Towards an Economic Framework for Network Neutrality Regulation

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I. Introduction[2]

Over the past years, the merits of network neutrality regulation have become a hot topic in telecommunications policy debates. Repeatedly, proponents of network neutrality regulation have asked the Federal Communications Commission to impose rules on the operators of broadband access networks that forbid network operators to discriminate against third-party applications, content or portals ("independent applications") and to exclude them from their network.[3] These proposals are based on the concern that in the absence of such regulation, network operators may discriminate against these products and that this behavior may reduce innovation by providers of these products to the detriment of society.

Opponents of regulation deny the need for network neutrality regulation.[4] They argue that regulation is not necessary because network operators do not have an incentive to discriminate against independent applications anyway,[5] or, alternatively,[6] that regulation is harmful because it would reduce network operators' incentive to upgrade their networks in the future.[7]

This paper aims at assessing the economic merits of network neutrality regulation.[8] To this aim, the paper applies insights from game theory, industrial organization, antitrust, evolutionary economics and management strategy to analyze network operators' incentives to discriminate, the impact of potential discriminatory behavior on innovation and social welfare, and the costs of regulation.

The analysis proceeds in three steps. Part II. explores whether network providers have an incentive to discriminate against applications. Economic theory predicts that a network operator that has a monopoly in the market for Internet services does not generally have an incentive to discriminate against independent applications. There are known exceptions to this rule, but there is considerable debate over whether these apply in the Internet context. The

2 Parts of this paper are based on Chapter 9 and Chapter 11 of van Schewick (2004), for which financial support of the German National Academic Foundation ("Studienstiftung des Deutschen Volkes") and the Gottlieb Daimler- and Karl Benz-Foundation is gratefully acknowledged. Thanks to Lawrence Lessig for comments on an earlier version of this paper, and to Robert Pepper and Tim Wu for discussions.

3 See, for example, National Association of Regulatory Utility Commissioners (2002)); Wu and Lessig (2003)); Amazon.com (2002)); High Tech Broadband Coalition (2002b); High Tech Broadband Coalition (2002a); Coalition of Broadband Users and Innovators (2002); Coalition of Broadband Users and Innovators (2003a); Coalition of Broadband Users and Innovators (2003b). For proponents of nondiscrimination rules in the scientific arena, see, for example, Lessig (2001), pp. 248-249; Weiser (2003); Wu and Lessig (2003); Wu (2003); Wu (2004).

4 See, for example, National Cable & Telecommunications Association (2002); National Cable & Telecommunications Association (2003); National Cable & Telecommunications Association (2003). For opponents of nondiscrimination rules in the scientific arena, see, for example, Yoo (2004); Owen and Rosston (2003).

5 For two representative examples of this view, see Speta (2000b) and Speta (2000a).

6 Both arguments are mutually exclusive. If network owners do not have an incentive to discriminate against independent applications anyway, the imposition of the network neutrality regime that prevents such discrimination will not reduce their profits. If it does not reduce their profits, however, it cannot reduce their incentives to invest in upgrades of their network infrastructure in the future.

7 For a representative example of this view, see Thierer (2004).

8 While the exact scope of network neutrality rules is still the subject of debate, the common rationale behind the various proposals is to design rules that explicitly forbid network operators and ISPs to use their power over the transmission technology to negatively affect competition in complementary markets for applications, content and portals. For example, whether network neutrality regulation should prevent price discrimination, is still an open question. See e.g. Wu (2003), pp. 151-154 (arguing against price discrimination, if it is based on discrimination between applications) on the one hand and Nuechterlein and Weiser (2005), p. 177 on the other hand. With respect to different proposals for implementation, see, for example, Wu (2004) and Weiser (2003), pp. 74-84. Network neutrality regulation is not intended to prevent vertical integration between network providers and application providers, i.e. network providers are allowed to offer applications as well (see Wu (2004), p. 89).

analysis shows that the threat of discrimination is more severe than is commonly assumed. First, there are more exceptions than have been previously identified. Second, some of the known exceptions may be more relevant in the Internet context than is commonly thought. Third, contrary to what is commonly assumed, discrimination may be a profitable strategy, even if the network provider does not manage to drive independent applications from the market. Thus, researchers commonly underestimate the potential for discriminatory behavior by network providers.

Finally, participants in the debate usually share the view that competition in the market for Internet services may be able to mitigate the problem. Two policy proposals, the proposals for facilities-based competition and for open access, are based on this view. The analysis contradicts this view. It highlights a variety of circumstances under which a network operator may have the ability and incentive to discriminate against independent applications in spite of competition in the market for Internet services. Thus, Part II. shows that in the absence of network neutrality regulation, there is a real threat of discriminatory behavior.

Part III. analyzes the impact of this threat on innovation in the markets for applications, content and portals ("application-level innovation"). It shows that the threat of discrimination reduces the amount of application-level innovation by independent producers of complementary products. While discrimination increases network providers' incentives to engage in application-level innovation, this increase cannot offset the reduction in innovation by independent producers. Thus, the threat of innovation reduces the amount of application-level innovation.

Part IV. explores the social benefits and costs of network neutrality regulation. It shows that the increase in application-level innovation resulting from network neutrality rules is socially beneficial. On the cost side, network neutrality rules reduce network providers' incentives to innovate at the network level and to deploy network infrastructure. While regulatory intervention has its own costs, these are not covered in detail. When deciding whether to introduce network neutrality regulation, regulators must trade-off the benefits against the costs. The analysis shows that in the context of the Internet, the benefits of network neutrality regulation are more important than the costs.

II. Threat of Discrimination

Calls for network neutrality regulation are based on the assumption that network providers have an incentive to discriminate against unaffiliated providers of complementary products. If network providers do not have such an incentive, there is no need for regulation. In this case, regulation may still serve an educational function and protect customers and providers of independent content, portals and applications from discriminatory or exclusionary conduct by "incompetent incumbents"[9] that fail to recognize that discrimination is not in their best economic interest.[10] Compared to a threat of discrimination due to a real incentive to discriminate, this constitutes a considerably weaker basis for regulatory intervention.

Network technology gives network providers the ability to discriminate against applications running over their networks or to exclude them from the network. The following part explores, whether network providers have an incentive to actually use this discriminatory power. The analysis is based on a stylized model (Section A.). As the answer may differ

[9] Farrell and Weiser (2003), p. 114.

[10] See, for example, Farrell and Weiser (2003), pp. 114-117; Wu (2003), pp. 154-156.

depending on the market structure in the market for Internet services, the analysis proceeds in two steps: In the first step, the network provider is a local monopolist (Section B.). In the second step, the network provider competes with at least one other network provider (Section C.).

The analysis shows that discrimination is much more likely than is commonly assumed.

A. Stylized Model

Network neutrality rules seek to protect competition in complementary products such as Internet applications, content and portals from anticompetitive behavior by network operators or ISPs. To reflect this goal, the analysis focuses on the competitive interactions between "the network" and "applications".[11] Economically, "the network" comprises two distinct layers of economic activity: the operation of physical networks and the provision of Internet access and transport services over these networks. In real life, these activities may or may not be provided by different economic actors with differing economic interests. The resulting competitive interactions between network operators and Internet service providers have featured prominently in the debate over "open access" for independent Internet service providers to broadband cable networks in the United States.[12] To focus on the specific impact of network neutrality rules, the following analysis abstracts from these issues and treats these players as a single economic entity called the "network provider".

The analysis will be based on the following stylized model: for a given physical network, Internet access and transport services and the operation of the network infrastructure are provided by the same economic entity, the "network provider". The corresponding service will be called "Internet service". The network is assumed to provide the same general functionality as the Internet in that it enables computers attached to distinct physical, but interconnected networks to communicate. Contrary to the original Internet,[13] but similar to networks today, the network is application-aware and can control the execution of applications running over its network. Today, technology is available that enables network operators and ISPs to distinguish between the different applications using the network and to

11 In the context of the four layer model of the Internet Architecture used by the Internet Engineering Task Force, "the network" consists of the network layer and the Internet layer, while the application domain consists of the transport layer and the application layer.

12 The open access debate focuses on the question whether the owners of cable networks should be required to allow independent Internet service providers to provide Internet access services over their cable networks. For proponents of open access regulation, see, for example, Lemley and Lessig (1999); Lemley and Lessig (2001); Lessig (2001), pp. 147-167, 246-249; Bar, Cohen et al. (2000); Chen (2001); Cooper (2000); Hausman, Sidak et al. (2001b); Rogerson (2000); Rubinfeld and Singer (2001b); Rubinfeld and Singer (2001a); Hausman, Sidak et al. (2001a). For opponents of open access regulation, see, for example, Lopatka and Page (2001); Robinson (2002); Speta (2000b); Speta (2000a); Woroch (2002); Yoo (2002).

13 In the original Internet, the network was application-blind, i.e. it was unable to distinguish between the applications running over the network. Consequently, network operators were unable to affect the execution of specific applications, shielding independent application developers from strategic behavior by network operators.

The application-blindness was the result of following the broad version of the end-to-end arguments during the design of the Internet (van Schewick (2004), pp. 101-103). This design principle requires that the lower layers of the network be as general as possible, while all application-specific functionality is concentrated at higher layers at end hosts. (There are two versions of the end-to-end arguments: a narrow version, which was first identified, named and described in a seminal paper by Saltzer, Clark and Reed in 1981 (Saltzer, Reed et al. (1981)), and a broad version which was the focus of later papers by the authors (e.g., Reed, Saltzer et al. (1998), p. 69; Clark and Blumenthal (2000), p.1). While both versions have shaped the original architecture of the Internet, only the broad version is responsible for the application-blindness of the network.). For a detailed analysis of the two versions and their relationship to the architecture of the Internet, see van Schewick (2004), pp. 87-129.

control their execution.[14] For example, network providers can slow down selected applications or content, speed them up or exclude them from the network completely.

In the analysis of Section B., the network provider is a local monopolist.[15] The size of its footprint relative to the size of the nationwide network may differ. In the extreme case, the network provider owns the nationwide network and has a nationwide monopoly in the provision of Internet services.

In Section C., the network provider competes with at least one other network provider.

The network provider also offers products in the market for applications, content or portals.[16] These products may be offered in two different ways:

In the first case, the complementary product is offered to consumers nationwide. Thus, if the size of the provider's footprint is smaller than the nationwide network, the product in question is not only offered to customers of its Internet services, but also to consumers living outside its footprint. A product that is offered this way will be called an affiliated product.

Alternatively, the network provider may only offer the product to customers of its Internet service. If the size of the provider's footprint is smaller than the nationwide network, consumers outside its footprint will not be able to use or buy the product. This kind of product will be referred to as proprietary product

For a particular product, the two ways of offering the product are mutually exclusive.

This division reflects the way in which network providers' complementary products are offered in today's Internet market. For example, AOL offers MapQuest, AOL Moviefone or its instant messenger to anybody using the Internet.[17] Similarly, AOL's portal is available both bundled with Internet service and separately.[18] By contrast, T-Online, the dominant German Internet provider, offers its portal only bundled with its Internet service.

The subsequent analysis does not further examine the choice of product provisioning, but takes the result as given.

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14 See, for example, Cisco Systems (2005). This technology violates the broad version of the end-to-end arguments, but as the end-to-end arguments are just a design principle, there is nothing that forces technology to comply with it.

15 See Federal Communications Commission (2001), p. 6578, paragraph 74: "The relevant geographic markets for residential high-speed Internet access services are local. That is, a consumer's choices are limited to those companies that offer high-speed Internet access services in his or her area, and the only way to obtain different choices is to move. While high-speed ISPs other than cable operators may offer service over different local areas (e.g., DSL or wireless) or may offer service over much wider areas, even nationally (e.g. satellite), a consumer's choices are dictated by what is offered in his or her locality." See also Hausman, Sidak et al. (2001a), p. 135: "From a consumer's perspective, the relevant geographic market is local because one can purchase broadband Internet access only from a local residence. Stated another way, a hypothetical monopoly supplier of broadband Internet access in a given geographic market could exercise market power without controlling the provision of broadband access in neighboring geographic markets."

16 Thus, the analysis assumes that the network provider is vertically integrated into the provision of at least some applications. Vertical integration, however, is not the only case to which the analysis applies. A similar analysis applies to other forms of close vertical relationships between the network provider and a provider of complementary products such as partial integration, partial equity investments, long-term contracts, or other forms of close affiliation.

17 TimeWarner (2002).

18 Breznick (2003).

B. Network Provider is Monopolist in the Market for Internet Services

Economic theory predicts that a network operator that has a monopoly in the market for Internet services does not generally have an incentive to discriminate against independent applications (Section 1.). There are known exceptions to this rule, but there is considerable debate over whether these apply in the Internet context. The following analysis shows that the threat of discrimination is more severe than is commonly assumed. First, there are more exceptions than have been previously identified (Section 2.). Second, some of the known exceptions may be more relevant in the Internet context than is commonly assumed (Section 3.). Third, discrimination may be a profitable strategy, even if the network provider does not manage to drive independent applications from the market (Section 4.).

1. No General Incentive to Discriminate

According to the "one monopoly rent theory", a monopolist has no incentive to monopolize a complementary product market, if the complementary product is used in fixed proportions[19] with the monopoly good and is competitively supplied.[20]

In this case, there is only one final product, and, therefore, only one monopoly profit available in the market for the final product. The monopolist can extract the complete monopoly profit through its pricing of the monopoly good, and does not gain additional profits by monopolizing the complementary good.

This line of reasoning suggests that the monopolist need not monopolize the secondary market to extract the entire monopoly rent and therefore has no incentive to drive rivals from that market.

