a type of technological determinism—that "technology differences in last-mile broadband facilities naturally introduce product differentiation."[17] But simply because different technologies are involved does not mean that government is entirely incapable of mandating a commodity service or price structure on the industry if it so desires. Indeed, proposals, such as the Network Neutrality Act of 2006 (H.R. 5273), and the Internet Freedom and Nondiscrimination Act of 2006 (H.R. 5417), affirmatively prohibit all broadband providers, regardless of technology used, from imposing a "surcharge" for prioritization or preferential treatment for particular forms of content. The fact that Dr. Roycroft's paper is cited by proponents of those bills is curious because Dr. Roycroft has basically asserted that those bills are unenforceable.

C. *Issue Three: Consideration of "Upstream" Competition*

In his third criticism, Dr. Roycroft claims that we "fail to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, service, and applications." We understand that Network Neutrality proposals involve a trade-off of the risks in the local broadband access market and competition in the "upstream" content, service and applications markets. Our research on this topic has stressed the cost-benefit analysis in which policymakers must engage.[18] As we state in the paper,

> 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.[19]

Also, we propose that

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16 Roycroft critique at 7-10.

17 *Id.* at 8.

18 *See* George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, *The Efficiency Risk of Network Neutrality Rules*, PHOENIX CENTER POLICY BULLETIN NO. 16 (May 2006) (available at: http://www.phoenix-center.org/PolicyBulletin/PCPB16Final.pdf).

19 POLICY PAPER NO. 24 at 4 (emphasis supplied).

> 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.[20]

We plainly acknowledge the concerns regarding anticompetitive behavior, and advise that such concerns be "balanced" against the adverse effect of commoditization on industry structure. Thus, while Dr. Roycroft's point that the impact of Network Neutrality on competition "upstream" is an important one, his criticism is misplaced, as we recognized these concerns and argued that they need to be balanced against the harm to "downstream" industry structure identified by our model.

D. *Issue Four: Allegedly Low Sunk Costs*

In his final criticism, Dr. Roycroft claims "the conclusions [of our model] … depend on the existence of low levels of sunk costs associated with constructing new last-mile access networks." It is a mystery how Dr. Roycroft can make this criticism of our paper. Our paper is based almost exclusively on the role of high fixed and sunk costs have on industry structure. (Indeed, almost all Phoenix Center research is based on the role of sunk costs on industry structure.) It is a *non sequitur* to read our paper and assert that that an essential ingredient of our analysis is that sunk costs are low.

Dr. Roycroft crafts his invalid criticism from the mathematical proof in Section IV.A, which states:

> *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.[21]

In POLICY PAPER NO. 24, we then provide a proof that this Proposition is true. Dr. Roycroft replicated this entire discussion in his comment. Dr. Roycroft focuses on the statement "*E* is positive but not too large," where *E* is the sunk costs of entry in arguing that we have assumed low sunk costs.

As an initial matter, the statement to which Dr. Roycroft objects merely discusses where entry costs are "not *too* large" (emphasis added). Our conclusions do not depend on "low levels of sunk costs," but only on levels of sunk costs that are not "too large." By "too large," we meant in the context of the model and the discussion of it that in some instances, the sunk costs

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20 *Id.* at 8 (emphasis supplied).

21 *Id.* at 18.

of entry may be too high so that entry is undesirable, regardless of the effect it has on consumers. Say, for example, that it costs $11 trillion in sunk investments to build a broadband network. Since this is roughly the size of Gross Domestic Product in the United States, it probably would not be beneficial for the country to have this network built. Thus, sunk costs of $11 trillion are probably "too large" in that the gains to consumers from lower prices will never exceed this amount.

The notion of sunk costs being "too large" is expressed clearly in the paper:

> 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 social perspective*.[22]

Thus, sunk costs are "too large" if they make the excluded firm an inefficient entrant from a social perspective. We engaged in this discussion in the paper because of our concern that certain Network Neutrality rules would deter entry, and proving this proposition was important because entry is not always socially beneficial, because entry in the case of markets with sunk costs of entry that are "too large" may not be socially beneficial.

Accordingly, our economic model does not assume a low level of sunk costs associated with constructing new last-mile access networks, and Dr. Roycroft is inaccurate in his assessment of the economic model. In stating in this proposition is dependent upon sunk entry costs not being "too large," we did not mean to state or assume that entry costs in this industry were "low." Equation (29) in fact specifically provides a method to determine how small or large entry costs (E) need to be for Network Neutrality rules to be inefficient. Our diction perhaps could have been more specific, and while we perhaps could have described textually this condition *ad infinitum*, we trust that most readers would have found such a discussion excessively pedantic and pedagogical.

III. Conclusion

In sum, none of the "fatal errors" claimed by Dr. Roycroft are present in PHOENIX CENTER POLICY PAPER NO. 24. To the contrary, the very concerns raised by Dr. Roycroft were directly and thoroughly addressed. It would seem, therefore, that Dr. Roycroft's perceptions of the key issues for Network Neutrality are in line with ours, particularly the importance of scale economies, and fixed and sunk costs and the role they play on industry structure. We appreciate the cross-check of our work.

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22 *Id.* (emphasis in original).

Network Neutrality, Product Differentiation, and Social Welfare

Response to Phoenix Center's Reply

A Policy White Paper Prepared by

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June 22, 2006

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Executive Summary

Phoenix Center Policy Paper No. 24 argues that network neutrality harms consumers and creates social inefficiency. I responded to Policy Paper No. 24 and identified four fatal flaws in Phoenix's approach. Because of these flaws, Phoenix's conclusions regarding network neutrality are unsupported. The four flaws in Phoenix Policy Paper No. 24 are:

> Phoenix's economic modeling does not address economies of scale in last-mile broadband networks.
>
> Phoenix's economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband providers.
>
> Phoenix fails to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, services, and applications.
>
> Finally, Phoenix draws conclusions from their model that depend on the existence of low levels of sunk costs associated with constructing new last-mile networks. Within the context of their model, as well as in reality, this assumption is highly unrealistic.

Phoenix has published a reply to my response. Their reply does nothing to undermine my original criticism. In this paper I evaluate and respond to Phoenix's reply. I take a more detailed look at Phoenix's economic model, and compare Phoenix's current interpretation of entry and competition in last-mile telecommunications networks with Phoenix's previous analysis of these issues. I conclude that Phoenix continues to get it wrong with regard to network neutrality policy.

This paper also notes that Phoenix has published "Policy Bulletin No. 16," which renews their claims that network neutrality will cause social inefficiency. However, this new Phoenix research relies heavily on the economic arguments contained in Phoenix Policy Paper No. 24, thus Phoenix's additional claims that network neutrality harms society rest on very shaky ground.

