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net neutrality issue

Dynamic Effects of Network Neutrality[1]

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At the heart of the network neutrality debate is a challenging institutional design problem: the selection of a regime to govern the relations between the stakeholders in the complex value net of advanced communication services, most importantly between platform operators and providers of applications and content. How it is resolved will have far-reaching effects on the future evolution of communication industries. A wide spectrum of arrangements to structure these relations is possible, ranging from a minimally restrictive antitrust approach to highly constraining rules and regulations in a framework of full regulation. Based on a stylized model, the paper examines the innovation incentives of platform operators and content providers in next-generation networks under three scenarios: (1) absence of network neutrality rules, (2) various non-discrimination rules, and (3) full regulation. The discussion reveals that no panacea exists to address the potential problems raised by the network neutrality debate. Alternative specifications of rules will result in different innovation trajectories at the platform and content layers and the system overall. Given the lack of knowledge and the high degree of uncertainty, a strategy of monitoring, combined with a willingness and authorization to intervene if a pattern of abuse becomes visible, seems to be the most appropriate immediate step forward.

I. Introduction

At the heart of the network neutrality debate is a challenging institutional design problem: the selection of a regime to govern the relations between the stakeholders in the complex value net of advanced communication services, most importantly between platform operators and providers of applications and content. How it is resolved will probably have far-reaching effects on the future evolutionary path of communication industries. A wide spectrum of arrangements to structure this

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relation is possible ranging from minimally restrictive to highly constraining rules and regulations. At the minimally restrictive end of the spectrum no network neutrality rules would be mandated. Network providers would enjoy full freedom to differentiate platforms, services, and prices as long as they do not violate pertinent competition law. Arrangements governing the relations between platform operators and application and content providers would emerge through repeated interactions of and contractual agreements between the players, possibly conventions negotiated by industry associations, and clarifying decisions by the courts. At the maximally intrusive end of the spectrum is full and detailed regulation of investment, prices, and the quality and conditions of access to the network platforms. In between these extreme solutions is a range of possible non-discrimination rules that constrain but do not fully eliminate network platform providers' ability to discriminate. Such rules span a space from light-handed to heavy-handed, intrusive approaches. Key questions that the network neutrality debate therefore should address are (1) how different specifications of the governance regimes affect the future trajectory of the industry, (2) which trade-offs exist between these regimes and (3) whether there is a dominant solution that outperforms all others.

The early policy debate framed network neutrality largely as a dichotomous issue, a feature that either exists or does not exist (Ganley and Allgrove 2006). Arguing in this frame, several pundits positioned themselves either in favor of network neutrality — however vaguely defined — (Wu 2003; Windhausen 2006; Herman 2007) or opposed to it (Yoo 2005; Dixon et al. 2006; Ford et al. 2006a; Ford et al. 2006b; Ford et al. 2006c; Hahn and Wallsten 2006). As the discussion matured, the positions became more nuanced, with a stronger emphasis on the contingencies under which network neutrality rules might make sense and the limits of such policies (Felten 2006; Frieden 2006; Kocsis and de Bijl 2006; van Schewick 2007). The policy discussion so far has generated a broad range of claims and counterclaims as to the nature of the policy problem and the range of possible solutions. Opponents of net neutrality often claim that net neutrality would imply a prohibition of price differentiation for network services, a mandate to roll-out a dumb network infrastructure, and the establishment of detailed and intrusive regulation. While there is a risk that approaches to secure an open network platform might deteriorate and have these effects, this is not inevitable. On the other hand, many proponents of net neutrality envision a future of strict discrimination against content providers with a significantly lowered innovation rate. Whereas this is one possibility, it is probably also a borderline case and not the most likely outcome.

To what extent platform operators would choose to discriminate against application and content providers that are dependent on access to these platforms to reach customers and to which degree public policy could mitigate the detrimental effects of such behavior is largely an unresolved issue. It is likely that the incentives of platform operators to discriminate or cooperate will be shaped by the rules established for their operations. In addition, they will depend on the boundaries of the firm, in particular whether or not platform operators are vertically integrated or not and their scope of diversification. In the most generic sense, the network neutrality debate attempts to determine which regime governing the relations between platform operators and vertically related application and content providers will have the most desirable efficiency and welfare effects.