Moreover, economists note that the monopolist may benefit from the presence of independent producers in the complementary product market, implying that the monopolist will welcome, not exclude independent producers of complementary products. This argument has been labeled “internalizing complementary efficiencies (ICE)”.[21]

If the presence of independent producers of complementary products generates additional surplus, the monopolist may be able to capture some of that surplus through its pricing of the primary good. In this case, the monopolist will earn greater profits when its rivals are in the market than when they are not. In this case, the monopolist does not wish to steal sales in the secondary market, but takes its profits by charging a higher price for the primary good.[22]

Whether the presence of independent producers generates additional surplus, depends on the structure of consumer preferences and on factors such as the intensity of competition in the complementary market or the degree of differentiation in the complementary market.[23]

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19 If the two goods are used in variable proportions, the monopolist may have an incentive to monopolize the complementary market, as this creates greater flexibility in its relative pricing of both components. Through appropriate pricing, the monopolist may be able to extract more surplus from consumers. If it needs a monopoly over both products to price discriminate in this fashion, monopolizing the second market will increase its profits. For an example, see Ordover, Sykes et al. (1985), p. 119.

20 See, for example, Bork (1993), pp. 372-375; Posner (2001), pp. 198-199.

21 See Farrell and Weiser (2003).

22 See, for example, Whinston (1990), pp. 840, 850-852; Farrell and Katz (2000); Farrell and Weiser (2003), p. 103.

23 As the intensity of competition increases, prices are driven down to marginal costs. Due to the complementarity between both products, the monopolist benefits from lower prices in the complementary market. The lower prices in the complementary market,

While the "one monopoly rent" theory argues that exclusionary conduct in the complementary market will not increase the monopolist's profits, the "internalizing complementary efficiencies" theory suggests that such conduct may even reduce its profits.

Recent research shows that this line of reasoning is incomplete: Contrary to the assumptions of the "one monopoly rent argument", there are cases in which the monopolist profits from monopolizing the complementary market. In these cases, the monopolist may profit from the presence of independent producers in the complementary market, but the loss of these profits may be more than offset by the gains associated with discriminating in the complementary market. In other words, although the monopolist may profit from the presence of independent producers in the complementary market, it may profit even more by excluding them from the market. In this case, the monopolist will engage in exclusionary conduct, if the associated profits are larger than the associated costs.[24]

2. New Exceptions

The following section highlights three exceptions that have not been previously thought of. In the first exception, the complementary product is a source of outside revenues that the monopolist cannot extract in the primary market. In the second exception, which is a variant of the first, only the monopolist's complementary product is a source of outside revenue which is lost when rival producers of the product make the sales. This exception is particularly relevant in the Voice over IP context. In the third exception, the exclusionary conduct in the complementary market preserves a legally acquired monopoly in the complementary market.

The following analysis sets out the theories underlying these exceptions, highlights the conditions under which they apply and shows that these conditions may well be met in the Internet context.

2.1. Complementary Product Source of Outside Revenue

a) Theory

A monopolist in the primary market may be unable to extract the maximum possible profit through its sales of the primary good, if some of the revenue in the complementary market comes from outside sources.[25]

In conventional markets, firms typically derive their revenue from sales of products or from fees for the provision of services. Firms also have the option of following the example of the media: they offer value to their customers, but at least partly charge third parties such as

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the higher demand (if demand is responsive to price) or consumer surplus (if demand is inelastic), and, consequently, the higher the profits that can be extracted in the primary market (e.g.,, Farrell and Katz (2000)).

Given the complementarity between both markets and appropriate consumer preferences, an increase in the quality or variety of complementary goods will increase consumers' valuation of the primary good. For example, consumer surplus rises, if a rival enters with a differentiated complementary product and some consumers prefer that product (e.g., Whinston (1990), pp. 850-852; Carlton and Waldman (2000), p. 11). The value consumers derive from greater variety may well differ depending on the type of complementary product. For example, consumers may value the fifth teleconferencing application less than the fifth multiplayer online game.

In general, two goods are complements, if a decrease in the price of one increases the demand for the other, Varian (1999), p. 112.

24 See Whinston (1990), pp. 850-852, 855.

25 This theory is new and has not been covered by the existing literature.

advertisers. In other words, a part of their revenue stems from selling access to their customers to interested third parties. In the extreme case, consumers get a firm's product or service for free, while all of the firm's revenue comes from outside sources.

If firms in the complementary market derive some of their revenue from outside sources, a monopolist in the primary market may be unable to earn the maximum possible profit unless it monopolizes the complementary market as well. To see this, consider the following example: suppose that firms in the complementary market offer their product or service for free and make all their revenue from selling access to their customers to third parties.

Usually, the monopolist can use a variety of tactics to extract or "squeeze" revenue from its rivals.

A common set of tactics forces rival producers of the complementary good to lower the quality-adjusted price of their product.[26] This increases the consumer surplus available for extraction in the primary market. In the example, the price of complementary products already equals zero; thus, these tactics are not feasible.

In another tactic, the monopolist threatens to exclude a rival from the complementary market, unless the rival pays an access charge.[27] To be able to apply this tactic, the monopolist must have the power to exclude its rivals, for example due to intellectual property rights or because rivals' access to the primary good requires the monopolist's cooperation. While this mechanism enables the monopolist to extract its rivals' outside revenue, the monopolist may still earn less than if it excludes its rivals, monopolizes the complementary product market and captures all outside revenue directly: first, by monopolizing the complementary market, the monopolist gains a monopoly in the market for access to the users of its primary good. As a result, it will be able to charge higher prices (per customer) for access to its customers than competing producers of complementary products.[28] Second, due to its relationship with consumers in the primary market, the monopolist may have information about its consumers that enables it to charge higher prices to third parties.[29] Third, even if the per customer prices charged to third parties stay the same, the monopolist's profits will be lower in the presence of rivals due to the costs of negotiating and administering the access fees.

Thus, the monopolist will have an incentive to exclude its rivals from the complementary market, if the gains from directly capturing the outside revenue more than offset the reduction in profits that results from the reduction in complementary goods variety.

b) Application to the Internet

In the market for Internet content, portals and applications, firms often derive at least some of their revenue from outside sources by selling access to their customers to advertisers or online merchants.[30]

26 For an overview of such tactics, see, for example, Farrell and Katz (2000), pp. 414-415.

27 See, for example, Farrell and Katz (2000), p. 422.

28 Ultimately, this will harm consumers, as firms will pass on at least some of the increased costs to their customers. For example, higher advertising fees will ultimately lead to higher prices for the goods that are advertised. See MacKie-Mason (2000), p. 23; Rubinfeld and Singer (2001b), p. 316.

29 See, for example, Shapiro and Varian (1999), pp. 34-35.

30 Afuah and Tucci (2001), p. 56; Shapiro and Varian (1999), pp. 162-163.

In the hypothetical network that is the focus of this analysis, the monopolist can extract at least some of its rivals' outside revenue: the network enables the monopolist to exclude applications from the network. Thus, the monopolist can condition the "access" of rivals' products and services on the payment of an access fee that captures some or all of its rivals' outside revenue. That this is not a mere theoretical possibility shows the practice of cable network owners in the United States. Unaffiliated Internet service providers who want to offer their service over a cable network have to pay a fixed fee per customer. In addition, the cable network owner receives a portion of the outside revenue that the Internet service provider earns on that customer.[31]

While the monopolist is able to capture some or all of its rivals' outside revenue by threatening exclusion, its outside revenue will be higher if it excludes its rivals and collects the outside revenue directly.

First, selling access to one large group of customers as a whole may yield substantially more revenue than selling access to subgroups of that group separately. This is obvious, if the monopolist network provider manages to monopolize the market in which access to its Internet service customers is sold.[32]

Second, through its billing relationship with customers of its Internet service, the network owner has data on customer demographics that enables it to charge higher advertising fees or commissions for online sales than a lot of its rivals in the market for Internet content, portals and applications.[33]

Finally, due to the potentially large number of complementary products, negotiating and administering the access charges for unaffiliated content, applications and portals may be prohibitively expensive. In any event, these transaction costs will further decrease the monopolist's profits in the presence of rivals.

Thus, if firms in the market for a particular type of application, content or portal derive some of their revenue from outside sources, a monopolist in Internet services may have an incentive to monopolize that market in order to capture all outside revenue available in that market directly.

2.2. Monopolist's Complementary Product Source of Outside Revenue

a) Theory

In the scenario outlined above, only the network provider, not its rivals in the complementary market can realize higher outside revenues. As a result, letting rivals make the sales and extracting the outside revenue from them is less profitable than making the sales directly.

The following exception is a variant of this line of reasoning. The network provider's offering is a source of outside revenue; the rivals' offering does not provide this revenue. Thus, this

31 See Schiesel (2002) with respect to a contract between AOL and AT&T Comcast.

32 See, for example, MacKie-Mason (2000), p. 23; Rubinfeld and Singer (2001b), p. 316. This remains true even if the monopolist does not manage to drive its rivals from the market completely. See the analysis in Section 4.2., p. 24 below.

33 Even if those rivals require consumers to register before using their product or service, they have no way to verify the information, unless they require payment; in this case, they can verify the information as part of the billing process. See Shapiro and Varian (1999), pp. 34-35; MacKie-Mason (2000), p. 11.

revenue is lost if rivals make the sales. As a result, the network provider has an incentive to make as many sales as possible directly.

b) Application to the Internet[34]

Consider a local phone company that offers broadband Internet services over its network. Independent companies such as Vonage or Skype offer Voice over IP (VoIP) services to customers of this network provider. As the costs of long-distance calls using VoIP are usually considerably lower than the costs of long-distance calls using the conventional telephone service, those of the network provider's customers using VoIP will place less long-distance calls using the network provider's legacy telephone service.

To the network provider, conventional long-distance services are a source of outside revenue that is not similarly available to the providers of VoIP services. In the US, local phone companies are paid so-called access charges by long-distance providers for every long-distance call they originate or terminate. As access charges were traditionally intended to implicitly cross-subsidize local telephone service, regulators have mostly set these access charges significantly above the costs of originating or terminating long-distance calls. Thus, for many local phone companies, access charges are an important source of revenue.[35]

Independent VoIP providers threaten the source of this revenue: The more of the network provider's telephone customers place their long-distance calls using VoIP, the less access charges the network provider will receive. If VoIP providers are excluded from the network, customers are forced to make their long-distance calls using the conventional telephone service. Thus, exclusion in the VoIP market serves to preserve the network provider's current profits.

It is not surprising that the first publicly documented incident of VoIP blocking involved a rural telephone company. For rural phone companies, access charges constitute a substantial portion of their revenue. Thus, they have a particularly high incentive to protect this revenue.

2.3. Monopoly Preservation in the Complementary Market

a) Theory

The monopolist may also use its monopoly over the primary good to protect a monopoly in the complementary market against dynamic competition. In this case, the exclusionary conduct in the complementary market preserves the monopoly in that market.[36]

For this theory to apply, the following conditions must be met:[37]
First, the monopolized product is not essential for all uses of the complementary good, i.e. there are uses of the complementary good that do not require the primary good. Second, the

34 Thanks to Robert Pepper for highlighting this example.

35 See Nuechterlein and Weiser (2005), pp. 195, 204, 294.

36 This theory has not been used as an exception to the one monopoly rent argument before. It generalizes from an argument that was used by the Federal Communications Commission in the AOL/ TimeWarner merger proceeding with regard to instant messaging (Federal Communications Commission (2001), pp. 6603-6629, paragraphs 128-200) and subsequently analyzed by Faulhaber (2002). See Section 2.3.b), p. 11 below.

37 The structure of the model and the underlying reasoning are parallel to the "primary good not essential" case outlined below: However, in the "primary good not essential" case, the monopolist takes advantage of economies of scale and network effects in the complementary market to extend its monopoly to the complementary market by excluding its rivals from the systems part of the market. In the case under consideration here, the monopolist uses the same mechanism to protect a legally acquired monopoly in the complementary market against emerging competition.

monopolist can prevent its rivals from selling their version of the complementary good to users of the primary good. Third, the complementary market is subject to economies of scale or network effects. Fourth, the monopolist also has a monopoly in the complementary market.

While the first condition explains why the monopolist will want to maintain its monopoly in the complementary market in spite of its monopoly in the primary market, the second and third condition provide the mechanism that enables the monopolist to protect its monopoly in the complementary market.

The first condition provides the motivation for preserving a monopoly in the complementary market in spite of the monopoly in the primary market: The existence of uses of the complementary good that do not require the primary good deprives the monopolist of its ability to extract all profits through sales of the primary good.

To see this, consider the following example: suppose there is some use of the complementary good that does not require the primary good. As a result, the complementary market consists of two parts: a "systems market" for uses in which the primary good is essential, and a "stand-alone market" for uses that do not require the primary good; consumers in the systems market desire the primary and the complementary good, whereas consumers in the stand-alone market desire only the complementary good.

Suppose there are rival producers of the complementary good. The monopolist can extract all monopoly profits in the systems market through its pricing of the primary good. As consumers in the stand-alone market do not buy the primary good, however, the monopolist does not derive any profit from its rivals' sales in that market. Moreover, the presence of rivals constrains its ability to price its version of the complementary good in the stand-alone market.

Thus, the monopolist cannot earn monopoly profits in the stand-alone market, unless it has a monopoly in that market. Consequently, keeping competitors out of the complementary market is a prerequisite for preserving current profits.

The second and third condition provide the mechanism that enables the monopolist to preserve the monopoly in the complementary market: In the presence of economies of scale or network effects, the monopolist may be able to drive potential rivals from the complementary market by excluding them from the systems part of the market.

When the second condition is met, the monopolist can deprive rival producers of complementary products of any sales in the systems part of the market.

This behavior does not exclude rivals from the stand-alone market. Given economies of scale[38] in the complementary market, the remaining sales to customers in the stand-alone market may not suffice to reach an economically efficient scale. Thus, being excluded from the systems part of the market, rivals may be forced to exit the stand-alone market as well.