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Introduction

Economic models are useful because they can simplify complex situations and cut away unnecessary details. However, economic models, if they are to be useful to policymakers, must reasonably reflect the reality which they are purporting to simplify. In my paper, "Network Neutrality, Product Differentiation, and Social Welfare,"[1] I provide a critique of Phoenix Center Policy Paper Number 24.[2] In that paper, I take issue with the Phoenix Center's application of an economic model to matters surrounding the network neutrality debate. I argue that the model applied by Phoenix Center to evaluate network neutrality does not do a very good job of reflecting the market reality which provides the backdrop to the debate. The Phoenix Center has now responded to my criticism,[3] which now inspires this response. While I appreciate Phoenix Center's efforts to clarify their position, nothing in their Reply undermines my original criticism of their work.

Scale Economies

In my critique of Phoenix Policy Paper No. 24, I pointed out that Phoenix's analysis did not reflect scale economies. Phoenix has previously provided a reasonable assessment of the nature of the scale economies associated with last-mile telecommunications facilities, including those utilized to provide broadband:

> The construction of a local communications network – whether used for voice, video, data or some combination thereof – requires enormous capital expenditures.

1 Available at: http://www.roycroftconsulting.org/response_to_Ford.pdf

2 Phoenix Policy Paper No. 24. George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Network Neutrality and Industry Structure," April 2006. Available at: http://www.phoenix-center.org/ppapers.html

3 Phoenix Center for Advanced Legal & Public Policy Studies. *Network Neutrality and Scale Economies: A Response to Dr. Roycroft*, May 2006. (Hereinafter, "Phoenix Reply to Dr. Roycroft.") Available at: http://www.phoenix-center.org/RoycroftResponseFinal.pdf

> These expenditures are fixed costs and, consequently, firms in these markets have considerable economies of scale (i.e., average costs fall as output increases). The presence of these significant scale economies results in highly-concentrated market structures, since larger firms operate at a sizeable cost advantage over smaller firms.[4]

To summarize the key points which Phoenix previously recognized: Last-mile broadband networks require huge capital expenses; these capital expenses are largely fixed costs (which are primarily sunk);[5] these fixed costs result in "significant" scale economies; significant scale economies result in cost advantages for large (incumbent) firms, and a highly concentrated market.

In Phoenix's Reply, they point to various discussions in Policy Paper No. 24 to demonstrate that economies of scale "play a key role in the analysis" that they conduct.[6] Let us consider whether the economic model Phoenix selects to analyze entry in last-mile telecommunications markets comports with the facts that Phoenix has elsewhere recognized. Specifically, does Phoenix's approach in Policy Paper No. 24 reflect the "significant" scale economies which are present in last-mile markets?

Phoenix's Modeling Choice: the Cournot Model

To model last-mile network entry, Phoenix has selected the Cournot model. The Cournot model assumes that firms compete by deciding what level of output to produce, and, as applied by Phoenix, is a static, one-shot entry game.[7] When a Cournot game is played, the Cournot assumption is that each firm takes the level of output of its rival as given, and then decides how

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4 Phoenix Policy White Paper No. 21, July 2005, p. 8.

5 *Id.*, p. 3.

6 Phoenix Reply to Dr. Roycroft, p. 3.

7 The Cournot model, while predating modern game theory, is widely recognized as a precursor to game theoretic analysis. Thus, I discuss Cournot in terms of game play. See, for example, Friedman, J. *Game Theory with Applications to Economics*, Oxford University Press, New York, 1986, p. 22.

much to produce.[8] When the entrant and incumbent are roughly equal-sized firms, with no firm having superior market advantage, or when no firm exercises a leadership position, Cournot may be a reasonable approach to predict how firms will behave. Cournot modeling may make the most sense if marginal costs are sharply rising.[9] These assumptions are completely out of sync with empirical evidence regarding market conditions in last-mile telecommunications networks, where incumbents have tremendous market advantages, where entrants are likely to face higher costs than incumbents, and where marginal costs are falling.

With Phoenix's application of the Cournot model:

- The incumbent and entrant face the same *constant* marginal costs of production, in other words, no firm has a cost advantage.[10]

Thus, Phoenix's use of Cournot does not comport with what we observe in a marketplace characterized by scale economies, i.e., cost advantages for incumbents and declining marginal costs.[11]

When Phoenix's Cournot game is played, the following outcome is observed if entrants can differentiate their product, and sunk costs are not "too large":

- In equilibrium, the incumbent and entrant split the market and earn equal profits.[12]

This outcome reflects the fact that the incumbent has no cost or other market advantages in Phoenix's model, therefore, entrants face incumbents who accommodate entry and share the

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8 Pindyck, R., and Rubinfeld, D. *Microeconomics,* MacMillan, 1989, p. 428.

9 Tirole, J. *The Theory of Industrial Organization*, MIT Press, 1989, p. 224.

10 Phoenix Policy Paper No. 24, p. 12. This is not a requirement of Cournot, but Phoenix does not explore the case where marginal costs differ.

11 Phoenix concedes that a model which introduced declining marginal costs might serve as an alternative interpretation of market outcomes where scale economies are present. Phoenix Reply to Dr. Roycroft, p. 4, footnote 9.

12 Phoenix Policy Paper No. 24, p. 16.

market.

Thus, according to Phoenix's application of Cournot, absent product differentiation, a "natural monopoly" market outcome results.[13] However, the "natural monopoly" with which Phoenix's model begins can be overcome if the entrant differentiates its product, even by a little bit. The market outcome in Phoenix's Cournot model, when product differentiation is allowed, is an incumbent that accommodates entry (rather than fighting entry).

Does the story told by Phoenix's Cournot model comport with the reality of an incumbent operating with "substantial" scale economies and cost advantages over its rivals, as is reasonable to expect in last-mile telecommunications markets? Phoenix's model's prediction is that a monopolist's response to entry by a firm which offers a slightly differentiated product is to accommodate and share the market. Clearly this is not a reasonable expectation when incumbents are dominant firms. Substantial scale economies award the incumbent cost and market advantages which are not acknowledged in Phoenix's modeling approach. Phoenix's analysis indicates that the incumbent cannot capitalize on the advantages which are driven by substantial scale economies (or take advantage of any other benefit which incumbents have at their disposal, such as first mover advantages, the ability to raise its rivals costs, or superior access to capital, rights of way, or multi-tenant buildings). Phoenix's model simply says: faced with entry prospects, incumbents accommodate and share the market. This outcome does not reflect a market characterized by significant scale economies.

Is Cournot the Only Way to Think About Last-Mile Markets?