Ideally, a choice between different governance options would be based on a detailed evaluation of their static and dynamic efficiency implications. As the debate is necessarily forward-looking, it is difficult to provide empirical support for the conflicting propositions. One way is to learn from the past: drawing on analogies from the history of telephone regulation Owen (2007) also reached a skeptical conclusion, opposed to network neutrality. However, there are important differences between past technologies and the present and future environment of broadband communications. An alternative approach is to analyze the incentives of the players under conceivable alternative governance regimes □ given the new technology conditions □ to produce a differentiated understanding of their inherent characteristics and trade-offs. Even such a conceptual systematic assessment is complicated by the fact that the multiple dynamic interactions in next-generation networks render the issues intractable and prohibit an analytical determination of probable outcomes.

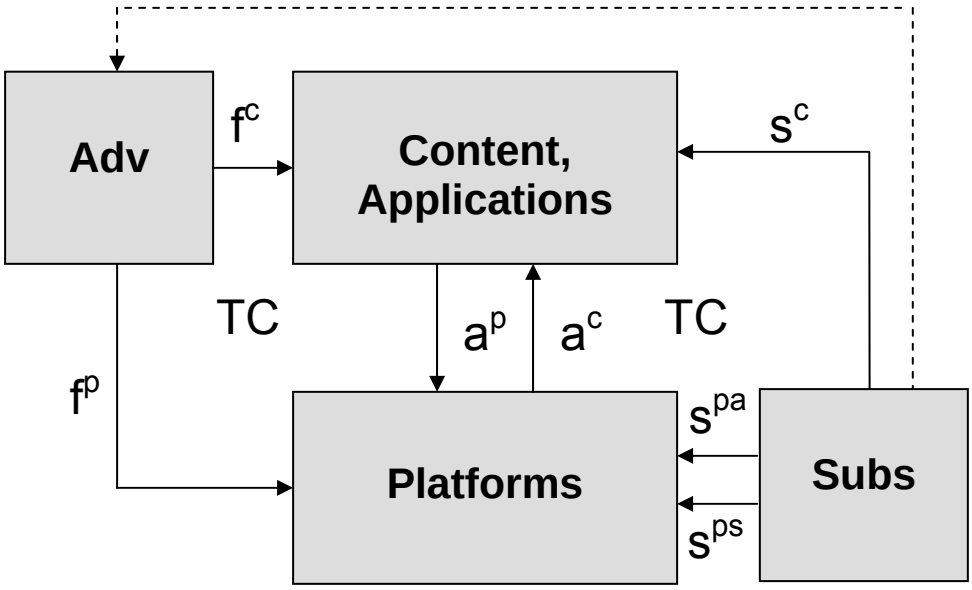
This paper explores a different approach, the use of scenario thinking and simulation models to develop a better understanding of the dynamic effects of different policy approaches. The next section develops a stylized model of key interactions in a next-generation network. Subsequent sections discuss a reference scenario based on the absence of any specific network neutrality regulations and compare this approach to alternative network neutrality regimes. The focus is on the innovation incentives of the stakeholders at the platform and at the application and services layers, recognizing the interdependence of innovation processes at these two layers. Section six draws some comparative conclusions. Overall, the discussion indicates that no panacea exists to address the problems raised by the network neutrality debate. Alternative specifications of rules will likely result in different innovation trajectories. A strategy of waiting combined with the willingness to intervene if necessary, perhaps backed by appropriate authority for the Federal Communications Commission (FCC), seems to be the most adequate immediate way forward.

II. A Stylized Model

To address the effects of alternative policy options on sector performance, it is necessary to understand dynamic competition in vertically related, concentrated markets. Provision of advanced communications and multimedia services requires the combination of services at different layers of the system. For example, IPTV requires the combination of platform services with content. Identification of layers is not always straightforward nor are they necessarily immutable. Nevertheless, for the economic and policy problem at hand it seems justified to distinguish, at least analytically, a physical platform layer, a logical layer, an application layer, and a content layer. To simplify matters, we will pool the former to into one physical/logical layer and the latter two into one content/applications layer. At each layer, entry barriers and network effects exist and the industry structure consequently shows some degree of concentration. Moreover, not all stakeholders have the financial and other resources as well as the strategic intention to integrate vertically across the layers. Some will only be active on the network platform and others only on the content layer. Figure 1 represents a simplified model of the financial relations between main players.