38 Economies of scale exist, if an increase in output causes long run average total costs to decrease. In other words, the more output is produced, the lower the cost per unit (see Hall and Lieberman (2001), pp. 177-178). For example, economies of scale exist, if fixed costs are large relative to marginal costs. In this case, an increase in output allows the firm to spread the fixed costs of production over greater amounts of output, lowering the costs of unit per output.

Similarly, in the presence of network effects[39] in the complementary market, exclusion from the systems part of the market may suffice to drive competitors from the market or into a niche existence. In markets with network effects, the incumbent's large installed base makes it difficult for new entrants to dislodge the incumbent. Exclusion from the customers in the systems part of the market makes it even more difficult for new entrants to reach the critical mass of customers necessary to start the positive feedback required to succeed with their product.

Thus, the exclusion of rivals from the systems part of the market enables the monopolist to protect a legally acquired monopoly in the complementary market against emerging competition.

Such a scenario may be particularly relevant, if the complementary market belongs to an R&D intensive industry subject to dynamic or "Schumpeterian" competition.[40] Due to the presence of intellectual property rights, economies of scale or network effects, R&D intensive industries are prone to short run exercise of market power. In other words, competition in these markets often results in a single firm dominating the market. Thus, firms in these industries typically compete "for the market", not "within the market". While firms with market power (the winners of the competition) are an inherent feature of such industries, their dominance may be temporary, as rapid technological change and drastic innovations may cause demand for their product to collapse: for example, rivals may come up with a vastly superior product or develop a new product that makes the incumbent's product obsolete. Thus, incumbents in these industries are primarily constrained by dynamic competition - by the innovation of other firms seeking to replace the existing firm with market power. To avoid being dislodged by rivals, incumbents are forced to innovate themselves.

In the scenario described above, a monopolist could use its market power in the primary market to preserve the legally obtained market power in the complementary market, distorting the dynamic competition for future market power. Instead of innovating to prevent being dislodged by competitors, the monopolist could simply exclude its rivals from the systems part of the complementary market, preventing them from reaching the scale or network size necessary to displace the incumbent.

b) Application to the Internet

The conditions underlying this model may well be present in the Internet context.

First, a specific provider's Internet service may be non-essential for using applications or accessing content. Consider the market for residential broadband Internet access in the United

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39 Network effects exist, if an individual customer's value of a good depends upon, and increases with, the number of other customers who also buy that good. Stated more technically, network effects exist if the utility an individual customer derives from the consumption of a good depends upon, and increases with, the number of other customers who consume products that are compatible with that good. See, for example, the definition by Katz and Shapiro (1985), p. 424. Network effects are covered by a large body of literature. See, for example, Rohlfs (1974); David (1985); Farrell and Saloner (1985); Katz and Shapiro (1985); Katz and Shapiro (1986); Matutes and Regibeau (1988); Arthur (1989); Church and Gandal (1992); Economides and Salop (1992); Farrell and Saloner (1992); Gilbert (1992); Katz and Shapiro (1992); Besen and Farrell (1994); Katz and Shapiro (1994); Economides (1996); Gandal, Kende et al. (2000); Church, Gandal et al. (2002). For an analysis of network effects in the context of information goods, see Shapiro and Varian (1999), chapter 7-9. For an analysis of the legal implications of network economic effects, see, for example, Lemley and McGowan (1998). For some critical voices, see Liebowitz and Margolis (2001); Kolasky (1999).

40 On dynamic or "Schumpeterian" competition, see, for example, Evans and Schmalensee (2001); Shelanski and Sidak (2001), pp. 10-15; Carlton and Gertner (2002), pp. 19-22.

States.[41] Depending on local conditions, the owner of a cable network that provides broadband Internet access through its affiliated broadband Internet access provider may well be a local monopolist.[42] While this monopolist offers broadband Internet access only in the area covered by its network, it may offer content or applications to Internet users nationwide. In this case, the area covered by its network constitutes the "systems market", while customers outside its footprint make up the "stand-alone market".

Such a situation is not uncommon. For example, where it has been able to strike a deal with cable network owners, AOL offers its portal bundled with broadband Internet access. In addition, consumers nationwide can buy the portal without access, known as the "bring your own access" option.[43] Other AOL services such as MapQuest or AOL Moviefone are also offered to all consumers on the Internet.[44]

Similarly, if a narrowband access provider has a monopoly with respect to narrowband access, but offers its portal both to its narrowband access customers and to anybody on the Internet, the narrowband access service will be non-essential for customers accessing the portal via broadband access services.[45]

Second, in the hypothetical network that forms the basis of the analysis, the monopolist can technically exclude rivals' applications, content or portals from running over its network. As a result, the monopolist's Internet service customers (the consumers in the systems market) are unable to access or use these products. Thus, rivals are deprived of any sales in the systems part of the market.

Third, the markets for software applications, Internet content and portals are all subject to significant economies of scale. The development of these products and services is characterized by large fixed costs, while the marginal costs of production and distribution over the Internet are very small. Thus, the marginal cost of production[46] is very low relative to the average cost of production,[47] resulting in significant economies of scale.[48]

41 The market for broadband Internet access is considered a distinct market from the narrowband access market, see, for example , Hausman, Sidak et al. (2001a), pp. 135-157; Federal Communications Commission (2001), pp. 6574-6577, paragraphs 68-73.

42 See Footnote 15, p. 4 above.

43 Breznick (2003).

44 See TimeWarner (2002).

45 For example, Beardsley, Doman et al. (2003) report statistics showing that "so far, [...] faster and better access to the Internet is the sole killer application of broadband". See Beardsley, Doman et al. (2003), Section "what happens next?" and Exhibit 6. Thus, the scenario described in the text may be quite common. This possibility is also highlighted by Farrell and Weiser (2003), p. 119.

46 The marginal cost of production is the incremental cost of producing an additional unit of the good. Thus, the marginal cost of production does not include the costs of product development. (See Hall and Lieberman (2001), pp. 168-169) In the case of software applications, Internet content and portals, the marginal cost of production is the cost of making an additional digital copy of the product, which is typically very low.

47 The average cost of production indicates a firm's total cost per unit of output. In other words, it denotes the total cost associated with a particular product divided by the quantity of output produced. Thus, contrary to the marginal cost of production which does not include the cost of developing the first unit of the product, the average cost of production includes the cost of development divided by the total number of copies. See, for example, Hall and Lieberman (2001), p. 168.

48 This cost structure (low marginal costs relative to average costs), which results in significant economies of scale, is generally viewed as a key economic characteristic of the markets for these products. See, for example, Shapiro and Varian (1999), pp. 3-4 for information goods in general; Katz and Shapiro (1998), pp. 6-7 for software markets; Posner (2001), pp. 245-246 for Internet content, portals and software; MacKie-Mason (2000), p. 14 for broadband portals; Rubinfeld and Singer (2001b), p. 307 for broadband content.

In addition, a lot of software applications are subject to direct or indirect network effects.[49] For example, a communication service like instant messenger or Internet telephony is more valuable the more people can be contacted using the service.[50] Viewers for multimedia content are subject to indirect network effects.[51] The larger the catalogue of content available in a particular format, the more users value owning viewers compatible with that format. At the same time, content providers are more likely to incur the costs of coding their content in a particular format, the larger the installed base of viewers compatible with that format.

Finally, at least some of these markets are subject to rapid technological change. Not surprisingly, markets for software applications are the canonical example of R&D intensive industries subject to dynamic competition.[52]

Now consider a network provider that is a local monopolist in Internet services and has acquired a dominant position in the nationwide market for a particular application. Such a provider has an incentive to exclude rivals from that market to protect itself from dynamic competition and preserve its monopoly in that market. Whether the monopolist will manage to prevent new entrants from entering the complementary market by excluding them from access to its Internet service customers, depends on the exact size of economies of scale with respect to the product in question, on the strength of any potential network effects and on the size of both the monopolist's network and the remaining network.

This theory played an important role in the FCC's evaluation of the merger between AOL and TimeWarner. TimeWarner owned a number of broadband cable networks; AOL held a dominant position in the market for instant messaging services and offered its instant messaging program to consumers nationwide. The FCC was concerned that the merged firm could use its control over broadband cable networks to disadvantage competitors seeking to overturn AOL's legally acquired monopoly in instant messaging services. To alleviate this problem, the FCC approved the merger subject to a condition (among others) that required AOL TimeWarner to interoperate with instant messenger competitors prior to offering "advanced" instant messaging services.[53]

3. Relevance of Known Exceptions

There are a number of known exceptions to the “one monopoly rent” argument and to the “internalizing complementary efficiencies” argument outlined above. The following section describes two exceptions that may be relevant in the network neutrality context, but whose relevance in the network neutrality context has not been discussed in detail yet.

49 Network effects are called “direct network effects”, if the consumption benefits directly result from the size of the network. See, for example, Katz and Shapiro (1985), p.424. “Indirect network effects” exist, if consumer demand for the primary good increases with the variety of complementary goods and services. In this case, network effects arise from supply-side economies of scale in the complementary market: a larger installed base for the primary product allows application developers to spread sunk development costs over a larger potential sales base. Thus, in the presence of economies of scale and free entry into the complementary product market, a larger customer base leads to lower costs and greater variety of complementary products. See, for example, Katz and Shapiro (1985), p. 424; Katz and Shapiro (1994), p. 99.The existence of direct or indirect network effects is a fundamental economic characteristic of many software markets. See, for example, Katz and Shapiro (1998), pp. 3-6; Evans and Schmalensee (2001), pp. 9-11.

50 See, for example, Faulhaber (2002).

51 See, for example, MacKie-Mason (2000), p. 16.

52 See for example Evans and Schmalensee (2001), pp. 4-15.

53 Federal Communications Commission (2001), pp. 6603-6629, paragraphs 128-200; for an in-depth analysis of the economic rationale underlying this condition, see Faulhaber (2002).

In the first exception, the primary good is not essential for all uses of the complementary good, making it impossible for the monopolist to extract all monopoly profits through its pricing of the primary good.

In the second exception, the monopolist excludes competitors from the complementary market in order to protect its monopoly in the primary market.

3.1. Primary Good not Essential

a) Theory

The structure of models in this category[54] and the underlying reasoning is similar to the "monopoly preservation in the complementary market" case described above:

First, the monopolist has a monopoly in the primary market. The primary good is not essential, i.e. there are uses of the complementary good that do not require the primary good. Thus, the complementary market consists of a systems market and a stand-alone market. As a result, the monopolist cannot extract all profits through its pricing of the primary good and profits from extending its monopoly to the complementary market.

Second, there is a mechanism that enables the monopolist to exclude rival producers of the complementary good from the systems part of the market. Third, the complementary market is subject to economies of scale or network effects.

Given economies of scale in the complementary market, the monopolist can force its rivals to exit the stand-alone market by excluding them from the systems part of the market, extending its monopoly to the complementary market.[55]

Similarly, in the presence of network effects[56] in the complementary market, exclusion from the systems part of the market may suffice to drive competitors from the market or into a niche existence:

If the benefits derived from a larger network are large relative to the benefits of product differentiation in the network good, competition between two incompatible technologies will usually result in a single technology dominating the market.[57] The reason is that network effects give rise to strong positive feedback in technology adoption: other things being equal, consumers derive larger benefits from a larger network. As the larger network is more attractive, more consumers will join that network, making it even more valuable, leading to even more consumers joining the network. Once this positive feedback loop sets in, the

54 The following theory was developed by Whinston (1990), pp. 854-855 and is widely accepted as an exception to the one monopoly rent argument. See, for example, Carlton (2001), pp. 667-668; Choi and Stefanadis (2001), p. 55; Whinston (2001), p. 71; Carlton and Waldman (2002), p. 195. For a detailed application of this theory in the context of the open access debate, see Rubinfeld and Singer (2001b). See also Farrell and Weiser (2003), p. 119.

55 In the "monopoly preservation" case described above, the monopolist uses this mechanism to protect a legally acquired monopoly in the complementary market against emerging competition.

56 On network effects in general, see Footnote 39, p. 11 above. On direct and indirect network effects, see Footnote 49, p. 13 above.

57 Often, competitors will not be driven completely from the market. In particular, some customers with high switching costs or a unique preference for a competitor's product will prefer to stay with that competitor in spite of the strong network effects associated with the winning technology. See, for example, Faulhaber (2002), p. 329, footnote 37.

affected technology will quickly pull away from its rivals in market share, ultimately dominating the market. This phenomenon is referred to as "tipping".[58]

As small initial advantages may quickly get magnified, small differences, in either perception[59] or reality, may determine the outcome of the competition. Therefore, establishing an early lead in installed base[60] that is large enough to start the positive feedback loop is an important strategy in network markets.[61]

Thus, if the monopolist excludes its rivals from the complementary market, it can capture all customers in the systems market. If the systems market is large enough, the monopolist's advantage in that market may enable it to reach a critical mass of customers that are so attractive to others that positive feedback sets in, making it impossible for a rival to catch up.

If the presence of rivals increases consumer surplus, the exclusion of rivals may reduce the monopolist's profits in the systems market.[62] In such a case, monopolizing the complementary market increases the monopolist's profits, if the gain from monopolizing the stand-alone market is larger than the loss resulting from the exclusion of the rival in the systems market.[63]

If the complementary market is subject to network effects, two effects make it even more likely that exclusion is a profitable strategy:

First, the potential profits from winning the competition between incompatible technologies are huge, increasing the benefits of exclusion. Imagine a competition between incompatible technologies that are subject to indirect network effects. If the winning standard is protected by intellectual property, the winner can make money on any primary and complementary product that uses the standard. Given the potentially large number of complementary products in markets with indirect network effects, licensing fees can lead to substantial profits.[64] For example, the winner in the standard competition between competing media player technologies who wins with a proprietary standard protected by intellectual property will not only dominate the market for media players, but will also be able to charge licensing fees for every piece of music or video that is encoded for use with the player.