Is there another way to think about, and model, the behavior of entrants and incumbents in last-mile telecommunications markets? If "significant scale economies" (as well as sunk

[13] Phoenix Reply to Dr. Roycroft, p. 4.

costs) are present, and “larger firms operate at a sizeable cost advantage over smaller firms,” then a market is better explained with a *dominant firm* approach.[14] In Phoenix Policy Paper No. 12, titled “Why ADCo? Why Now?,” Phoenix used a dominant firm model to explain why it is good policy to encourage the provision of last-mile networks on a “neutral” basis.[15] In “Why ADCo?” Phoenix points out the inherent conflict of interest associated with an integrated last-mile network provider that offers retail services, and which also provides access to its network facilities for competing retail firms to reach their customers.[16] Specifically, Phoenix finds that in these circumstances an incumbent will have the incentive to “sabotage and discriminate against rivals.”[17]

In “Why ADCo?” Phoenix concludes that the entry of an unintegrated last-mile network provider (the “alternative distribution company” or ADCo) that allows unaffiliated third-party retail providers equal access to the last-mile will have the following favorable result:

> [W]hile the number of local access networks the market can sustain may be few, the wholesale nature of the ADCo nonetheless permits the number of providers of advanced telecoms products and services to be many.[18]

Thus, Phoenix observed that in spite of market conditions dictating that competing last-mile

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14 See, for example, Carlton, D. And Perloff, J. *Modern Industrial Organization, 4th Ed.* Pearson Addison Wesley, 2005, pp. 111-112.

15 Phoenix Center Policy Paper Number 12: “Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the ‘Last Mile’ in Local Telecommunications Markets,” November 2001. The authors of Phoenix Policy Paper No. 24, George Ford and Lawrence Spiwak, are coauthors of the “Why ADCo?” paper.

Their dominant firm model appears on pp. 23-25. The benefits of a neutral last - mile network are discussed on p. 40 and *passim.*

16 “Why ADCo?”, pp. 34-35.

17 *Id.*, p. 35.

18 *Id.*, p. 40.

networks are few, competition for advanced retail services can be achieved if a neutral last-mile platform is available, in other words—nondiscrimination (network neutrality) encourages retail competition over last-mile networks where facilities-based competition is unlikely.

Given the difference in Phoenix's approach to interpreting last-mile markets in "Why ADCo?" and Policy Paper No. 24, its fair to consider whether Phoenix is addressing different underlying market structures. Phoenix's position on the nature of last-mile telecommunications networks in Policy Paper No. 24 is described by Phoenix as follows:

> We set out to analyze how Network Neutrality rules would affect industry structure in a market that is characterized by economies of scale, and fixed and sunk costs.[19]

Phoenix also indicates that it currently expects the fixed and sunk costs to be "large."[20] How did Phoenix perceive the underlying market structure in "Why ADCo?" Was it different than the market structure that Phoenix addresses in Policy Paper No. 24? Clearly not, here is Phoenix's take on market structure from "Why ADCo?":

> [T]his Policy Paper. . . explains that entry into the local exchange market requires large fixed and sunk costs, making entry risky and necessitating scale economies.[21]

Thus, in "Why ADCo?" the market structure they describe is the same as the last-mile world they model in Phoenix Policy Paper No. 24, i.e., fixed and sunk costs and scale economies prevail. However, the logical description of market conditions which Phoenix acknowledged in "Why ADCo?" is not reflected in Phoenix's modeling approach in Policy Paper No. 24, where they do not employ a dominant firm approach.

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19 Phoenix Reply to Dr. Roycroft, p. 3.

20 *Id.*

21 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 1.

Furthermore, it is clear from Phoenix's discussion in "Why ADCo?" that the economics of telecommunications market entry that they modeled with a dominant firm approach applied to broadband markets. In "Why ADCo?" Phoenix discussed the last-mile broadband provider RCN to make the point that the business case for last-mile entry was tenuous:

> The inability of local telecoms markets to support large numbers competition can be illustrated by example. Telecommunications firm RCN targets residential customers in densely populated markets with its own network facilities over which it provides telephone, data and video services. According to its financial documents, RCN has $2.75 billion in plant and passes about 1.5 million homes, or 1.1 million marketable homes. Network costs run about $1,750 per home passed, $2,500 per marketable home, or about $6,500 per customer. A rough estimate of RCN's monthly plant costs (assuming a 15% hurdle rate and 15 year payoff) is about $25 per home passed. Average revenue per subscriber per month is about $130 and direct costs are about 46% of revenues, implying a gross monthly margin of about $68 per subscriber. In order to cover plant costs with its net revenues, RCN needs a penetration rate of about 35%-40% (and that is in the more densely populated markets targeted by RCN over a network capable of generating services worth $130 per subscriber). Notably, if a 35%-40% penetration is required for profitability, then only two firms can profitably service the same market, and RCN and the incumbent makes two. To construct an RCN-style network for every household in the U.S., the plant investment and total entry costs would be about $300 billion and $600 billion, respectively. Clearly, network-based entry is incredibly costly and not something that is replicable by numerous firms in the same market.[22]

Phoenix's previous view of the difficulties facing a last-mile broadband provider, as illustrated by RCN's experience, was reasonable. In fact, RCN filed for Chapter 11 bankruptcy protection in 2004, and has yet to return to profitable operations.[23]

Phoenix's Cournot approach to modeling entry in last-mile markets in Policy Paper No. 24 does not reflect the reality they previously recognized. Last-mile telecommunications competition faces an uphill battle, and incumbents hold a decided market advantage. It is entirely unreasonable to expect, as Phoenix does, that incumbents will not leverage their market

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22 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, pp. 11-12.

23 RCN Corporation, 10-K, December 31, 2005, p. 6.

advantages, including the advantages associated with scale economies, and fight entry.

When Dominant Firms are Present, a Neutral Last-Mile Network Serves the Public Interest

In "Why ADCo?" Phoenix's policy vision called for the entry of a "wholesale-only carriers-carrier"[24] (the ADCo) which provides a neutral platform over which market entrants can sell retail services. Phoenix concluded that such an arrangement would serve the public interest.[25] Apparently, Phoenix does not see the parallel between a neutral wholesale network allowing retail service providers to reach their customers, and neutral last-mile broadband Internet access facilities which allow third-party providers of Internet content, applications, and services to reach their customers. Nor does Phoenix currently see the incentives which integrated incumbent last-mile providers have to disadvantage non-integrated rivals, even though it previously recognized these incentives. In "Why ADCo?" Phoenix was well aware of the power that a dominant firm has to disadvantage its rivals, and Phoenix indicated that "*to the extent that the incumbent dominant firm is able to impose costs on rivals, its incentives are to do so.*"[26] It is entirely reasonable to expect that a dominant last-mile broadband provider will disadvantage its rivals in a similar fashion, another lesson Phoenix has now forgotten. Dominant firms in last-mile markets make network neutrality the best policy.

In summary, Phoenix has now taken an economic position on the nature of entry in last-mile broadband networks that does not address the significant scale economies and sunk costs which hinder market entry. In "Why ADCo?" Phoenix noted:

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[24] Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 2.