The model reflects the possible financial streams between the players at the platform and content/application layers as well as subscribers and advertisers. Not all of these financial streams are currently (or necessarily) utilized by all players. Each player at the platform and content/application layers will attempt to maximize profits. Given the cost structures of activities in information industries, it is justified to assume that all costs are fixed and incremental costs negligible, that is Π=R-F, with Π … profits, R … revenues, F … fixed costs. In this case, profit maximization is equivalent to revenue maximization. Platform operators may derive revenues from different sources: subscriber access payments (s^{pa}), subscriber service payments (s^{ps}), access fees paid by content providers (a^p), and revenues from advertisers (f^p). Content providers may receive revenues from advertisers (f^c), payments for services from subscribers (s^c), and possibly payments from platform operators who would like to get access to content (a^c). Subscribers base their decisions on the value derived from platform access, which is to a large degree dependent on the services that are accessible. The lower the price of access, the more subscribers will sign up other things equal. Likewise, other things equal, the higher the quality of services accessible, the more subscribers will sign up. Advertisers will pay for audiences of a certain demographic composition.

Figure 1
A stylized model of the revenue streams in next-generation networks



s^{pa} .... subscriber access payments
s^{ps} ..... subscriber service payments
s^c ..... subscriber service payments to C/A
f^c, f^p …. payments by advertisers to C/A, P
a^p, a^c ... platform, content access payments
TC …. transaction costs

There are multiple interdependencies between the revenue streams of platform providers and content providers. Not all of the possible revenue streams are necessarily utilized equally across segments of players. If no direct payments between access platform providers and content providers are established and content providers do not receive direct payments for services ($a^p=0$, $a^c=0$, $s^c=0$), as has been and continues to be the case for many Internet services, the link between the players is indirect via the dependence of advertising revenues for content providers on the number of subscribers (indicated by the dotted lines). Other things equal, advertisers and content providers will have an interest in low subscriber access fees to platforms because it increases the online population. Platform operators, in turn, will have an interest in appealing content at low or zero costs but will try to set prices for subscriber access to maximize profits, that is, dependent on the price elasticity of demand for access. These streams will be affected by the transaction costs (TC) associated with coordinating the relations between the players. As will be discussed in more detail below, net neutrality policies affect the level and incidence of transaction costs and potentially any direct payments for access to platforms.

Strong interdependencies also exist with regard to innovation. Many factors influence the incentives of a firm to innovate but it critically depends on the available innovation opportunities, the ability to realize an innovation premium (or an "innovation quasi rent"), and the ease at which such premiums can be contested by competitors. The latter two factors jointly determine the appropriability of an innovation premium. The importance of innovation quasi rents has been clearly recognized by Schumpeter (1942) and the subsequent innovation literature. Both emphasize radical process and product innovations as motors of economic growth. However, not all innovation is of a radical type as many innovations stem from more incremental entrepreneurial activities, taking advantage of differential information and knowledge of market conditions (Kirzner 1973; Kirzner 1985).