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58 "Tipping" occurs, when a single provider reaches a critical mass of customers that are so attractive to others that competitors must inevitably shrink, in the absence of interoperation." Faulhaber (2002), p. 316.

59 In network markets, consumer expectations about the future size of the network play a crucial role in determining the outcome of the competition. This is due to the costs of belonging to the losing network: A consumer who has chosen the losing network can either switch to the winner, which may be costly, or suffer from the lower value of a small network. To avoid this situation, the consumer will choose the network that it expects to be the winner. See, for example, Besen and Farrell (1994), p. 118.

60 The installed base is the total number of consumers who have already bought the network good.

61 A substantial lead in installed base is not the only factor that influences the outcome of the competition. Due to the huge benefits of belonging to the winning network, users have a strong desire to choose the technology that will ultimately prevail. Therefore, consumers expectations of who the winner will be are at least as important. Other factors that may influence customers' expectations and that may therefore result in a competitive advantage are an established reputation, a well-known brand name, or ready visible access to capital. Thus, an unknown firm with an early lead may be overtaken by a market leader that enters second, but has a well-known brand name and good reputation. See, for example, Katz and Shapiro (1994), p. 107.

62 For example, if the rival produces a differentiated product, the rival's presence creates additional surplus, some of which the monopolist can extract through its sales of the primary good. Thus, the monopolist's profits in the systems market are increased if its rival is in the market.

63 See Whinston (1990), pp. 850-852, 855.

64 Due to the cost structure of information products, profits are not even dependent on charging a monopoly price. See the analysis in Section 4.1., p. 23 below.

Second, if the complementary product is subject to network effects, the presence of an independent rival in the complementary market does not necessarily increase the monopolist's profits in the systems market, a fact that reduces the costs of exclusion. If the monopolist's and the rival's complementary product are incompatible, sales to the rival decrease the size of the network of users of the monopolist's complementary product. As a result, the value users can derive from the monopolist's complementary product (and the profit the monopolist can extract from them) is lower than the corresponding value if the rival does not make any sales.[65]

b) Application to the Internet

As has been set out above,[66] the conditions underlying this theory are quite common in the Internet context:

Network providers may be local monopolists in the market for Internet services, but offer applications, content or portals to consumers nationwide. Network technology enables network providers to exclude providers of complementary products from access to its Internet service customers. At the same time, the markets for applications, content or portals are usually subject to significant economies of scale and, potentially, network effects.

As a result, an Internet service provider may be able to force its rivals from the nationwide market (the stand-alone market) by excluding rival portal, content or application providers from access to its Internet service customers (the systems part of the market). Whether exclusion from its Internet service customers suffices to drive its competitors from the nation-wide market[67] depends on the exact size of economies of scale with respect to the product in question, on the strength of any potential network effects and on the size of both the monopolist's network and the remaining network.[68]

Such a provider will have an incentive to monopolize the market for a particular type of application, content or portal, if the increased profit from additional application, content or portal sales nationwide more than offsets the reduction in broadband access revenues due to the reduction in variety resulting from the exclusion of its rivals with respect to its Internet service customers.[69]

3.2. Monopoly Preservation in the Primary Market

a) Theory

In the following class of models, exclusionary behavior in the complementary market maintains the monopoly in the primary market.[70]

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65 Carlton and Waldman (2002), pp. 206-207.

66 See Section 2.3.b), p. 11 above.

67 See Rubinfeld and Singer (2001b), pp. 310-313 for a numerical example. The paper assesses the likelihood of content discrimination (i.e. blocking or degrading the quality of outside content) by a broadband network provider that is vertically integrated into the market for broadband content and portals in the context of the merger between AOL and TimeWarner.

68 Even if the monopolist's footprint is not large enough to force its rivals to exit the market completely, exclusion from a part of the market may put them at a severe competitive disadvantage by forcing them to operate at a less efficient scale or with a smaller network. See the analysis in Section 4.1., p. 23 below.

69 See, for example, Rubinfeld and Singer (2001b), pp. 310-313.

70 On this type of monopoly maintenance in general, see, for example, Salop and Romaine (1999), pp. 623-624; Carlton (2001), pp. 668-671; Farrell and Weiser (2003), pp. 109-112. For specific models, see, for example, Choi and Stefanadis (2001); Carlton and Waldman (2002).

In models belonging to this category, the monopolist faces potential competition in the primary market. The monopolist can deter entry to the primary market by engaging in exclusionary conduct in the complementary market. Thus, by deterring entry to the primary market, the exclusionary behavior in the complementary market preserves the monopoly in the primary market.

Economists have come up with a number of explanations of why exclusionary conduct in the complementary market may be able to deter entry to the primary market. The following analysis will focus on an explanation that is particularly relevant in the Internet context: the exclusionary behavior in the complementary market harms future competitors in the primary market by depriving them of a source of complementary products.[71] As a result, in order to make any sales in the primary market, an entrant to the primary market needs to enter the complementary market as well (or otherwise secure a sufficient supply of complementary products). If this is significantly more difficult or costly than entering the primary market alone, potential entrants to the primary market may refrain from entering.

For such a strategy to succeed, two conditions must be met:

First, the exclusionary behavior in the complementary market must deprive a potential entrant to the primary market of a source of complementary products. As a result, the entrant cannot enter the primary market alone, but must enter both markets at once.

Second, simultaneously entering both markets must be more difficult or costly than the sum of the costs of entering both markets on their own.[72] Otherwise, the exclusionary behavior in the complementary market is unlikely to adversely affect entry to the primary market.

Economists have identified four alternative reasons why simultaneous entry to both markets may be significantly more difficult or costly than the sum of the costs of entering each market on its own:

1. increased cost of capital,
2. differing economies of scale in both markets,
3. the uncertainty of innovation, or
4. the existence of indirect network effects.

Increased Cost of Capital

An entrant that is forced to enter both markets may face an increased cost of capital, if it only has experience relevant for operating in one of the markets. If the skills and knowledge necessary to succeed in both markets differ considerably, the increased probability of failure due to his inexperience in one of them may lead lenders to charge a higher rate for the necessary capital. The risk premium will be even larger, if the entrant has to incur huge sunk costs to enter the market. The higher sunk costs, the more costs cannot be recovered in the event of failure.[73]

71 See, for example, Carlton (2001), pp. 669-670.

72 "The relevant question is whether the need for simultaneous entry to the secondary market gives rise to a substantial incremental difficulty as compared to entry into the primary market alone. If the entry at the secondary level is easy in absolute terms, the requirement of simultaneous entry to that market is unlikely adversely to affect entry to the primary market." U.S. Department of Justice and Federal Trade Commission (1984), Section 4.212.

73 For an argument along these lines, see Williamson (1979), pp. 953-993; U.S. Department of Justice and Federal Trade Commission (1984), Section 4.212.

Differing Economies of Scale in Both Markets

Entering two markets is more difficult than entering one, if the minimum efficient scale in both markets differs considerably. In this case, the entrant must choose between operating at an inefficiently small size in one market or at a larger than necessary scale in the other. Both strategies may significantly increase the operating costs of the entering firm.[74]

Uncertainty of Innovation

Given the uncertainty associated with the innovative process, the need to innovate successfully in two markets may decrease the probability of successful entry. To see this, assume that the probability of innovating successfully in one component is k. In this case, the chances of successful innovation in n components are k^n. Unless k is close to 1, this is considerably lower than k.[75] Thus, the probability of successful innovation in n components required to enter into n markets simultaneously is lower than the probability of successful innovation and successful entry in one component market.

Existence of Indirect Network Effects

If the primary good is subject to indirect network effects[76] and any available complementary goods are offered exclusively with the monopolist's platform, an entrant into the primary market faces a "chicken and egg" problem: due to consumers' desire for variety in complementary products, consumers prefer a primary good that already offers a large number of complementary goods and services. At the same time, due to economies of scale and sunk costs in complementary product development, developers of complementary products prefer to develop products for primary goods that already have a large number of users. Thus, "[an entrant into the primary market] either has to offer consumers much lower value or has to incur large sunk costs to develop (or subsidize) a wide range of [complementary goods and services] before there is a large user base to purchase them." [77]

b) Application to the Internet

The conditions underlying this theory may well be present in the Internet context.

First, the exclusionary behavior in the complementary market must deprive a potential entrant to the market for Internet services of a source of complementary products.

By excluding rival producers of Internet portals, content and application from its network, the monopolist network provider may be able to drive its rivals from the nationwide market.

To deprive a potential entrant of a source of complementary products, the monopolist needs not only drive rival content and application producers from the market. He also needs to deny access to its own content and applications to consumers outside its network.[78] Otherwise,

74 See U.S. Department of Justice and Federal Trade Commission (1984), Section 4.212.

75 Choi and Stefanadis (2001); Carlton and Gertner (2002), pp. 23-27.

76 For a definition of indirect network effects, see Footnote 49, p. 13.

77 Gilbert and Katz (2001), p. 30, referring to operating systems and application programs. Under the label "applications barrier to entry", this line of reasoning has featured prominently in the Microsoft case. See, for example, United States Court of Appeals. District of Columbia Circuit (2001), pp. 54-56; Gilbert and Katz (2001), pp. 28-30.

78 In addition to offering its own content and applications to the customers of its Internet service, the monopolist may also "allow" independent producers of these products to offer their products to the customers of its Internet service, as long as they agree to offer their products exclusively to these customers. Stated differently, instead of depriving a potential entrant into the market for Internet services of a source of complementary products by driving rival content and application producers from the market, the

customers of rival network providers could simply use the monopolist's content and applications with the rival's Internet service.[79] Hence, for a particular application or content, this strategy and the "primary good not essential" strategy are mutually exclusive.[80]

Thus, this theory is only applicable, if (a) an Internet service provider offers proprietary content and applications exclusively to customers of its Internet service,[81] and if (b) - potentially due to the exclusion of rivals from its customers - there are not enough remaining independent applications, content or portals available that could be used by customers of rival or newly entering network providers.[82] In this case, a new entrant into the market for Internet services needs to develop (or subsidize the development of) its own content or applications.

One may wonder whether the condition (b) may ever be fulfilled in the Internet context: after all, there are a number of portals, content and applications that are available to anyone using the Internet today. The condition may be met in emerging markets such as the market for broadband Internet services, the market for Internet services for mobile phones or in emerging national markets in countries outside the United States. For example, there may be not enough independent applications or content that take advantage of broadband specific characteristics such as high transport speed or broadband's always on capacity.[83] Similarly, there may not be enough independent applications or content that are adapted to the specific limitations associated with using the Internet from mobile phones.[84] In a country that just started adopting the Internet, there may not be enough independent applications or content in the national language.

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monopolist could deprive the potential entrant of a source of complementary products by signing exclusive contracts with independent content and application producers. Whether a monopolist could profitably impose such an exclusivity provision, has been the subject of considerable debate. The Chicago school denied such a possibility, arguing that the other party to the exclusive contract would not agree to contracts that made it worse off (see for example Bork (1993), p. 309). More recent research has shown that this argument is incomplete: it does not consider the possibility that the exclusive contract imposes harm on third parties that are not parties to the contract, while not making the contracting parties worse off. In other words, the exclusive contract gives rise to a negative externality on third parties, and due to this externality, signing an exclusive contract is jointly optimal for the contracting parties. For a discussion of this question with pointers to the literature, see, for example, Gilbert and Katz (2001), pp. 31-33; Whinston (2001), pp. 66-70.

79 Usually, this theory is applied to cases, where the entrant's primary good is technically unable to take advantage of the set of applications developed for the monopolist's primary good. For example, software applications make use of a specific operating system's application programming interfaces and therefore run only on this operating system. As a result, customers of the entrant's operating system are technically unable to use applications developed for the incumbent's operating system. By contrast, as long as an application complies with the specifications of the Internet protocol, it can run over any physical network that supports the Internet protocol. As a result, applications adhering to that standard can be used by anyone connected to the Internet. Thus, from a technical point of view, the applications offered by the monopolist could be used by customers of a rival network provider as well. Therefore, the entrant's inability to use the monopolist's applications and content is not due to technical differences or incompatibility between the Internet services offered by the monopolist and a potential entrant, but results from the monopolist's business decision to offer its content and applications exclusively to customers of its own Internet service.

80 The strategy described here requires that the monopolist does not offer the content, application or portal to consumers outside its network; by contrast, in the "primary good not essential" strategy, the inability to earn monopoly profits on its sales to consumers outside its network is the reason that leads the monopolist to monopolize the complementary market as well. See Section 3.1, p. 14.

81 The potential anti-competitive implications of such a strategy are explored by, for example, MacKie-Mason (2000), pp. 23-25; Rubinfeld and Singer (2001b), pp. 313-316.

82 Alternatively, the monopolist could reach the same result by allowing independent producers of applications, content and portals to offer their products to the customers of its Internet service, if they agree to provide the products exclusively to its customers. See the discussion in the footnotes above.

83 A lot of broadband customers may simply use broadband Internet services to access narrowband offerings at higher speed. According to McKinsey, "so far, [...] faster and better access to the Internet is the sole killer application of broadband." Beardsley, Doman et al. (2003), Section "what happens next?" and Exhibit 6.

84 For example, compared to PCs, mobile handsets have small screens, limited keypads and not a lot of storage. See, for example, Deprez, Rosengren et al. (2002).