[25] *Id.,* p. 36.

[26] *Id,* p. 29, emphasis in the original.

> The economics of the telecommunications industry, particularly the supply-side economics, have not changed that much over time. Fewness in supply is the rule, not the exception. Instead, fiber optics, and other technological innovations, notwithstanding the inherent economies of scale and sunk costs of telecommunications networks, remain key drivers of industry structure. As Professors Carl Shapiro and Hal Varian succinctly state in their book INFORMATION RULES: *"Technology Changes. Economic laws do not."*[27]

Phoenix can't have it both ways. Significant scale economies in last-mile markets result in a dominant incumbent that is willing to disadvantage its rivals and fight entry. We can't reasonably expect, as Phoenix does in Policy Paper No. 24, that an incumbent which commands the advantages of significant scale economies will accommodate entry and share the market.

Product Differentiation

Phoenix's basic premise in Policy Paper No. 24 with regard to product differentiation is that policymakers, by enforcing a policy of network neutrality, can eliminate all product differentiation between last-mile networks. Phoenix Center's Reply indicates that I have misunderstood their assumptions regrading product differentiation, and that their model "allows one to establish different degrees of permissible differentiation."[28] Phoenix's argument is not on point.

Within the context of their model, the parameter in question is represented by the Greek letter Theta (θ). In their Reply, Phoenix argues that θ can take on any value, "from identical goods ($\theta = 1$) to completely differentiated goods ($\theta = 0$), and everything in between."[29] Phoenix's Reply is a red herring. In Policy Paper No. 24, their conclusion regarding the undesirable nature of network neutrality is based on their analysis of the value which θ takes in

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27 *Id.*, p. 39, emphasis in the original.

28 Phoenix Reply to Dr. Roycroft, p. 5.

29 *Id.*

equilibrium. Specifically, they state: "*Without Network Neutrality requiring $\theta = 1$, a firm may enter with $\theta < 1$,*" as long as sunk costs "are not too large."[30] Thus, it is not the case, as suggested by Phoenix's Reply, that θ can "take on any value" for purposes of policy measures designed to enforce network neutrality, as defined in their model. Rather, the key assumption in Policy Paper No. 24, on which their conclusion fully rests, is that policymakers can force $\theta = 1$. If policymakers can't force $\theta = 1$, then entry will occur (if sunk costs are not too high).

In my original response to Phoenix, I pointed out that policymakers would have a difficult time preventing all product differentiation, as network neutrality principles are consistent with both marketing differences (e.g., how much bandwidth is sold), and with inherent technological differences across broadband platforms (e.g., low-bandwidth mobility vs. high-bandwidth fixed). Phoenix, in its Reply, now suggests that these marketing and technology differences are not really differentiation.[31] They accuse me of assuming "technological determinism."[32] Given Phoenix's previous writings on product differentiation, this is a puzzling accusation. Phoenix Center has previously recognized that technological differences across platforms can introduce differentiation:

> A recent study by the General Accounting Office ("GAO") on competition between cable television and DBS firms illustrates the importance of product differentiation. While both terrestrial and satellite multichannel video providers offer similar products, there are some meaningful forms of differentiation between the two. The differences in the delivery technology itself (i.e., inter-modality) are not lost on consumers.[33]

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30 Phoenix Center Policy Paper No. 24, p. 18, emphasis added.

31 Phoenix Reply to Dr. Roycroft, p. 6.

32 *Id.*

33 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, p. 24. Available at:

(continued...)

It's not clear why consumers of video services will be able to identify "meaningful forms of differentiation" resulting from "differences in delivery technology," while broadband customers will not. Thus, within the context of their model, differentiation sufficient to result in $\theta < 1$ is likely, regardless of policy decisions regarding network neutrality. Phoenix falsely concludes that network neutrality policy could eliminate all differentiation and prevent entry.

Finally, on the issue of product differentiation, Phoenix states that my analysis indicates that recent drafts of network neutrality legislation are "unenforceable."[34] Phoenix's illogic on this point is based on the premise that prohibitions on discrimination, such as those which have been included in draft legislation, would somehow trump technology differences which create the differentiation which Phoenix's model predicts will encourage entry. Network neutrality principles do not rule out technical or marketing differentiation, they simply rule out discrimination. In "Why ADCo?" Phoenix recognized the major problems that discrimination creates, and the overwhelming incentives that incumbents have to discriminate:

> [T]he ADCo provides a viable economic solution for new entrants to the problems raised by the inherent incentive of an incumbent to unduly discriminate to protect its profits. This issue of incentives is key to understanding the current ills of the market, as it is now clear that policymakers significantly under-estimated the significant incentives of the incumbents to unduly discriminate against their rivals (not to mention . . . underestimating the entry costs of the local market).[35]

Network neutrality principles are a much more modest solution to the discriminatory incentives faced by incumbents than structural separation, which was previously identified by Phoenix as

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[33](...continued) http://www.phoenix-center.org/ppapers.html

[34] Phoenix Reply to Dr. Roycroft, p. 6.

[35] Phoenix Policy Paper No. 12, "Why ADCo?", pp. 7-8.

the best way to address the incumbent's incentives to discriminate.[36]

Upstream Competition

Abandonment of Network Neutrality principles will have definite consequences on the delivery of content, services, and applications over last-mile broadband facilities. Competition and innovation at the network edge could be damaged by gatekeepers in the last mile. In my original paper, I was critical of Phoenix's analysis as its model did not address the loss of social welfare that is likely to arise if competition and innovation at the network edge are harmed.

Phoenix states in its Reply that it was concerned about these issues, and points to two passages from Policy Paper No. 24 as proof.[37] While it is appreciated that these passages do pay lip service to the proposition that abandonment of network neutrality could lead to some other harms, Phoenix did not include these negative consequences in its modeling exercise, and otherwise ignores the larger issue of the harm to upstream competition. Most important, their social welfare analysis, as well as the mathematical proof which provides the entire economic basis for their conclusions, fails to incorporate the potential harm to upstream competition. This results in an incomplete analysis of the proposed policy change. When Phoenix states in its mathematical proof that if sunk costs of entry are "not too large, then Network Neutrality is socially inefficient,"[38] the "social inefficiency" is completely devoid of any consideration of the impact on upstream markets. This oversight makes Phoenix's analysis incomplete and incapable of lending any guidance to policymakers on the issue of network neutrality.

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[36] *Id.*. p. 8.

[37] Phoenix Reply to Dr. Roycroft, pp. 6-7.

[38] Phoenix Policy Paper No. 24, p. 18.