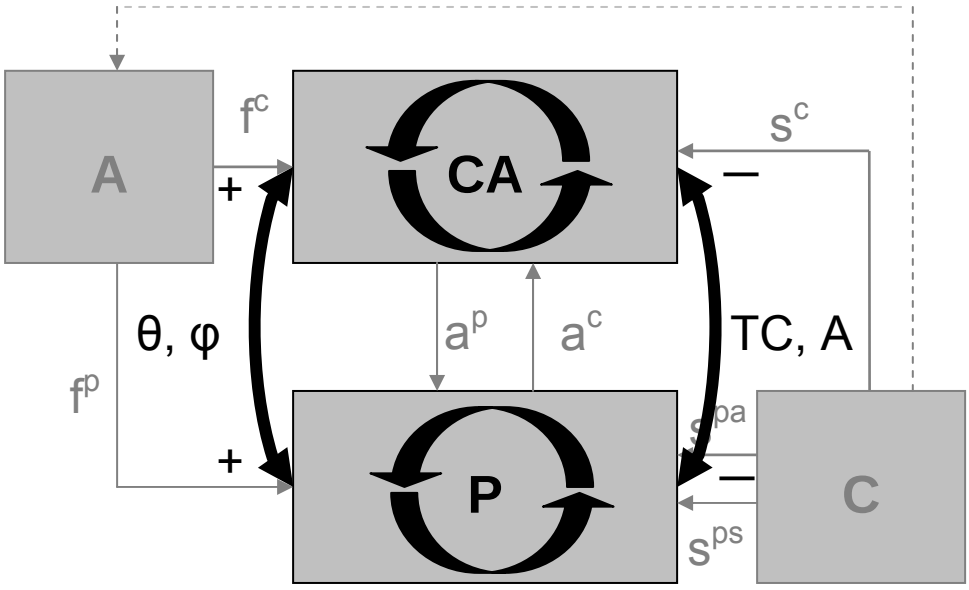
Innovation opportunity is, to a certain degree, external to the innovating firm and the entrepreneurs behind it. For entrepreneurs to accept the innovation risk, they need to be able to appropriate an innovation premium. This required premium is higher for the radical Schumpeterian innovations than for the more incremental Kirznerian type. It is reasonable to assume that at any point in time the risk-adjusted distribution of innovation projects follows a long-tail distribution, with some projects that promise very high innovation premiums but many more that promise lower premiums. As will be seen in more detail, network neutrality policies affect which projects at the content layer will be attractive to entrepreneurs and hence the cutoff point along this distribution up to which projects will be pursued.

At both the platform and the content layers, the ability of a firm to appropriate innovation quasi rents increases with market concentration. Thus, it is lowest in a perfectly competitive market and highest in a monopoly market. On the other hand, the innovation incentive is also related to the degree of contestability of a market. The less contested the activity in a layer, the lower the innovation incentive. In combination, these two effects result in a non-linear relation between market structure and innovation premium. Other things equal, lower innovation incentives exist in perfectly competitive and monopoly markets. The highest innovation incentive generally exists in loose oligopoly market structures. This also

implies that loose oligopolies will more likely support Schumpeterian types of innovation whereas more competitive market structures will tend to be more conducive to Kirznerian innovation. Uncontestable monopolies generally will generate only very weak innovation dynamics.

It is important to recognize that at each layer the innovation premium is also affected by conditions at the complementary layer (Figure 2). A first set of factors are the transaction costs (TC) and adaptation costs (A) associated with coordination in advanced communication industries. Transaction costs may occur because of coordination requirements between different components of a service, such as software supporting an e-commerce transaction, content, and devices. They also exist between activities at the network and content layers, for example, in the form of cost to negotiate access to a platform or to adjust content to multiple proprietary protocols. The latter are directly affected by the regulatory framework governing the interactions of platform operators and content providers. For example, if strong network neutrality rules are in place, content producers can design content with little concern about the delivery platforms. If, on the other hand, platform operators are able to discriminate or rely on proprietary protocols, content owners may be forced to negotiate numerous contracts to be carried on multiple access networks. Other things equal, the higher TC are, the lower the innovation incentives overall and at the complementary layer. (In this case, benefits might be gained from vertical integration in one firm.) Adaptation costs have a similar effect.

Figure 2
Interdependent innovation



A second set of factors relates to the degree of complementarity between the layers (θ, φ). Innovation at the content layer could be fully independent of the platform layer and vice versa (θ=0, φ=0). In this case, content and applications would be fully access independent. Likewise, investment and innovation in platforms would be fully independent of the type of content transported on them. It is unlikely that such independence exists between all combinations of platform services and content. Rather, some applications and services will thrive independently of specific platform configurations but others, such as applications with low latency requirements, can only be configured if the platform provides certain specific functionalities. It is hence reasonable to assume that the range of possible innovation projects at the content and application layers includes both projects with high and projects with low complementarity with the network platform. If this is the case, no single platform will support both types of innovation at the content and application layer. Different specification of network neutrality rules hence may inadvertently bias innovation at the application and content layer in one direction or the other.