One may also imagine that consumers perceive certain applications and content as indispensable elements of Internet usage. If these applications and content are exclusively available with the incumbent's Internet service, consumers may not consider an entrant's Internet service an adequate alternative to the incumbent's Internet service, unless the entrant offers a similar set of applications and content itself. In this case, to deter entry to the market for Internet services, the incumbent does not need to drive all existing independent applications, portals and content from the market and offer all affiliated complementary products exclusively to customers of its Internet service. It suffices to restrict the exclusionary conduct to those applications and content that consumers view as essential. Although there are independent applications and content left that customers of a rival Internet service could use, the entrant will still be forced to enter the market for specific applications and content in order to be able to compete in the primary market.[85]

Second, simultaneously entering the market for Internet services and the market for content or applications must be more difficult or costly than entering the market for Internet services alone. This requirement is fulfilled as well. Simultaneous entry into both markets is more difficult or costly than entry into the market for Internet services alone if the two markets exhibit at least one of the four characteristics described above. In the Internet context, all four characteristics are present: first, entry to both markets requires very different capabilities, second, production in both markets is subject to differing economies of scale, third, success in the different markets is uncertain, and finally, due to the incumbent's exclusionary conduct, the provision of Internet service is subject to indirect network effects with respect to the individual provider's network.

First, developing software applications or interesting content requires very different capabilities than operating a network. As a result, a potential entrant to the market for Internet services may not necessarily have the capabilities required for entering the markets for applications or content.[86] In addition, most of the cost of entry into those complementary industries consists of the sunk costs of developing the offering that cannot be recovered in case of failure.[87] Due to these factors, the need to enter the complementary markets as well considerably increases the risks associated with entry to the primary market. Consequently, an entrant into both markets will most likely be charged higher rates for capital than an entrant to the primary market alone.

Second, the market for Internet services and the markets for complementary products are subject to very different economies of scale: for example, McKinsey estimates that assuming an average revenue per user of $ 18 to $ 22.50 a year in 2005, a broadband PC portal in Germany would need more than 8 million unique users to break even.[88] By contrast, the economies of building and operating physical networks over which IP services could be provided are much lower.[89]

85 Finally, one may imagine a situation in which the nationwide market for Internet services consists of a collection of local monopolies who all bundle their content, portal and applications exclusively with their Internet service. In this case, a new entrant into the market for Internet services would have to enter the market for content, portals, or applications as well.

86 See, for example, Niewijk, Songhurst et al. (2003), Section "moving towards partnerships".

87 That the costs of capital may increase with the amount of entry costs that are sunk is discussed by Viscusi, Vernon et al. (2000), pp. 157-158, 161.

88 Deprez, Rosengren et al. (2002), Section "PC portals".

89 For example, as of June 30, 2001, the 10 largest providers in the market for broadband transport services in the United States had between 1,409,000 and 360,000 residential broadband customers. See Yoo (2002), p. 257, Table VII., using data reported by Cable Datacom News.

Third, although network technology is undergoing rapid innovation, a new entrant into the market for Internet services can take advantage of existing technology and does not have to innovate itself. By contrast, the development of applications and content is subject to considerable uncertainty. If a potential entrant to the market for Internet services needs to develop several applications and services in order to be able to compete with the incumbent's Internet service, the uncertainty associated with each development reduces the likelihood of successful entry to the market for Internet services.

Fourth, Internet service is subject to indirect network effects:[90] the more applications and content are available for users, the more valuable Internet service becomes. At the same time, the development of content and applications is subject to economies of scale.[91] As a larger number of users allows application and content developers to spread the fixed costs of development over a larger potential sales base, under free entry to these markets the variety of applications and content will be higher and their cost will be lower, the larger the number of users.

Technically, any application based on the Internet protocol can run over any network that is connected to the public Internet and supports the Internet protocol. As a result, from a technical point of view, the relevant network for indirect network effects is not an individual provider's network, but the global Internet. Thus, technically, Internet service providers compete under conditions of compatibility.

By excluding independent applications from its network and offering its own applications exclusively to its own Internet customers, an Internet service provider can reintroduce indirect network effects with respect to its own network.[92] Stated differently, as a result of this strategy, the benefits of adding a new user do not accrue to anyone connected to the Internet, but are limited to the customers of the new user's Internet service provider. Application and content developers now have to decide whether to offer their product to the customers of the Internet service provider with the "closed" network or to the customers of Internet service providers following an open system strategy. Due to economies of scale in the production of application and content, the developers will base their decision on the size of the different networks.

As a result, an entrant to the market for Internet services will have difficulties attracting application and content developers who write for its network instead of the incumbent's. Thus, due to the incumbent's strategy, the entrant faces the chicken and egg problem described above: consumers will not subscribe to its Internet service in the absence of an attractive amount of content and applications; application and content developers will not produce for its network in the absence of an attractive number of users.[93]

90 See, for example, Speta (2000a), pp. 83-84.

91 See Section 2.3.b) , p.11.

92 An Internet service provider could reach the same effect (i.e. reintroduce indirect network effects with respect to its own network) by using proprietary protocols inside its network. See, for example, Computer Science and Telecommunications Board and National Research Council (2001), pp. 147-149. An alternative strategy may be the provision of quality of service only within an Internet provider's network. See, for example, Shapiro and Varian (1999), p. 187.

93 The Computer Science and Telecommunications Board and National Research Council (2001) describes a similar situation in the context of provider-specific indirect network effects due to the use of proprietary protocols inside the network. See Computer Science and Telecommunications Board and National Research Council (2001), pp. 147-149.

Thus, a monopolist provider of Internet services may be able to deter entry to the market for Internet services by excluding rival producers of applications, content and portals from the market and offering its own content and applications exclusively to the customers of its own Internet service.[94] This strategy may reduce consumers' valuation of its Internet service, as the exclusion of rival producers of applications, content and portals reduces the variety of complementary products available to customers of its Internet service. Thus, in deciding whether to employ such a strategy, the monopolist must trade off the loss in Internet service fees against the gains in future monopoly profits.

4. Profitability of Discrimination without Monopolization

In the network neutrality context, researchers commonly focus on the ability and incentive of a network provider to monopolize the market for selected complementary products. The previous sections have followed this approach. It is based on the implicit assumption that discrimination is only profitable, if the network provider manages to monopolize the complementary market. As the following section shows, this focus may be too narrow: A network provider may have an incentive to discriminate against an application even if the provider does not manage to drive it from the market.

As a result, researchers commonly underestimate the likelihood of discriminatory behavior by network providers: If discrimination requires the network provider to monopolize the complementary market to be a profitable strategy, discrimination will be restricted to those cases where the network provider can expect to drive its competitors from the complementary market. If, however, the discrimination is a profitable strategy, even if the network provider does not manage to monopolize the complementary market, it is much more likely to occur.

The following analysis will cover four of the five exceptions outlined above.[95] It is based on the assumption that the exclusion of rivals from the network provider's Internet service customers increases the number of sales of the network provider's complementary product. At least some of the network provider's Internet service customers that would have used a rival's complementary product in the absence of exclusion will use the network provider's offering instead. Thus, by excluding rival producers of applications or content from its network, the network provider gains additional sales from its Internet service customers at the expense of its rivals. If the complementary product is subject to economies of scale or network effects and the network provider offers its complementary product to customers nation-wide, the exclusion from the network provider's Internet service customers may force rivals to operate at an economically less efficient scale or with a smaller network of customers, putting the rivals at a competitive disadvantage in the rest of the market as well and potentially leading to even more additional sales for the network provider's complementary product.

Based on this assumption, the analysis will ask, whether a larger number of sales of the network provider's complementary product increase its profits, even if the network provider does not manage to monopolize the complementary market in question.

94 As highlighted above, an alternative way of deterring entry would be to sign exclusive contracts with independent producers of applications, content and portals. Such a strategy would have the advantage that the monopolist does not have to bear losses with respect to its Internet service fees, as its customers would have access to all existing applications, content and portals.

95 The fifth exception, "monopoly preservation in the primary market" requires that rival producers of excluded complementary products are driven from the market.

4.1. More Sales at Market Prices

In a perfectly competitive market subject to constant returns to scale, simply increasing the number of sales at the market price will not increase profits. In such an industry, long-run equilibrium prices equal marginal costs, resulting in zero profit per unit sold. As a result, a firm cannot increase its profits by making additional sales at the market price. Instead, it needs to gain a monopoly position that enables it to raise prices above marginal costs.

Markets for applications, content and portals are different: In these markets, the exclusionary conduct need not result in a monopoly to increase the network provider's profits; it suffices if it results in a larger number of sales. This is due to the cost structure underlying the production of applications and content: the production of these goods is characterized by high fixed costs and very low marginal costs. While the costs of developing the first instance of an application or content may be significant, the costs of producing additional copies may be negligible. Due to the need to cover fixed costs, such products are priced significantly above marginal costs.[96]

If the market price is significantly above marginal costs, a firm does not need to be able to charge monopoly prices to increase its profits: Instead, making additional sales at the market price may be enough.[97] More sales enable the firm to spread the fixed costs of production over more units, resulting in lower average costs per unit and a higher profit margin at the same price. Put differently, once a firm has made enough sales to cover the fixed costs, any additional sale at the market price only adds to the profits. For example, given that gross margins of 80% or 90% are common in computer software,[98] any additional sale may lead to a significant increase in profits.

By excluding rival producers of complementary products from its network, the network provider gains additional sales. These additional sales increase the network provider's profit, even if the excluded rivals are not driven from the complementary market completely.

For example, this fact has important implications for the relevance of the exception "primary good not essential" outlined above. Whether a network provider can monopolize the nation-wide complementary market in question by excluding its rivals from access to its Internet service customers, depends on a variety of factors such as the exact size of economies of scale with respect to the complementary product in question, the strength of any potential network effects and the size of both the monopolist's network and the remaining network. Ultimately, the cases in which monopolization is a realistic prospect may not be very common. As monopolization is not necessary to increase the network provider's profits, however, this restriction does not matter. As long as the exclusion of rivals from its Internet service customers enables the network provider to increase the number of sales of its complementary product and the additional profits resulting from more sales at the market price are larger than the costs of exclusion, exclusion will be a profitable strategy. Given how often the conditions

96 If the price were equal to marginal costs, firms would not be able to cover their fixed costs and would earn negative profits. In the long run, firms would not operate in such a market. Thus, even if all firms earn zero profit per unit in long-run equilibrium, equilibrium prices are above marginal costs.

97 See also Shapiro and Varian (1999), p. 161. The importance of market share and number of units sold in knowledge-based products is also described by Afuah and Tucci (2001), pp. 52-54.

98 See Katz and Shapiro (1998), p. 13.

underlying the "primary good not essential" exception[99] are met, this drastically increases the likelihood that exclusion may be a profitable strategy.

4.2. More Outside Revenue

As indicated above,[100] a network provider may have an incentive to monopolize the complementary market, if the complementary product is a source of outside revenue that cannot be extracted in the market for Internet services. For reasons outlined above, its outside revenue will be higher if it excludes its rivals and collects the outside revenue directly than if tries to capture some or all of its rivals' outside revenue by threatening exclusion.

This increase in profit, however, is not dependent on a monopolization of the complementary product market.

Although the network provider's revenue from outside sources will be highest if it manages to monopolize the market for access to its customers, increasing the number of customers who access the network provider's offering may still lead to higher profits than trying to extract the outside revenue from its rivals.

Evidence suggests that even without a monopoly, the relationship between the number of customers and advertising revenue is not a linear one: for example, MacKie-Mason reports that although Lycos had 72 percent as many unique visitors as Yahoo! in September 1999, it received only 36 percent as much advertising revenue.[101] This implies that selling access to one large group of customers as a whole may still yield substantially more revenue than selling access to subgroups of that group separately, even if the seller does not have a monopoly in the market for access to its customers.

In addition, through its billing relationship with customers of its Internet service, the network provider has data on customer demographics that enables it to charge higher advertising fees or commissions for online sales than a lot of its rivals in the market for Internet content, portals and applications.[102] Again, this ability is not dependent on a monopoly in the complementary market.

A similar argument applies to the variant of this exception described above.[103] In this variant, a network provider excludes VoIP providers from access to its Internet Service customers in order to preserve the outside revenue in the form of access charges associated with traditional long-distance calls. Such a strategy will also be profitable, if the network provider does not manage to exclude the VoIP providers from its customers completely: Access charges are per-

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99 As outlined in Section 3.1., p. 14 above, these conditions are: The network provider has a monopoly in the primary market, i.e. the market for Internet services. The primary good is not essential, i.e. there are uses of the complementary product that do not require the primary good. This condition is met when the Internet service provider offers its complementary product not only to its Internet service customers, but to customers nation-wide. The complementary market is subject to economies of scale or network effects, a condition that is met in most markets for applications, content or portals. The monopolist has a mechanism at its disposal that enables it to exclude its rivals from access to its primary good customers. In the Internet context, technology that enables the network provider to distinguish between applications running over its network and to control their execution provides the network provider with this capability.

100 See Section 2.1., p. 6 above.

101 See MacKie-Mason (2000), p. 13.

102 Even if those rivals require consumers to register before using their product or service, they have no way to verify the information, unless they require payment; in this case, they can verify the information as part of the billing process. See Shapiro and Varian (1999), pp. 34-35; MacKie-Mason (2000), p. 11.

103 See Section 2.2., p. 8 above.

call charges set by regulators; the ability to charge them is not dependent on keeping all long-distance customers. Every long-distance call lost to a VoIP provider reduces profits; the more conventional long-distance calls the network provider manages to keep, the higher its profits.

4.3. Monopoly Preservation in the Complementary Market

In the "monopoly preservation in the complementary market" exception outlined above, the network provider excludes rival producers of a complementary product from access to its Internet service customers to preserve a legally acquired monopoly in the corresponding complementary market.

In the exception outlined above, the analysis assumes that the monopolist will be able to keep its rivals out of the nation-wide market by excluding them from access to its Internet service customers.