The Level of Sunk Costs

In my response to Phoenix Policy Paper No. 24, I pointed out that their analysis hinged on a low level of sunk costs. Phoenix says that their analysis depends on sunk costs which are "not too large." In its reply, Phoenix provides a rather entertaining exercise in illogic to support the proposition that "low level" and "not too large" are entirely different concepts.[39]

Of course, sunk costs of entry in the telecommunications industry in general, and the last-mile broadband market in particular, are very large. This fact has been previously acknowledged by the Phoenix Center:

> As consistently demonstrated by academic and Phoenix Center research, and again in this POLICY PAPER, given the *huge fixed and sunk costs* inherent to the construction and commercial operation of communications networks, the equilibrium level of concentration of terrestrial firms in local communications markets (voice, video, and data) will be relatively high. . . . *fewness arises because scale economies and sunk costs limit the number of firms that can profitably serve a market – and local communications networks are notoriously riddled with scale economies and sunk costs.* Any policymaker interested in local communications markets should, therefore, start from the assumption that there will, at best be only a "few" facilities-based firms.[40]

Furthermore, sunk costs of market entry are not just limited to the tremendous up-front costs of building a network. As Phoenix has previously observed:

> On average, however, net plant amounts to about 37% (approximately two-thirds) of total entry costs. . . . In other words, for every dollar of investment in plant and equipment, an additional $2 of entry costs are incurred on average. There is no reason to suspect that these additional entry costs are less sunk than plant and equipment, but good reason to believe such costs are more sunk.[41]

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39 Phoenix Reply to Dr. Roycroft, pp. 7-8.

40 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

41 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An
(continued...)

Given these facts, it is clear that Phoenix's attempt to paint "low" and "not too large" as diametrically opposites is another red herring.

As is noted by Phoenix, their mathematical proof associated with the level of sunk entry costs which will deter entry "provides a method to determine how small or large entry costs need to be for Network Neutrality rules to be inefficient."[42] However, now with two opportunities, Phoenix has not utilized this "method to determine how small or large entry costs need to be" to provide any absolute numerical value, or relative evaluation, of what level of sunk costs deter entry within the context of their model. They say they can do it, but they don't. Let's consider why that might be.

Phoenix's modeling approach is a one-shot game. Interpreting the impact of sunk costs within the context of a one shot game is likely to drive the entry-deterring threshold level of sunk costs to an extremely low level, as the entrant has only one period of play to earn profits sufficient to justify the sunk investments. In other words, within the context of Phoenix's model, the entrant must be able to justify the recovery of all sunk costs in a short period of time, thus making it imperative that the sunk costs are negligible for entry to be feasible. So, within the context of their modeling exercise, Phoenix's one-shot game makes it likely that a very low level of sunk costs will be sufficient to deter entry.

Phoenix might argue that the period of game play could be long enough to allow for the recovery of sunk costs, but such an assumption would create further inconsistencies. Sunk assets may be long-lived and interpreting a "one-shot" interaction which lasts over a period long

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[41](...continued)
Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 14.

[42] Phoenix Reply to Dr. Roycroft, p. 8.

enough to allow for the recovery of long-lived sunk costs is necessarily contradictory. Recall that an assumption of the Cournot model is that players of the game do not expect that other players will change their output during the play of the game. Holding this expectation over a long period of time is entirely unreasonable. Of course, to give the game a longer period of play, Phoenix could have selected a modeling approach which assumed that the Cournot game was repeated. However, when Cournot games are repeated, it is easy to show that incumbents are very likely to fight entry and attempt to drive rivals out.[43] This reality is one that Phoenix now prefers to ignore.

Conclusion

Policymakers need sound economic advice when considering issues associated with network neutrality. Economic analysis may be able to assist with this process. However, theoretical economic analysis must be reasonably consistent with empirical evidence regarding the nature of the market and the behavior of incumbent firms. The economic analysis contained in Phoenix Policy Paper No. 24 is entirely unsatisfactory as a result. Phoenix does not provide any economic evidence that network neutrality might be economically inefficient or harmful to consumers or society. Nor does their Reply to my critique undermine my conclusion that their approach is fatally flawed.

While Phoenix indicates in Policy Paper No. 24 that they do not take any position on the need for network neutrality rules, they have made their position more clear in their new paper on this matter. In this new research, Phoenix alleges that it has identified "efficiency risks"

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[43] See, for example, Friedman, J. *Game Theory with Applications to Economics*, Oxford University Press, New York, 1986, pp. 136-139.

associated with network neutrality policy, based on a benefit/cost analysis.[44] To support their claims, they point to analyses produced by AT&T and BellSouth regarding alleged costs of building network capacity. They also attack views that dissent from the RBOC conclusions. As time permits, I will provide a detailed critique of the numerous problems associated with Phoenix's new research. However, first and foremost among these problems is the fact that Phoenix's new research points repeatedly to Phoenix Policy Paper No. 24 to support Phoenix's new conclusions.[45] Given this indefensible foundation, Phoenix's new claims regarding efficiency risks and network neutrality are dubious.

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44 "The Efficiency Risks of Network Neutrality Rules," Phoenix Policy Bulletin No. 16, May, 2006.

45 *Id.*, pp. 2, 5, 6, & 7.

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IN RESPONSE…

July 2006

A RESPONSE TO DR. ROYCROFT (REDUX)

I. Introduction

In this IN RESPONSE, we reply to further comments by Dr. Trevor Roycroft[1] on our PHOENIX CENTER POLICY PAPER NO. 24, *Network Neutrality and Industry Structure*.[2] In our reply to his first set of comments,[3] we clearly showed that all of Dr. Roycroft's criticisms were either incorrect or irrelevant. In fact, it was plain in our reply that his comments were difficult to reconcile with a basic reading of POLICY PAPER NO. 24 and with the established literature in general.[4] Not withstanding, despite showing conclusively in our first IN RESPONSE that Dr. Roycroft clearly did not carefully read, much less understand, our original paper, Dr. Roycroft simply chose to ignore our first IN RESPONSE and to issue both a subsequent paper critiquing our work[5] and a

[1] Dr. Roycroft's rejoinder to our first IN RESPONSE is available on the Phoenix Center's web page at: http://www.phoenix-center.org/Reply_to_Phoenix_Final.pdf. The Phoenix Center has a long-standing policy to post substantive critiques of our work in an effort to ensure the accuracy and legitimacy of all analysis performed and released by the Phoenix Center. In some cases, comments on our work provide direction for future research. At the Phoenix Center, we appreciate criticism and comment, since such review can be used to either affirm or improve our analysis, thereby making our work more useful for policy decisions.

[2] G. Ford, T. Koutsky and L. Spiwak, *Network Neutrality and Industry Structure*, PHOENIX CENTER POLICY PAPER NO. 24 (April 2006) (available at: http://www.phoenix-center.org/pcpp/PCPP24Final.pdf).