In our stylized model, the innovation incentives at each layer depend on the factors just outlined. However, because of the interdependencies between platform and content layers, the innovation incentive at each layer also depends on the innovation conditions in the other layer. Thus, the overall innovation incentive at the content layer is dependent on the appropriability conditions at that layer but also on the innovation rate at the platform layer. For example, whether or not an IPTV service is successful may well depend on the innovation activity at the network platform layer. Unless the network can reliably carry the necessary traffic volume, an IPTV service cannot be offered successfully. Only in the special case of fully independent platform and content layers will the latter effect not have any impact. Likewise, the overall innovation incentive at the platform layer is dependent on the appropriability conditions at that layer but also on the innovation rate at the content layer. After all, a broadband network without usable content is of limited value to its users and hence to the platform owner. This interdependence at the level of innovation creates a dynamically interrelated ecosystem. Network neutrality policies affect transaction costs as well as the appropriability conditions at each level and hence the innovation rate at each layer and in the system overall. These effects will be discussed for three scenarios — no specific regulation, non-discrimination rules, full regulation — in the next sections of the paper.

III. Absence of Regulation

In this scenario, no specific network neutrality regulations are in place. Firms are free to adopt such provisions on a voluntary basis but they need not. They are only constrained in their ability to differentiate and discriminate between different services (and players) by the general provisions of antitrust law. Two sub-cases shall be differentiated. First, it shall be assumed that the platform is a monopoly in a given local market. (Alternatively, each consumer may only subscribe to one network platform provider.) Absence of regulation could be — and often is — justified with potential competition or fringe competition. Second, we will examine a situation of platform rivalry. In either case, the platform owner is allowed to vertically expand into content and application layers. Whether or not a platform owner will do so depends, among other factors, on the resource base of the firm, the potential advantages

of presence in the content and applications layer, and the comparative transaction costs of organizing an activity within the firm as opposed to via a market.

A platform monopolist may elect to serve as a wholeseller of capacity but without any presence in content and application markets. In this case, there is a strong incentive to cooperate with content providers as long as content is complementary to the platform service. However, a monopolist may attempt to set the fee a^p at a level so as to expropriate some or all of the innovation premium at the content payer. This scenario has been explored at length in the discussion on the internalization of complementary externalities (ICE). The essential claim is that there is only one monopoly profit available and the platform owner will be able to capture it through an appropriate choice of an access price. Several exceptions to this model have been identified. Farrell and Weiser (2003) discuss eight cases, including the presence of forms of price regulation and myopic managers, in which the ICE conclusions do not hold. Van Schewick (2007) adds several additional scenarios to these situations, including cases where platform operators cannot capture any rent at the content layer via access fees.

Even if none of these exceptions applies, the simple ICE model does not fully reflect innovation incentives. If innovation is possible at the content and application layers, platform operators will want to capture part of any innovation premium at the content layer. They can do so directly by increasing the access charge. Alternatively, in services for which they are vertically integrated, platform operators may compete aggressively, thus reducing the available innovation premium (Farrell 2003). However, such strategies will eventually change the innovation activity of pure content providers. Only a myopic platform owner would not realize that expropriating the full innovation premium would retard the innovation activity at the content and applications layer (or intensify the search for alternative delivery modes). It is unlikely that platform operators will have sufficient know-how and resources to produce all content consumed on their platforms. Thus, even a platform monopolist will realize the interdependence with other content providers and not fully suppress such activity. It is hence not likely that platform operators will block access to alternative content altogether. There will be a broad range of content that is complementary to the platform operators' own activity. The critical question then is whether, and if so to what degree, innovation activity at the content layer might be reduced by the presence of a platform monopolist.

The ability of platform operators to appropriate the innovation rents of higher layers will be further reduced if content providers are offering highly valued services. Platform operators may vie for access to content and be willing to pay a price a^c for such access. In such bilateral negotiating situations, content producers may be able to retain a higher share of the innovation premium. Moreover, the high value added content will most likely be more difficult to imitate by the platform owner, further limiting strategies to compete aggressively. However, given the complexity of these interdependences, it is exceedingly difficult to give an analytical answer to these questions.