Even if the monopolist's footprint is not large enough to force its rivals to stay out of the market completely, exclusion from a part of the market may put them at a severe competitive disadvantage by forcing them to operate at a less efficient scale or with a smaller network. Compared to a world without exclusion, this may slow down the erosion of the network provider's monopoly in the complementary market, preserving its ability to charge monopoly profits for a longer time. Again, this may make exclusion a profitable strategy, even if the network provider does not manage to keep its rivals out of the market completely.[104]

C. Network Provider Faces Competition in the Market for Internet Services

Up to now, the analysis was based on the assumption that the network provider is at least a local monopolist in the market for Internet services. This assumption is in line with standard economic thinking on vertical exclusionary conduct in complementary markets: according to economic theory, an economic actor without monopoly power in the primary market will be incapable of excluding competitors in the complementary market using vertical practices such as tying, vertical mergers or exclusive dealing. A monopoly in the primary market is therefore considered to be an indispensable precondition for successful monopolization of the secondary market.[105]

Given this theory, it is not surprising that most of the literature on vertical exclusionary conduct in complementary product markets focuses on exclusionary conduct by monopolists: after all, the same conduct is unlikely to pose any significant anti-competitive threat, if the firm faces competition in the primary market.[106] This theory has also shaped the evaluation of existing firms' behavior in a complementary market: allegations of anti-competitive conduct in a secondary market are often countered by evidence that the accused firm does not have monopoly power in the primary market.[107] Alternatively, the analysis of the monopoly case is

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104 For a similar argument with respect to the profitability of monopoly preservation through exclusionary conduct in new economy markets, if the monopoly is of intellectual property, see Posner (2001), p. 254.

105 See for example Posner (2001), p. 195; Yoo (2002), pp. 188-191; similarly, some sort of market power or political power is considered to be a prerequisite for strategies that raise rivals costs. See, for example, Carlton and Perloff (2000), p. 353.

106 For an important exception to this point, see the literature on the exercise of aftermarket power by a firm that faces competition in the foremarket. This literature focuses on the question whether primary market competition precludes anti-competitive aftermarket actions. For an analysis of these issues with pointers to the literature, see MacKie-Mason and Metzler (1999).

107 See, for example, Yoo (2002), pp. 249-250, 253 in the open access debate: "I conclude that the structure of the broadband industry renders it unlikely that such combinations will pose any significant anti-competitive threat."

used as an argument "a maiore ad minus": if a monopolist in the primary market does not have the ability and incentive to impede competition in the secondary market, it is argued, then a competitive firm's conduct will pose even less of a threat.[108]

Based on this line of reasoning, most commentators believe that the threat of discrimination against independent providers of complementary products can be mitigated by competition in the market for Internet services. Stated differently, it is usually assumed that competition in the market for Internet services will restrict a network operator's ability and incentive to discriminate against independent content, portals, or applications. This assumption forms the basis for two common policy proposals: the first proposal assumes that fostering facilities-based competition, i.e. increased competition between operators of different physical networks, will mitigate a network provider's ability and incentive to discriminate.[109] The second proposal seeks to restore competition at the Internet service provider level by requiring the owners of broadband networks to allow independent Internet service providers to offer their services over these networks. This regulatory response is called "open access", "multiple access" or "forced access", depending on the point of view of the commentator.[110]

The following analysis shows that this assumption is not correct: a network provider may have the ability and incentive to exclude rival content, applications or portals from its network, even if it faces competition in the market for Internet services. Apart from increasing the number of cases in which unaffiliated providers of complementary products face a real threat of discrimination, this result also implies that neither facilities-based competition nor open access regulation are the appropriate tools to mitigate this threat.[111]

Four arguments drive this result: First, in the Internet context, the ability to exclude competitors from a complementary market (the markets for applications, content and portals) is not dependent on a monopoly position in the primary market (the market for Internet services). Instead, the power to exclude is conferred by network technology (Section 1.). Second, realizing the benefits of exclusion, i.e. an increase in profits (or, sometimes, a preservation of current profits), does not require a monopoly position in the primary market. The lack of monopoly in the primary market even increases the network provider's incentive to increase profits by engaging in exclusionary conduct in the complementary market, as the network provider cannot simply extract the available monopoly profit by charging higher prices in the primary market (Section 2.). Third, due to various factors such as the existence of switching costs or the ability to use discrimination instead of exclusion, the exclusion of rivals will not necessarily cause the network provider's Internet service customers to switch to another provider, making the costs of exclusion lower than is commonly assumed (Section 3.).

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108 See for example Speta (2000b), p. 986 in the open access debate.

109 For an example of this view, see Yoo (2004), p. 35: "On the other hand, regulators can adopt a more humble posture about their ability to distinguish anticompetitive from procompetitive behavior and attempt to resolve the problem by promoting entry by alternative broadband platforms. Once a sufficient number of alternative last mile providers exists, the danger of anticompetitive effects disappears, as any attempt to use an exclusivity arrangement to harm competition will simply induce consumers to obtain their services from another last mile provider."

110 An example of this line of reasoning can be found in the FCC memorandum and opinion in the AOL TimeWarner merger proceeding: "We believe that if unaffiliated ISPs receive non-discriminatory access to TimeWarner cable systems […] the merged firm's incentives and ability to withhold unaffiliated content from its subscribers will be substantially mitigated." Federal Communications Commission (2001), pp. 6594-6595, paragraph 107. See also Federal Communications Commission (2001), p. 6596, paragraph 112. See also Lemley and Lessig (1999), reprinted as Lemley and Lessig (2000).

111 There may be other reasons that justify these proposals, though. For example, according to Lemley and Lessig (1999), pp. 21-25, paragraphs 54-65, the reduction in application-level innovation by independent providers resulting from the threat of discrimination constitutes only one of three arguments in favor of open access.

The following analysis assumes that the network provider competes with at least one other network provider. In addition, the network provider may offer content or applications. A particular application or content may be offered to all consumers (affiliated product) or exclusively to the customers of its own Internet service (proprietary product).[112]

1. Ability to Exclude

Today, technology is available that enables network providers to distinguish between applications and content running over its network and to control their execution. This technology enables the network provider to exclude selected complementary products from its network or to slow down their execution.

This technology enables the network provider to exclude unaffiliated providers of complementary products from access to its Internet service customers, independent of a monopoly in the market for Internet services.

While the exclusionary power of the technology does not reach beyond the network provider's network, exclusion from the network provider's Internet service customers may suffice to drive rival producers of complementary products from the nation-wide market, if there are economies of scale or network effects in the complementary market.[113] Whether this will happen, depends on the exact size of economies of scale with respect to the complementary product in question, on the strength of any potential network effects and on the nation-wide number of both the monopolist's Internet service customers and the customers of other network providers.[114] Thus, in this context, the ability to drive competitors from the nation-wide complementary market depends on the network provider's nation-wide market share in the market for Internet services. Again, a monopoly position in this market is not required.

2. Benefits of Exclusion

In a variety of cases, the exclusionary conduct will increase (or preserve) the network provider's profits in the complementary market. As the analysis will show, this increase is not dependent on a monopoly position in the market for Internet services; nor does it require the network provider to gain a monopoly in the complementary market. Instead, the lack of monopoly in the primary market constrains the network provider's ability to extract profits in the market for Internet services, making the ability to realize profits in the complementary market even more attractive. As a result, there are a lot more cases in which exclusion may be profitable than is commonly assumed.

In general, by excluding rival producers of a specific complementary product from access to the network provider's Internet service customers, the network provider will increase the number of sales of its own complementary product.[115]

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112 See Section A., p. 3 above.

113 See Section 3.1., p. 14 above.

114 Even if the monopolist's footprint is not large enough to force its rivals to exit the market completely, exclusion from a part of the market may put them at a severe competitive disadvantage by forcing them to operate at a less efficient scale or with a smaller network. See the analysis above in Section 4.1., p. 23 above.

115 See Section 4., p. 22 above.

As set out in detail above, the increase in the number of sales will often lead to an increase in profits. In the cases outlined above, the increase in profits results from an increase in the number of sales, not from the ability to charge monopoly profits. Thus, to be profitable, the exclusionary conduct need not drive rivals from the complementary market completely.

In the cases described above, the network provider had a monopoly in the market for Internet services. As the following analysis will show, however, the increase in profits due to exclusion was not dependent on this monopoly position (Sections 2.1. – 2.3.). In addition, it will highlight a variant of the "monopoly preservation in the primary market" exception outlined above: the network provider may exclude selected producers of complementary products from access to its customers to protect its competitive position in the primary market (Section 2.4.).

2.1. More Sales at Market Prices

In the exception "more sales at market prices",[116] the increase in profits resulting from the higher number of sales in the complementary market was driven by the specific cost structure of the markets for applications, content or portals, which are characterized by high fixed costs and low marginal costs. This cost structure is not affected by the existence of market power in the market for Internet services.

2.2. More Outside Revenue

In the exception "more outside revenue",[117] the increase in profits resulted from the logic of pricing in the markets for advertising. This enabled the network provider to realize higher outside revenue by selling access to a large group of its Internet service customers directly, instead of letting rival producers of complementary products sell access to smaller groups of customers and extracting the outside revenue from them. Again, a monopoly in the market for Internet services is not required for this relationship to hold.

There is evidence that some Internet service providers, i.e. economic actors that face competition in the Internet service market, do in fact attempt to reduce the amount of time their customers spend on unaffiliated content or portal offerings. For example, in the AOL/TimeWarner merger proceeding the FCC found that "the record in this proceeding provides some evidence that AOL already seeks to limit its members' access to unaffiliated content on the World Wide Web. For example, AOL requires that content appearing on AOL web sites have only a limited number of hyperlinks to unaffiliated content." [References omitted][118]

In the variant of this exception,[119] the network provider was interested in excluding Voice over IP providers from access to its customers, because it could only charge access charges for long-distance calls placed using the conventional telephone service, not for long-distance calls using Voice over IP. Access charges are per-call charges set by regulation; they do not depend on a monopoly in the market for Internet services.

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116 Section 3.1., p. 14 and Section 4.1., p. 23 above.

117 Section 2.1., p. 6 and Section 4.2., p. 24 above.

118 Federal Communications Commission (2001), p. 6594, paragraph 106. See also Federal Communications Commission (2001), pp. 6593-6594, paragraph 104-106.

119 Section 2.2., p. 8 and Section 4.2., p. 24 above.

2.3. Monopoly Preservation in the Complementary Market

In the exception "monopoly preservation in the complementary market",[120] the ability to preserve the monopoly in the complementary market depended on various factors such as the exact size of economies of scale with respect to the complementary product in question, on the strength of any potential network effects and on the nation-wide number of both the monopolist's Internet service customers and the customers of other network providers. A monopoly in the market for Internet services is not required.

2.4. Preserving Competitive Position in the Primary Market

The exclusion of rivals may protect the network provider's competitive position in the market for Internet services, even if it faces competition in this market. Such an incentive may occur, if an Internet transport provider offers proprietary content and applications exclusively to its transport customers. This is a common strategy, as it enables the transport provider to relax price competition in the market for Internet services by differentiating its transport service from rival offerings, to reduce customer turnover and increase profits by raising switching costs and to make additional profits by selling access to its customers to advertisers, content providers or online merchants.[121]

Independent content and applications that can be used from any provider threaten the success of this strategy:

First, they reduce the differentiation of a provider's offerings by providing comparable, but independent alternatives.

Second, independent offerings may reduce the switching costs of the network provider's Internet service customers. Switching costs are the costs a customer incurs when switching to a competitor.[122] For example, when switching from one dial up access provider to another, a consumer must reconfigure his or her Internet access program. When switching from broadband access over cable to DSL, a consumer also needs to buy and install new equipment such as a DSL modem. Switching costs reduce customer turnover: when considering whether to switch to a competitor, a customer takes his switching costs into account. Switching costs also make demand more inelastic, enabling the seller to raise prices.[123]

Bundling Internet transport service with proprietary content and applications that are offered exclusively to transport customers is a common way to increase switching costs.[124] In this case, consumers loose access to their old provider's proprietary applications when they switch to another provider. As a result, they have to search for new ones and learn how to use them. In addition, many proprietary offerings induce their customers to engage in nontransferable database creation and customization. For example, Internet service providers offer provider-specific e-mail addresses that cannot be transferred to another provider; to take advantage of services like stock portfolio tracking, instant messaging or customized news pages, users have to enter nontransferable data as well. When switching providers, customers need to notify

120 Section 2.3., p. 9 and Section 4.3., p. 25 above.

121 See, for example, MacKie-Mason (2000), p. 11.

122 For an overview of switching costs, see, for example, Varian (1999), pp. 603-605; for a treatment of switching costs in the context of information goods, see Shapiro and Varian (1999), chapters 5-6.

123 See, for example, Varian (1999), pp. 604-605; Hausman, Sidak et al. (2001a), p. 164.

124 See, for example, MacKie-Mason (2000), p. 11.

relevant parties of their new e-mail addresses or instant messaging IDs and loose their site-specific data.

Independent offerings may reduce the effectiveness of this strategy by reducing customers' switching costs: as the independent application or content is not tied to a specific provider of Internet services, consumers can continue to use it after switching providers. In addition, by creating site-specific data on independent offerings, customers can avoid becoming locked in to a specific access provider.[125]

Third, as has been set out above, independent alternatives may also reduce the time customers spend using proprietary offerings, reducing third party revenues such as advertising fees or commissions for online sales.

By excluding independent applications and content that compete with the network provider's proprietary offerings, the network provider may be able to prevent these problems.

3. Costs of Exclusion

Compared to the monopoly case, the existence of other, competing network providers may increase the costs of exclusionary behavior in the complementary market. Due to a variety of factors such as the existence of switching costs or the ability to use discrimination instead of exclusion, the costs of exclusion will still be lower than is commonly assumed.