[3] Dr. Roycroft's first critique to POLICY PAPER NO. 24 may be downloaded from the Phoenix Center's web page at: http://www.phoenix-center.org/RoycroftRespPCPP24.pdf.

[4] *Network Neutrality and Scale Economies: A Response to Dr. Roycroft* (May 2006) (available at http://www.phoenix-center.org/RoycroftResponseFinal.pdf).

[5] Trevor R. Roycroft, *Economic Analysis And Network Neutrality: Separating Empirical Facts From Theoretical Fiction — Issue Brief Prepared for Consumer Federation of America, Consumers Union and Free Press* (June 2006) (available at: http://www.freepress.net/docs/roycroft_study.pdf).

subsequent comment on our initial IN RESPONSE where he not only repeats the analytical errors of his first flawed critique but adds to them. As we describe briefly in this IN RESPONSE, Roycroft's additional criticisms of POLICY PAPER NO. 24 are as irrelevant and inaccurate as his initial commentary. Roycroft's sophomoric comments continue to exhibit a fundamental failure to carefully read and fully comprehend the analysis contained in POLICY PAPER NO. 24, and perhaps a general lack of familiarity with the basic principles and tools of economic analysis. Equally as important, the fact that Dr. Roycroft deliberately continues to ignore these obvious points in his subsequent papers — despite the fact that he was made aware of the patent errors in his original critique — is disingenuous.

To remind the reader, the theme of POLICY PAPER NO. 24 was simple and logical, and can be summarized as an analysis which:

> … shows that policymakers should avoid Network Neutrality mandates that have the intent or effect of "commoditizing" broadband access services since such a policy approach is likely to deter facilities-based competition, reduce the expansion and deployment of advanced communications networks, and increase prices. 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 (at 1).

Our findings were based on (what we thought was) a well-understood principle of economics.[6] Specifically, the basic underlying theory of the paper is that *as the products of firms become more differentiated, price competition weakens thereby increasing profits, and this increase in profits allows, under certain conditions, additional entry*.[7] This simple theme is fairly standard industrial economics and holds under a wide range of assumptions including the theoretical

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[6] J. Tirole, THE THEORY OF INDUSTRIAL ORGANIZATION (1995) ("price competition is softened when the firms face sharply rising marginal costs (capacity constraints, in an extreme case), when they compete repeatedly, or where their products are differentiated (at 223-4); "Moving toward the other firm increases the intensity of price competition (at 329)."; S. Martin, ADVANCED INDUSTRIAL ECONOMICS (1993) ("We see that [with homogeneous products] price equals marginal costs (the competitive result), while [if products are completely differentiated] price is set at the monopoly level (at 39)"); and even M. E. Porter, COMPETITIVE STRATEGY (1980) ("Where the product or service is perceived as a commodity or near commodity, choice by the buyer is largely based on price and service, and pressures for intense price and service competition results. These forms of competition are particularly volatile []. Product differentiation, on the other hand, creates layers of insulation against competitive warfare because buyers have preferences and loyalties to particular sellers (at 19)."

[7] The analysis was unique in that we considered only the effect of differentiation on price competition and ignored the value of variety. A similar theoretical approach to product differentiation and competition is presented in S. Martin (1993), *supra* n. 6 at 38-40.

specification of competition, the nature of demand, and/or the cost structure.[8] Our economic model shows that this additional entry increases consumer welfare, even if consumers do not value differentiation *per se* (i.e., the benefits are purely from price reductions). The theoretical contribution of our paper related primarily to the specification of a demand system where product differentiation could impact consumer welfare even if consumers did not value the differentiation itself. This approach to the problem was a fresh analysis of the well-known relationship between differentiation and profits.

The focus of our analysis (as always) was how policies (in that case Network Neutrality proposals) affect consumer welfare. In the PAPER, we repeatedly noted that we took no position on the desire or need for Network Neutrality legislation. Rather, the purpose of the paper was to illustrate how particular manifestations of Network Neutrality rules can adversely affect market structure and, consequently, harm consumers. We encouraged policymakers in POLICY PAPER NO. 24 to "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 (at 4)." The need to balance the conflicting effects of Network Neutrality rules is undeniably pro-consumer.

In the sections that follow, we will address the additional comments of Dr. Roycroft on POLICY PAPER NO. 24, somewhat in the order they appear in his document.

II. Sunk Costs and Scale Economies

Despite the apparent and fundamental role played by sunk costs and scale economies in our analysis (see our first IN RESPONSE to Roycroft), in his latest round of comments Roycroft continues to argue that our paper failed to consider sunk costs and economies of scale. Roycroft states:

> Phoenix's Cournot approach to modeling entry in last-mile markets in POLICY PAPER NO. 24 does not reflect the reality [that entry into the local exchange market requires large fixed and sunk costs, making entry risky and necessitating scale economies]. Last-mile telecommunications competition faces an uphill battle, and incumbents hold a decided market advantage (at 7)."

As we explained in our initial IN RESPONSE, Dr. Roycroft's allegation is simply ridiculous because it is impossible to reconcile such a critique with the plain text of POLICY PAPER NO. 24. In describing our findings, we note:

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[8] *Id.*

> Economic theory suggests that product differentiation is an important component of competition, particularly in industries with large fixed and sunk costs (at 2).

Also, we observe,

> … 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 POLICY PAPER, Network Neutrality rules that encourage commoditization of broadband service *exacerbate* this tendency toward concentration in an industry that already characterized by an inherently high equilibrium industry concentration level (at 3-4).

As we have shown clearly and repeatedly in our work, the communications industry is characterized by an inherently high equilibrium industry concentration level because of fixed and sunk costs (and Roycroft, in his comments, quotes us repeatedly on this point).[9] We also observe in the paper:

> … 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 (at 20).