These conclusions need to be modified if platform rivalry exists. The available technical platforms (DSL, cable modem, FTTx, fixed and mobile broadband wireless) are not full substitutes as they differ in important attributes. For example, FTTx far outperforms any other platform with regard to available bandwidth. While mobile broadband offers better mobility than fixed wireless broadband, the latter

provides better security features. As a result, some platforms are better suited than others to configure certain services. It is, for instance, unlikely that mobile broadband will be used in the near future to deliver IPTV (but it may be used to deliver mobile TV). Therefore, even if multiple fixed and wireless platforms are available in a location, platform competition will be a limited form of rivalry. Compared to the monopoly scenario, assuming that collusion is not possible, the ability of rivaling platform operators to appropriate innovation premiums from the content and application layers will be somewhat constrained.

In a situation with platform rivalry and proprietary protocols, content and application service providers will have to adapt their services to multiple platforms. They may also have to negotiate access agreements with different platform operators. The level of the associated costs will vary depending on several factors. With regard to adaptation costs, the differences in the technical architecture and protocols as well as the cost of converters will be important (Gottinger 2003). The larger the technical differences and the higher the costs of converters, the higher adaptation costs will be. As a result, costs for all participants will likely be higher compared to a situation with relatively homogenous platforms. Likewise, the more differentiated and fragmented the platform market structure is the higher transaction costs, predominantly in the form of negotiating and enforcement costs, will tend to be. Higher transaction costs will, other things equal, reduce the incentive to innovate as they reduce the expected net innovation premium. In this scenario it can, furthermore, be expected that the emerging market structure will be spatially more highly fragmented compared to a situation with more homogenous network platforms.

IV. Non-Discrimination Rules

Non-discrimination rules have a long history in telecommunications. There are many ways how such rules can be specified. Common carrier obligations, which emerged from medieval British common law, constitute one specific bundle of non-discrimination principles that encompass technical and pricing aspects (for an insightful discussion of common carriage see Cherry 2005). Cable systems in the United States are also subject to some non-discrimination rules. Most franchise agreements contain provisions for public, educational and government channels. Depending on system size, cable systems need to make some channel capacity available to third parties via commercial leased access rules. Moreover, retransmission consent and must carry rules, defining the relation between over-the-air broadcasters and cable systems, also have some non-discrimination component. Nevertheless, as private contract carriers, cable operators have much broader discretion over their networks.

On the Internet, non-discrimination rules emerged as informal norms and conventions from decentralized coordination efforts by web pioneers. In a sense, they are similar to common carriage principles. Often referred to as the "end-to-end" design, they imply that packets would be transported without modification in a best-effort fashion (see Blumenthal and Clark 2001 for a critical discussion). These principles remained uncontested as long as consensus prevailed among important stakeholders that they facilitate Internet communications and services.

Common carrier and other non-discrimination rules in existing networks did not remain static but evolved over time in response to technical, economic, and policy changes. Sometimes these rules were

curtailed and sometimes they were put on a more solid footing through statutory legal measures, as when common carriage obligations were specified in the Communications Act of 1934 and in subsequent legislation. Sometimes rules were changed in a consensual and deliberate way and in other cases — as illustrated by the American unbundling debate — they were modified or abandoned in a rather contested process because the supporting coalition collapsed.

Presently, most of the Internet constitutes a "neutral" platform because packets are not inspected as to their content (Kocsis and de Bijl 2006). As transmission pipes can handle larger and larger amounts of information and servers and routers become more sophisticated due to increased and less costly processing power, inspecting packets becomes more feasible. Internet Protocol Version 6 (IPv6) offers much more room for header information. This information can be used to configure more advanced services and engineer transmission pathways to support such services. In the context of our paper, several aspects are of concern. At the platform level, the ability to differentiate platforms may increase the incentives of network providers to deploy new technology. However, it may also increase the cost of deployment if differentiation requires equipment manufacturers to produce smaller series. At the content and application layer, technical and price differentiation of platforms may increase adaptation and transaction costs. However, differentiation may also enable services requiring low latency, such as interactive online games or voice. Whether non-discrimination rules are meaningful will depend on the relative strength of these two effects and the specification of the rules.