If the network provider is the only supplier of Internet services in a particular geographic area, consumers have no alternative way of accessing the excluded application or content. They either subscribe to the provider's Internet service or do not use Internet services at all. Thus, the costs of the exclusionary behavior are twofold: first, the price of Internet services will be lower due to the reduction in application and content variety.[126] Second, without being able to use the excluded application or content, some consumers may not value Internet services enough to pay the lower price.[127] Given that that the pricing of the service already reflects the reduced value, the number of lost transport customers will probably not be very high.
If the provider competes with at least one other network provider, consumers who desire access to the excluded application may switch to another provider. As these consumers do not have to forgo Internet services altogether, the number of lost transport customers will probably be higher than if the excluding network provider does not face competition. Thus, competition increases the costs of exclusionary behavior in the complementary market.[128]

Several factors may limit the costs of exclusionary behavior in spite of competition in the market for Internet services:

First, if the exclusionary conduct manages to drive the producers of the excluded application or content from the market, switching providers will not enable consumers to get access to the excluded product. As a result, fewer consumers will switch in response to the exclusion.[129]

125 They get locked in to the independent offering, though.

126 A similar point is made by Wu (2003) in his discussion of the costs of a discriminatory pricing scheme that prohibits customers of a network provider's basic Internet service from using specific applications. See Wu (2003), p. 153.

127 See, for example, Rubinfeld and Singer (2001b), p. 310.

128 See, for example, Rubinfeld and Singer (2001b), p. 310.

129 See, for example, Rubinfeld and Singer (2001b), pp. 312-313.

Second, switching costs may prevent consumers from changing providers to get access to the excluded application.[130] This is the case, if the increased value from being able to use the excluded application is smaller than the costs of switching to another network provider. Thus, the higher switching costs, the lower the number of customers lost to other network providers.[131]

Third, and potentially most importantly, the network provider may be able to avoid this problem altogether by using discrimination instead of direct exclusion.[132] As today's network technology provides the ability to control the execution of applications running over the network, a network provider can negatively affect the execution of particular applications. For example, the network provider can slow down the transport of certain applications or the delivery of selected content. If a network provider discriminates against a rival's complementary product, consumers' use of the rival's product is less satisfactory than their use of the network provider's own offering, even if the rival's product is of higher quality.

Thus, discrimination works indirectly by changing consumers' perception of the quality of a rival's offering. As consumers are unable to detect the true cause of the lower quality, they may mistakenly attribute it to bad product design and use competing products whose use is more satisfactory. For example, a slow gaming experience may be due to bad application programming, insufficient server capacity at the gaming site or slow Internet transport. Similarly, long waiting times for pages from an online shop could result from bad programming of the underlying databases or insufficient server speed. If customers do not usually experience problems with network speed, they will be inclined to blame the online game or the online shop.

With discrimination, consumers have the option of choosing the rival's product, but prefer the network provider's product which they perceive to be of higher quality. Contrary to direct technical exclusion or tying, they will not feel that their choice has been restricted. As they do not wish to use the rival's product, the discrimination will neither reduce their valuation of the network provider's Internet services nor cause them to switch to a competing provider.

Thus, if the network provider discriminates against rival products instead of excluding them directly, competition in the market for Internet services does not increase the costs of the exclusionary conduct.

D. Conclusion

Although a network provider does not generally have an incentive to discriminate against independent providers of content, applications or content, the analysis has highlighted a variety of circumstances under which it may have such an incentive. Such an incentive may not only occur if it has a (local) monopoly in the market for Internet services, but also if it faces competition. Whether the conditions giving rise to such an incentive are present in a real life situation, is an empirical question. In most cases, however, the network provider need not be able to gain a monopoly in the complementary market to make exclusion a profitable strategy, making the threat of discrimination more relevant than commonly assumed.

130 See, for example, Hausman, Sidak et al. (2001a), p. 164; Nuechterlein and Weiser (2005), p. 156.

131 Switching costs do not protect the network provider from losing business from new customers.

132 See, for example, Rubinfeld and Singer (2001b), pp. 310, 313.

In most cases, the network provider need not exclude all independent developers of complementary products from its network in order to increase its profits. Instead, it will often be profitable to exclude only those complementary products that directly compete with one of its own complementary products. This reduces the costs of exclusion, as the reduction in complementary goods variety is restricted to those products that are actually excluded.

Due to the specific characteristics of markets for applications and content such as the cost structure of information goods and (sometimes) the existence of network effects, the exclusion of rivals may lead to gains that are significantly higher than in traditional markets. As a result, it is more likely that the gains from exclusion exceed the associated costs, making it more likely that exclusion is a profitable strategy.[133]

III. Impact on Application-Level Innovation

The previous part has highlighted conditions under which a network provider may have an incentive to exclude independent producers of applications, content or portals from access to its Internet service customers. When these conditions are present, independent producers of complementary products face a real threat of discrimination.

The following section analyzes the impact of this threat on innovation in the markets for applications, content and portals ("application-level innovation"). It shows that the threat of discrimination reduces the amount of application-level innovation by independent producers of complementary products (Section A.). While discrimination increases network providers' incentives to engage in application-level innovation, this increase cannot offset the reduction in innovation by independent producers (Section B.). Thus, the threat of discrimination reduces the amount of application-level innovation.

A. Incentives of Independent Producers of Complementary Products

In the absence of network neutrality regulation, the threat of discrimination reduces the amount of application-level innovation by independent producers of complementary products in three ways.

First, when the conditions for profitable exclusion outlined above are present in a particular complementary market, a network provider will discriminate against rivals in this market. As indicated above, discrimination will reduce their profits.[134] A potential innovator bases its decision to innovate on the expected costs and benefits of realizing the innovation. Facing the threat of discrimination, potential innovators in affected markets will expect lower profits. Thus, the threat of discrimination reduces their incentives to innovate.

Second, the profitability of exclusion depends on a large number of factors that may not be common knowledge for all market participants. As a result, an economic actor with an idea for a complementary product may not be able to decide whether the network provider will

133 For a similar argument with respect to the profitability of monopoly preservation through exclusionary conduct in new economy markets, if the monopoly is of intellectual property, see Posner (2001), p. 254.

134 The exclusionary conduct hurts independent producers of excluded complementary products in several ways: first, they are excluded from the part of the complementary market that consists of the network provider's Internet service customers. As a result, they are unable to make any sales in that market. In addition, due to economies of scale and, potentially, network effects in the production of their products, the exclusion from a part of the market may put them at a competitive disadvantage in the rest of the market as well. In the worst case, they may be forced to exit the complementary market completely. If they had made at least some sales to the network provider's Internet service customers in the absence of the exclusionary conduct, the exclusion will reduce their profits.

have an incentive to exclude the final product from the market.[135] As a result, potential innovators face a significant uncertainty with respect to their future competitive environment. This uncertainty may reduce a developer's incentive to innovate, even if the factual conditions for profitable exclusion are not present.

Third, the above analysis suggests that independent producers of complementary products need not be concerned about exclusion, if the network provider does not currently offer a competing product. This seems to imply that innovation will only be harmed where the network provider is already vertically integrated into one or more complementary markets. Economic theory shows that this is not correct: Even if the network provider does not currently offer a competing product, it may be tempted to imitate the entrant, exclude the entrant from its network and exploit the complementary market itself, once the entrant starts to make significant profits.

Economic models show that in the presence of demand uncertainty in a complementary market, a primary good monopolist with a selling advantage in this market may have an incentive to let an independent producer enter the complementary market first to let him "test the waters".[136] If the level of demand turns out to be large enough once the demand uncertainty is resolved, the primary good monopolist enters the market as well and uses its selling advantage to make most of the sales. Foreseeing this course of events, the independent producer refrains from entering the market. As a result, nobody enters the complementary market; there is a region of foregone invention where privately and socially beneficial innovations are not realized.

For this situation to occur, three conditions must be realized: First, there must be demand uncertainty in the complementary market. Second, in the presence of demand uncertainty, entry to the complementary market is attractive for the independent producer, but not for the primary good monopolist, e.g. due to cost heterogeneity. Third, the primary good monopolist has a selling advantage in the complementary market.

In the Internet context, these conditions will often be met: First, in markets for new applications or content, there is usually a considerable demand uncertainty. Second, the economics and business strategy literature highlights a variety of reasons, why an incumbent network provider may not have an incentive to enter a complementary market for a new product in the presence of demand uncertainty, while an independent producer may have such an incentive. For example, start-ups often have lower entry costs than an incumbent due to the different cost structure of incumbents and new entrants.[137] In addition, while a small level of demand may meet the growth needs of a small company, a large incumbent will need much higher levels of demand to meet its growth needs.[138] Similarly, even if the level of demand is too uncertain for the network provider to justify innovation, users may find it attractive to innovate to meet their own application needs.[139] Third, the ability to technically exclude a

135 Similarly, the network provider may fail to assess the situation correctly and discriminate against or exclude an independent provider of complementary products, even if none of the conditions under which this conduct would be profitable apply. Farrell and Weiser (2003) call this problem "incompetent incumbents" and include it in their list of exceptions to their version of the one monopoly rent argument. See Farrell and Weiser (2003), pp. 114-117.

136 See Miller (2004).

137 See, for example, Christensen (2000), p. 132.

138 See, for example, Christensen (2000), p. 128-130.

139 See van Schewick (2004), pp. 329-342 with pointers to the relevant literature.

rival producer of complementary products from its network provides the network provider with a huge selling advantage in the complementary market.

Thus, the number of markets in which independent developers' incentives to innovate are reduced will be larger than implied by the exceptions outlined above.

B. Incentives of Network Providers

As the previous section has shown, the threat of discrimination reduces independent producers' incentives to innovate in the markets for applications, content or portals. This reduction is only relevant, if it is not offset by a corresponding increase in network providers' incentives to innovate in these markets. While network providers' incentives to innovate at this level do rise due to the increase in profit under discrimination, this increase in a few network providers' incentives to innovate cannot compensate for the reduction in innovation by independent producers.

There are three reasons for this: First, the reduction in potential innovators results in less diverse approaches to innovation, with negative consequences for the amount and quality of innovation. Second, with respect to particular innovations, economic actors other than the network providers may have an incentive to innovate, while the network providers may lack such an incentive. This further reduces the amount of innovation. Third, there are specific benefits associated with specific types of independent innovators which a network provider cannot replicate.

First, while there are a large number of (potential) independent producers of complementary products, there are only a few network providers. Thus, by reducing the innovation incentives of a large number of independent developers, the threat of discrimination ultimately reduces the number of innovators at the application-level. In the presence of technological uncertainty, market uncertainty or consumer heterogeneity, this reduction negatively affects the amount and potentially the quality of application-level innovation.

Human beings and, consequently, the firms for which they work have different experiences, capabilities and organizations, a fact that is stressed by research in evolutionary economics and management strategy. Due to these differences, economic actors may react very differently when exposed to the same situation. The impact of these differences rises with technological uncertainty, market uncertainty or consumer heterogeneity. Under these conditions, an increase in the number of potential innovators will result in a more diverse set of approaches to innovation,[140] and a more diverse set of approaches will be socially beneficial:[141] It guarantees a more complete search of the space of potential complementary products and decreases the probability that beneficial uses of the platform remain undetected. It increases the expected quality of the resulting products and may increase the amount of heterogeneous consumer needs that are served.

Second, research in economics and management strategy has identified systematic differences in the nature and direction of innovative activity between different types of innovators. In particular, due to differences in history, economic position and capabilities, the same innovation may be attractive to one type of innovator, but not to another. This research suggests that there are a large number of cases in which economic actors other than the network provider may have an incentive to realize an innovative idea, while the network

[140] See van Schewick (2004), pp. 299-305 with pointers to the relevant literature.

[141] See van Schewick (2004), pp. 305-310 with pointers to the relevant literature.

provider may lack such an incentive. For example, this has been shown for new entrants to a complementary market, for venture-capital backed firms and for users.[142] When independent producers loose their incentive to innovate, this innovation will be lost.

Third, there are specific benefits associated with specific types of independent innovators which a network provider cannot replicate. For example, research has shown that the participation of firms backed by venture capitalists may increase the amount and the quality of innovation. Enabling users to innovate, may leave less customer needs unserved. In addition, users often make their innovation freely available to others; as a result, such innovations will reach a higher level of diffusion than a similar innovation of comparable quality that is produced by a network provider which sells the innovation to make a profit.[143]

In the context of the Internet, technological and market uncertainty as well as user heterogeneity are high,[144] suggesting that the reduction in independent producers' incentives to innovate will have the detrimental impact on application-level innovation outlined above.

IV. Impact on Social Welfare

Network neutrality rules prevent network providers from discriminating against independent producers of complementary products or excluding them from their network. In the absence of network neutrality regulation, there is a real threat of discrimination (see Part II.). Regulatory intervention to remove this threat is only justified, if the social benefits of regulatory intervention are larger than the costs.

As Part III. has shown, network neutrality regulation increases the amount of application-level innovation. The increase is only relevant, if it is socially beneficial (Section A.) On the cost side, network neutrality rules reduce network providers' incentives to innovate at the network level and to deploy network infrastructure (Section B.1.). While regulatory intervention has its own costs, these are not covered in detail (Section B.2). When deciding whether to introduce network neutrality regulation, regulators must trade-off the benefits against the costs (Section C.).

The analysis shows that the increase in application-level innovation is socially beneficial and that these benefits are more important than the costs.

A. Benefits

Network neutrality rules increase the amount of application-level innovation. This increase is only relevant to public policy, if it increases social welfare. This question can be approached in several ways.

First, one may ask whether the amount of innovation is generally lower than the social optimum. In this case, an increase in the amount of innovation would be socially beneficial.