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[9] Indeed, many of our papers were heavily influenced by the pioneering work of John Sutton (*see* John Sutton, SUNK COSTS AND MARKET STRUCTURE (Cambridge, MA: The MIT Press, 1996)) and rely on Sutton's general conceptual framework of understanding the relationship of sunk costs to industry equilibrium for their theoretical orientation. *See, e.g.*, J. Duvall and G. Ford, *Changing Industry Structure: The Economics of Entry and Price Competition*, PHOENIX CENTER POLICY PAPER NO. 10 (April 2001), reprinted in 7 TELECOMMUNICATIONS & SPACE JOURNAL 11 (2001); T. R. Beard, G. Ford and L. Spiwak, *Why ADCo? Why Now? An Economic Exploration into the Future Industry Structure for the "Last Mile" in Local Telecommunications Markets*, PHOENIX CENTER POLICY PAPER NO. 12 (November 2001); reprinted in 54 FED. COM. L. J. 421 (May 2002); G. Ford, T. Koutsky and L. Spiwak, *Competition After Unbundling: Entry, Industry Structure and Convergence*, PHOENIX CENTER POLICY PAPER NO. 21 (July 2005). Moreover, we have also discussed the presence of high fixed and sunk costs as entry barriers for years. *See e.g.*, G. Ford, T. Koutsky and L. Spiwak, *The Consumer Welfare Cost of Cable "Build-out" Rules*, PHOENIX CENTER POLICY PAPER NO. 22 (July 2005), reprinted as *The Economics of Build-Out Rules in Cable Television*, 28 HASTINGS COMMUNICATIONS AND ENTERTAINMENT LAW JOURNAL 207 (2006); T. Hazlett & G. Ford, *The Fallacy of Regulatory Symmetry: An Economic Analysis of the 'Level Playing Field' in Cable TV Franchising Statutes*, 3 BUSINESS AND POLITICS 21 (2001); J. Olson and L. Spiwak, *Can Short-Term Limits on Strategic Vertical Restraints Improve Long-Term Cable Industry Market Performance?* 13 CARDOZO ARTS & ENT. L.J. 283 (1995). Given such a long and consistent record of recognizing the presence of high fixed and sunk costs in the telecommunications industry, Dr. Roycroft's claim's that we ignore the presence of sunk costs is laughable.

All three of these statements are found in either the Introduction or Conclusion, so even a marginally interested reader would likely read them. Further, the term "sunk costs" appears over 20 times in POLICY PAPER NO. 24. Why Dr. Roycroft continues to bull-headily ignore the obvious and vital role played by sunk costs and scale economies in our paper (and in our research over the years) is a total mystery.

III. The Cournot Model

In his latest commentary, Roycroft spends a great deal of time complaining about our (alleged) exclusive use the Cournot model of competition in our theoretical analysis. Yet, one needs to look no further than the Table of Contents to our POLICY PAPER to see that our theoretical analysis considers not one but *three* alternative models of competition: (1) monopoly (the lack of competition); (2) Cournot competition; and (3) Bertrand competition. Or, had he read the text of the POLICY PAPER, he may have stumbled upon the sentence reading, "[i]n our model, price competition can be either Cournot competition in quantities or Bertrand competition in prices (at 10)." Again, Dr. Roycroft appears not to have studied our analysis sufficiently to provide meaningful commentary on it.

As for the validity of his that "Cournot modeling may make the most sense if marginal costs are sharply rising," which he supports with a quotation from Jean Tirole's seminal text "Theory of Industrial Organization," Roycroft has confused general modeling technique with Tirole's reconciliation of Bertrand and Cournot outcomes when capacity-constrained Bertrand competition occurs (rendering the Cournot outcome).[10] Looking back to Tirole's treatment of "Traditional Cournot Competition," Tirole assumes constant cost.[11] Further, those with even a casual familiarity with the economic literature know that Cournot competition with constant costs is a common modeling approach.[12] Or, as the notable scholar of oligopoly theory James Friedman observed, "[i]f one must choose between the models of Cournot and Bertrand as providing the best simple vehicle for exhibiting the nature of oligopoly, the Cournot model is definitely superior ….").[13] But even more important, whether or not costs are rising, falling, or

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10 The seminal article illustrating the point is D. M. Kreps and J. A. Scheinkman, *Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes*, 14 BELL JOURNAL OF ECONOMICS 326-37 (1983).

11 Tirole (1995), *supra* n. 6 at 220.

12 Consider these recently published papers in the AMERICAN ECONOMIC REVIEW (the most prestigious journal of the economics profession): C. E. Hall and R. E. Hall, *Toward a Quantification of the Effects of Microsoft's Conduct*, 90 AMERICAN ECONOMIC REVIEW 188-191 (2000); S. W. Salant and Greg Shaffer, *Unequal Treatment of Identical Agents in Cournot Equilibrium*, 89 AMERICAN ECONOMIC REVIEW 585-604 (1999); and R. Schmalensee, *Sunk Costs and Antitrust Barriers to Entry*, 94 AMERICAN ECONOMIC REVIEW 472-475 (2004).

13 J. Friedman, *Oligopoly Theory*, in K. J. Arrow and M. D. Intriligator (eds), HANDBOOK OF MATHEMATICAL ECONOMICS, VOL. II (1982): 491-534 at 505.

constant, the conclusions of our POLICY PAPER are unchanged, and that fact should be apparent to the trained eye of an economist.[14] So, not only is Dr. Roycroft wrong on all counts, but his entire discussion is irrelevant to the conclusions of our paper.

IV. Product Differentiation

Roycroft contends that our model requires that product differentiation be entirely eliminated. In the model in our paper, goods are commodities when the "theta" term equals 1.00 (that is, $\theta = 1$). Roycroft's comment on differentiation is incorrect and apparently the consequence of a failure to comprehend mathematical economic models. While we do assume $\theta = 1$ in our *Proposition* and *Proof* (at 18), this assumption is merely a modeling convenience. We could just have easily assumed that Network Neutrality rendered $\theta = 0.9$ (or any other value less than 1), and then said that absent Network Neutrality $\theta < 0.9$ (or whatever value we assumed for θ). Since the model is continuous in θ, the results holds irrespective of the initial value of θ chosen for comparison. Again, Roycroft's comments on our paper reveal his failure to fully comprehend our analysis.

V. "Large" versus "Not Too Large"

In his first round of comments, Roycroft incorrectly asserted that we assumed in our model that sunk costs were small. In fact, our paper states that sunk costs are "not too large." Obviously, there's a difference. "Large" is an absolute concept, whereas "not too large" is a relative concept.

In his second set of comments, Roycroft again exhibits his inability to grasp the simple difference between the concepts of absolute and relative sizes. In our first IN RESPONSE, Roycroft claims that we provided an "entertaining exercise in illogic to support the proposition that 'low level' and 'not too large' are entirely different concepts (at 13)." Yet, they are entirely different concepts, and any respectable economists would know why.

The issue of sunk costs being "not too large" is part of the discussion of Equation (29). Equation (29) essentially states that a firm will enter (and increase consumer welfare) if the firm's gross profits exceed the sunk costs of entry (*E* in the equation). By "not too large," we

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[14] While the mathematical analysis would be more complex, there is no reason to complicate an economic model with assumptions that do not meaningfully alter the conclusions. The only potential change to the conclusion is that with rapidly declining marginal cost, it may be best for the government to prohibit competition altogether and regulate a statutory monopoly. We do not believe government-sanctioned and protected monopoly is a legitimate approach to broadband policy. Even so, our mathematical model remains valid, but satisfying the condition for welfare improving entry would be very difficult.

mean that this condition is satisfied only if *E* is less than gross profits, not that *E* is small or large in terms of its level. Thus, being "not too large" is a relative matter, not an absolute one.

For example, say that gross profits are $100 billion dollars. Then, *E* would need to be $99.99 billion to be "not too large." Of course, $99.99 billion dollars is not a small level of sunk costs by any standard, but it is "not too large" in the context of our model. Or, in contrast, if gross profits are only $1, then *E* is "too large" if it is $1.01, but obviously $1.01 is not a large number in absolute terms, but it would be "too large" in our model. Again, Roycroft fails to understand our economic model and, it appears, economic modeling and logic more generally.

VI. Additional Irrelevancies

Roycroft's careless commentary is not restricted to his limited understanding of POLICY PAPER NO. 24. For example, Roycroft criticizes our model because we fail to address the issue of whether incumbents will accommodate or deter the entry made possible by product differentiation (Roycroft 2, at 4). In his comments, he states:

> Phoenix's model's prediction is that a monopolist's response to entry by a firm which offers a slightly differentiated product is to accommodate and share the market. Clearly this is not a reasonable expectation when incumbents are dominant firms (at 4).

Roycroft is precisely wrong on this point. Had Dr. Roycroft made even a cursory review of the literature on entry accommodation and deterrence, he would have observed that product differentiation is a form of "puppy dog" behavior, implying that an incumbent (even a monopolist) is more likely to accommodate entry if there is product differentiation.[15] So, unlike Roycroft's claim, accommodation *is* a reasonable expectation when incumbents are dominant firms and there is differentiation. Thus, Roycroft has pointed out an additional harm of Network Neutrality legislation that leads to commoditization – such rules will encourage incumbent firms to fight entry more aggressively.

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[15] D. Fudenberg and J. Tirole, *The Fat-Cat Effect, The Puppy-Dog Ploy, and the Lean and Hungry Look*, 74 AMERICAN ECONOMIC REVIEW 361-366 (1984); Tirole (1995), *supra* n. 6 ("Product differentiation is another instance of "puppy dog" behavior (at 329)"). The prospects for sabotage are also diminished when there is product differentiation. *See* N. Economides, *The Incentive for Non-Price Discrimination by an Input Monopolist*, 16 INTERNATIONAL JOURNAL OF INDUSTRIAL ORGANIZATION 271-284(1998); D. Mandy, *Killing The Goose That May Have Laid The Golden Egg: Only The Data Know Whether Sabotage Pays*, 17 JOURNAL OF REGULATORY ECONOMICS 157-172 (2000); D. Mandy and D. E. M. Sappington, *Incentives for Sabotage in Vertically Related Industries*, JOURNAL OF REGULATORY ECONOMICS (Forthcoming 2006) ("the integrated producer will refrain from sabotage when products are sufficiently differentiated and undertake the foreclosure level of sabotage when products are sufficiently homogeneous in the linear setting with Cournot competition").

VII. Comments on PHOENIX CENTER POLICY PAPER NO. 12

A number of Roycroft's new comments are based on a comparison of the analysis in POLICY PAPER NO. 24 and the earlier paper PHOENIX CENTER POLICY PAPER NO. 12, *Why ADCo? Why Now? An Economic Exploration into the Future Industry Structure for the "Last Mile" in Local Telecommunications Markets*.[16] As is the case with all our papers, both papers are available (at no charge) on the Phoenix Center website (www.phoenix-center.org). Our series of POLICY PAPERS and POLICY BULLETINS reveals our consistent and analytically rigorous approach to public policy issues.

In the next two sections, we will describe Roycroft's gross mis-interpretation and/or misunderstanding of our analysis in POLICY PAPER NO. 12.

A. *Incentives for Sabotage*

In relation of a firm's incentive to sabotage rivals, Dr. Roycroft completely misunderstands our analysis in POLICY PAPER NO. 12. In fact, his failure to grasp the essence of the argument leads him to argue *against* the need for network neutrality.

In POLICY PAPER NO. 12, we presented an analysis of the incentives of a dominant firm (essentially a monopolist) to sell unbundled elements to retail competitors. As part of the analysis, we presented a theoretical argument explaining the incentives of this dominant firm to sabotage downstream retailers through non-price discriminatory actions. The relevance of that analysis to the Network Neutrality debate is abundantly clear to us (and has been), even though Dr. Roycroft contends that we have failed to "see the parallel" between that research and analysis in POLICY PAPER NO. 24. Strangely, the relevance of that work is entirely at odds with the positions taken by Dr. Roycroft on Network Neutrality.

Let us explain. Roycroft quotes our POLICY PAPER NO. 12 where it states, "to the extent that the incumbent dominant firm is able to impose costs on rivals, its incentives are to do so (at 8)." However, Dr. Roycroft fails to mention that *the incentive to sabotage rivals is solely the consequence of the imposition of price regulation on the dominant firm. In the absence of price regulation, there is no incentive to sabotage rivals* (and this result is general in models of sabotage).[17] Thus, network neutrality advocates calling for the regulation of the prices of broadband service providers (either the prices firms can charge end-users or content providers) are, in effect, calling for their

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[16] *Supra* n. 9.

[17] The definition of the term "sabotage" originates T. Randolph Beard, David Kaserman, and John Mayo, *Regulation, Vertical Integration, and Sabotage*, 49 JOURNAL OF INDUSTRIAL ECONOMICS 319-33 (2001). *See also* Economides (1998), Mandy (2000), and Mandy and Sappington (2006), *supra* n. 15.

own sabotage. As anyone familiar with the economic literature on sabotage knows: *regulation is not the cure for sabotage; regulation is the cause of sabotage*. Clearly, Dr. Roycroft is not familiar with the literature on this point.

B. *Modeling Choice in Policy Paper No. 12*

Dr. Roycroft claims that we should have applied the "dominant firm, competitive fringe" model from POLICY PAPER NO. 12 to the issue considered in POLICY PAPER NO. 24. Again, Dr. Roycroft has a problem reading the text of our papers. The economic model of competition in POLICY PAPER NO. 12 is not the dominant firm/competitive fringe model, which should be obvious since the phrase "competitive fringe" never appears in the paper and the particular mathematical calculations of that model are entirely absent from the analysis. As for POLICY PAPER NO. 24, dominance is inherent to the model, since we consider only concentrated market structures with significant scale economies. Thus, Dr. Roycroft's comment is again incorrect and irrelevant.

VIII. Conclusion

The Phoenix Center is strong advocate of, and significant contributor to, the meaningful debate over the economic and legal principles relevant to the reform of communications legislation and regulation. We encourage commentary on our analysis, critical or supportive, and have a long-standing policy of publishing on our website all thoughtful analysis. Dr. Roycroft, however, has not once *but twice* failed this basic test of basic professionalism and analytical rigor. As such, while we will certainly continue to offer to publish Dr. Roycroft's comments in the future, we will do so only if he is able to construct a meaningful and relevant set of comments that exhibit an understanding of our work and the fundamental economic principles therein.