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142 van Schewick (2004), pp. 311-324 (new entrants), pp. 324-329 (venture capital backed firms), pp. 329-342 (users), based on a discussion of the relevant literature.

143 Ibd. While it is difficult to quantify these benefits, there are indications that they may be significant. For example, surveys indicate that today's standard commercial products may on average leave between 46% and 54% of customer needs unserved. See Franke and von Hippel (2003), p. 5-6.

144 Both network technology as well as technologies for the development of applications are still evolving, creating considerable technological uncertainty. A large number of useful applications are still waiting to be identified; in these areas, market uncertainty is high. The more people and businesses get connected to the Internet, the higher the heterogeneity of Internet users will become. Ultimately, the heterogeneity of Internet users will mirror the heterogeneity of society. As a result, the heterogeneity of user needs is bound to be increasing, not decreasing.

In dealing with such questions, economists often note that the link between innovation and social welfare is theoretically ambiguous:[145] on the one hand, some economic models highlight the possibility that in their desire to capture the rents from innovation, firms may increase the level of investment in research and development above the socially efficient amount.[146] On the other hand, the existence of uncompensated spillovers and other factors such as the inability of innovators to perfectly appropriate the increase in consumer surplus lead to the theoretical prediction that firms will not be able to completely appropriate the social gains from innovation, leading them to invest less than the socially optimal amount in innovation.[147]

A closer look at the underlying models indicates that under conditions of uncertainty this ambiguity may disappear, leading to the insight that the amount of innovation is usually too low, which makes any increase in innovation socially beneficial. In models where firms invest more than the socially efficient amount in innovation, the wedge between private and social benefits from innovation results from the argument that society does not care which firm is ultimately successful, whereas each individual firm wants to be the winner.[148] Thus, these models are based on the implicit assumption that similar approaches by different firms constitute a wasteful duplication of efforts that should better be avoided. As indicated above, such an assumption neglects differences in firm heterogeneity. Once firm heterogeneity is taken into account, having different firms approach a particular problem will often be socially beneficial.

These theoretical insights are supported by empirical studies. They indicate that there is indeed too little innovation, because private firms are typically unable to appropriate all social gains from the innovation.[149]

Second, one may ask whether in the specific case under analysis there is likely to be less innovation than the socially optimal amount. Innovation in platform products[150] and complementary products is subject to two types of externalities that are likely to reduce the amount of innovation below the social optimum:[151] while the first operates vertically between the platform product and each complementary product, the second externality operates horizontally between different complementary products.

Due to the complementarity between the platform product and complementary products, innovation in complementary products usually increases demand for the platform product and vice versa. If the platform product and the complementary product are developed by different economic actors, the innovator in a complementary component does not appropriate the positive effect on the platform product, and vice versa.[152]

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145 See, for example, Reinganum (1989), Tirole (1988), pp. 399-400; Katz (2002), Section C.

146 For an overview of this literature, see Reinganum (1989). For a particular example of such a model, see Dasgupta and Maskin (1987).

147 See, for example, Tirole (1988), pp. 399-400.

148 See, for example, Dasgupta and Maskin (1987), pp. 584-585.

149 See, for example, Mansfield, Rapoport et al. (1977); Jones and Williams (1998).

150 A platform product is a product that may be used with a large number of complementary products. See, e.g. Lichtman (2000).

151 This observation is made in two different contexts by Bresnahan and Trajtenberg (1995) and Lichtman (2000).

152 See, for example, Farrell and Katz (2000), p. 414 and appendix; Bresnahan and Trajtenberg (1995), p. 94.

Innovation in one complementary product usually increases demand for the platform product, which may in turn positively affect demand for other complementary products. If different economic actors pursue innovation in the different components, each actor does not appropriate the positive effect on the other components. As a result, each actor's incentives to innovate will be lower than the social optimum.

A common solution to the problems caused by such externalities is integration by all affected parties. The integrated entity internalizes the externalities and has therefore higher incentives to innovate.[153] In the current context, this is not a feasible solution: no single economic actor will be able to identify and realize all beneficial uses of the Internet.[154]

Finally, any assessment of the benefits of additional application-level innovation needs to take account of the character of the Internet as a general purpose technology.[155]

As a general purpose technology, the Internet has the potential to significantly increase economic growth.[156] General-purpose technologies offer a generic functionality that can potentially be applied in a large number of sectors within the economy. As the use of a general-purpose technology spreads throughout the economy and increases productivity in the sectors in which it is applied, the promises for economic growth that this technology holds materialize. At the same time, new applications trigger new advances in the general-purpose technology itself; these advances may in turn spawn the adoption of the general-purpose technology in additional sectors of the economy or may lead to new or improved applications in sectors that already use the technology. Thus, the adoption of general-purpose technologies exhibits increasing returns to scale, leading to potentially enormous increases in economic growth.[157]

As the positive impact of a general purpose technology stems primarily from the productivity increases resulting from its adoption in more and more sectors of the economy, the existence of a general-purpose technology is not sufficient to positively impact economic growth. Instead, the rate at which a general purpose technology affects economic growth depends on the rate of co-invention,[158] i.e. the rate at which potential uses of the technology are identified and realized.

With respect to the Internet, this analysis implies that identifying potential uses for the Internet and developing the corresponding applications is the prerequisite for realizing the enormous growth potential inherent in the Internet as a general-purpose technology.[159]

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153 For some important refinements to this statement, see Farrell and Katz (2000). As Farrell and Katz (2000) demonstrate, integration between two firms that each are the sole supplier of a component that is complementary with the other does not necessarily increase the incentives to invest in socially valuable research and development. (See Farrell and Katz (2000), appendix). In addition, they show that integration between a monopoly supplier of one component with one of several suppliers of a complementary component may inefficiently lower independent suppliers' incentives to innovate.

154 Bresnahan and Greenstein (2001), p. 98; Lichtman (2000).

155 For a detailed exposition of the argument in the text with pointers to the literature, see van Schewick (2004), pp. 346-349.

156 On general-purpose technologies, see, for example, Bresnahan and Trajtenberg (1995); Bresnahan and Greenstein (2001) and the collection of papers in Helpman (1998). On the Internet as a general-purpose technology, see, for example, Harris (1998).

157 See, for example, Bresnahan and Trajtenberg (1995); Helpman and Trajtenberg (1998).

158 The term "co-invention" denotes the innovative activity associated with identifying and realizing potential uses of the general purpose-technology in particular sectors of the economy. See, for example, Bresnahan and Trajtenberg (1995), pp. 86-88; Bresnahan and Greenstein (2001), pp. 95-97.

159 For a similar observation, see Litan and Rivlin (2001), pp. 104-107.

As a result, measures that reduce the amount of application-level innovation have the potential to significantly harm social welfare by significantly limiting economic growth.

B. Costs

On the cost side, network neutrality rules reduce network providers' incentives to innovate at the network level and to deploy network infrastructure (Section 1.). Regulatory intervention also creates its own costs (Section 2.); however, these are not covered in detail.

1. Impact on Incentives at the Network Level

As highlighted in Part II., there is a variety of cases in which discrimination increases (or preserves) network providers' profits. As network neutrality regulation prevents network providers from realizing these profits, network neutrality regulation reduces their profits. Due to the complementarity between applications, content and portals on the one hand and Internet services on the other hand, this reduction in profits also affects network providers' incentives to innovate at the network level and to deploy network infrastructure.

2. Costs of Regulation

The costs of network neutrality regulation depend on the chosen form of implementation. While the costs of network neutrality regulation are not the focus of this article, existing literature suggests that the costs of regulation itself will not be significant. In particular, they will be significantly lower than the costs associated with implementing and overseeing an open access regime.[160]

C. Trade-Off

The social benefits and costs outlined above suggest that the introduction of network neutrality regulation requires a trade-off: On the one hand, network neutrality regulation increases the amount of application-level innovation, which is critically important for economic growth. On the other hand, it decreases network providers' incentives to innovate at the network level and to deploy network infrastructure. The following section analyzes the two trade-offs in turn.

1. Application-Level Innovation vs. Innovation at the Network Level

Research on information-technology based general-purpose technologies suggests that increasing co-invention[161] is more important than increasing innovation in the general-purpose technology itself. Applied to the Internet, this implies that increasing application-level innovation is relatively more important than increasing innovation at the network level.

In information technology-based general-purpose technologies the incentives to invest in advancing the general-purpose technology itself seem to be higher than the incentives to invest in co-invention,[162] making it relatively more important to foster co-invention. This difference is attributed to two factors: first, the science and engineering base of hardware technologies is more developed than the science base of software engineering and of finding attractive business uses. Second, due to their generality, general-purpose technologies have

[160] See, for example, Weiser (2003), pp. 79-80.

[161] The term "co-invention" denotes the innovative activity associated with identifying and realizing potential uses of the general purpose-technology in particular sectors of the economy. See, for example, Bresnahan and Trajtenberg (1995), pp. 86-88; Bresnahan and Greenstein (2001), pp. 95-97.

[162] Bresnahan (1998), p. 10.

larger markets than the individual applications; after all, while not all users of a general-purpose technology need all applications, all users need the general-purpose technology.

These factors are also present in the context of the Internet, making it reasonable to assume that the imbalance between incentives to innovate found in information-based general-purpose technologies in general also exists in the context of the Internet: Network engineering has a more developed science base than the identification of uses and software engineering. Due to the generality of the networking infrastructure, the market for network technology itself is larger than the market for individual applications.

Thus, compared to the incentives to innovate at the application-level, incentives to innovate at the network level are higher. At the same time, application-level innovation is the main determinant of economic growth. This suggests that increasing the amount of application-level innovation is relatively more important than increasing innovation at the network level.

2. Application-Level Innovation vs. Deployment of Network Infrastructure

As indicated above, network neutrality regulation reduces network providers' profits. This reduction in profits will also affect their incentive to deploy network infrastructure. This causal relationship, however, does not say anything about the degree to which these incentives are reduced.

Thus, in determining the appropriate trade-off between infrastructure deployment and application-level innovation, two questions must be answered: First, will the reduction in profits reduce the incentive to deploy infrastructure below the necessary level? Second, even if this is the case, is allowing network providers to discriminate the appropriate solution to this problem?

First, it is an open question, whether network neutrality regulation will reduce incentives to deploy network infrastructure below the necessary level. Not surprisingly, network providers and their industry organizations have claimed that this is the case. There are several reasons to doubt this assessment, though: Network neutrality regulation does not forbid network providers to vertically integrate into complementary markets; it only bans them from using discrimination to increase their sales at the expense of rivals. Thus, it does not prevent network providers from making profit in complementary markets; it just takes away the additional profits that could be realized due to discrimination.[163] It also does not prevent them from making profit in the market for Internet services. As a result, the remaining profit may still be sufficient to motivate them to deploy the necessary infrastructure. Moreover, new wireless technologies may ameliorate the problem by further reducing the costs of broadband infrastructure. Thus, it still needs to be proven that the reduction in profits caused by network neutrality regulation suffices to reduce network providers' incentives to deploy infrastructure so severely that it becomes relevant for public policy.

Second, even if network providers' incentives are too low to guarantee the necessary deployment of broadband infrastructure under network neutrality regulation, this does not necessarily imply that network providers should be allowed to discriminate. As Michael Katz has put it, "In the antitrust – if not regulatory – context […] U.S. policy rejects the notion that the otherwise illegal maintenance or acquisition of monopoly power in a market can be

[163] Whether and, if yes, what form of price discrimination should be forbidden under network neutrality regulation, is still an open question. See e.g. Wu (2003), pp. 151-154 (no price discrimination, if it is based on discrimination between applications) on the one hand and Nuechterlein and Weiser (2005), p. 177 on the other hand.

justified by "good" use of the monopoly profits in that market or another one."[164] Following this line of reasoning, instead of allowing discrimination, regulators should contemplate other ways of ensuring a sufficient deployment of network infrastructure, if necessary. For example, in light of the severe consequences of stifling application-level innovation for economic growth, subsidizing the deployment of broadband infrastructure may be preferable to allowing network providers to discriminate.

Thus, in trading off application-level innovation against infrastructure deployment, it seems reasonable to opt for fostering application-level innovation in order to realize the enormous growth potential inherent in Internet technology, and to contemplate other ways of ensuring a sufficient deployment of network infrastructure, if necessary.

V. Conclusion

This paper advances the debate over network neutrality by providing an economic framework within which claims for network neutrality regulation can be analyzed.

The analysis shows that calls for network neutrality regulation are justified: In the absence of network neutrality regulation, there is a real threat that network providers will discriminate against independent producers of applications, content or portals or exclude them from their network. This threat reduces the amount of innovation in the markets for applications, content and portals at significant costs to society.

While network neutrality rules remove this threat, they are not without costs: Apart from creating the costs of regulation itself, network neutrality rules reduce network providers' incentives to innovate at the network level and to deploy network infrastructure. Thus, regulators face a trade-off. As the paper shows, due to the potentially enormous benefits of application-level innovation for economic growth, increasing the amount of application-level innovation through network neutrality regulation is more important than the costs associated with it.

Before network neutrality regulation can be drafted, however, more research is needed. In particular, the open questions surrounding the scope of network neutrality regulation need to be resolved. In addition, the best way of implementing network neutrality rules still needs to be identified.

The paper also contributes to the debate over "open access" and "facilities-based competition". As has been set out above, the proposals for "facilities-based competition" and "open access" are based on the assumption that competition in the market for Internet services will mitigate a network operator's ability and incentive to discriminate against or exclude independent portals, content and applications. The analysis has highlighted a variety of circumstances under which a network provider may have the ability and incentive to discriminate against unaffiliated producers of complementary products or exclude them from its network, even if it faces competition in the market for Internet services. Thus, neither increased facilities-based competition nor open access regulation are the appropriate tools to mitigate the threat of discrimination.

[164] Katz (2002), p. 340.

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