Several options for stating non-discrimination rules are discussed in the literature and policy debate. Components of non-discrimination rules include (in order of increasing intrusiveness):

- Most favored nation obligations (e.g., for transit)
- Obligations to offer comparable services to all requesting parties
- Obligations to offer the same services to all requesting parties
- Anti-discrimination rules for the transportation of packets
- An obligation to provide "naked" broadband in sufficient capacity and quality
- Functional separation of network platform services from the provision of applications and content
- Structural separation of network platform services from the provision of applications and content

These components could be implemented on a stand-alone basis or in combinations. For example, functional separation requirements could be combined with most-favored nation obligations. If existing rules are to be modified, the question needs to be addressed whether and to what extent the transition from historically grown rules and conventions to new rules will increase or decrease welfare. Answering this question is a tall order that needs to be broken down into more manageable pieces. It is often easier to assess how different stakeholders will be affected by changes in rules than how welfare overall is impacted. Likewise, it is less challenging to assess the direction of change compared to an existing set of rules.

Compared to the set of rules outlined in section III, it is possible to make a few general comments. The magnitude of the effects will depend on the specific selection and implementation of rules. Non-discrimination rules will likely have the following ceteris paribus effects: The set of competitive strategies available to platform operators to appropriate innovation rents of content and application providers will be reduced the more stringent such rules are. It will be more difficult to leverage control of the network to create entry barriers for competitors. Similarly, network operators will face greater challenges in creating more favorable conditions for a specific sect of content providers with whom they would like to establish exclusive relations.

As a consequence, we surmise that transaction costs at the content and platform level will re reduced compared to a scenario without mandatory non-discrimination requirements. The lower transaction costs will shift the threshold for innovation projects out to endeavors with a lower expected profitability. Consequently, higher innovation efforts will be undertaken at the content and application layer. As innovation efforts take place under uncertainty, search for new products and services will probably be directed into more alternative areas, perhaps enhancing the likelihood that some major breakthrough will be discovered. If the non-discrimination rules permit tiering, access-dependent services and applications may be easier to configure. Hence such rules may shift innovation activity in favor of projects that benefit from differentiation of the service platform.

In as far as the incentives of platform operators to upgrade networks are dependent on the ability to appropriate part of the innovation premium at the vertically related layer, they will be weakened compared to a scenario without any regulation. Non-discrimination rules may also incent vertically integrated platform providers to compete more vigorously in services offered in rivalry with independent content and service providers. This may reduce the number and diversity of the independent players but it will create a new strong competitor, laving the net effects on consumers somewhat ambiguous but not necessarily negative (Farrell 2003). Also, the overall innovation pattern at the content and application layer may be changed. Successful innovations have to transit through several stages. During the invention and early start-up phase, diversity of effort is probably beneficial for the overall innovation rate. As more entrepreneurs search for new services, applications and business models, the chance that some will come up with successful solutions increases.

The same is not necessarily true for later stages in the evolution of enterprises. To develop an initial idea into a sustainable business model, firms need to transform themselves, most importantly by developing commercial management practices. This could happen in a bottom-up approach from within the start-up, with the help of venture capitalists or by larger firms taking over start-ups. Larger firms may have advantages in the latter stages of the innovation cycle. If this were the case, the overall innovation rate of a sector would only decline if vigorous competition by platform operators reduced entrepreneurial activity during the start-up phase. If it predominantly affects the later stages of the innovation process, the flow of new ideas and market experiments may remain largely unaffected. It is even possible that the presence of large firms who take over small start-ups is beneficial to the innovation process, as the sale price will allow start-up entrepreneurs to appropriate an innovation premium.

The effects are somewhat different with regard to access-independent services. The term was coined for services that can easily be provided as long as consumers have a broadband access platform. By definition, some level of open access is a precondition for the ability of firms to offer such access-independent services (otherwise they would be access-dependent). In the case of access-independent services, the ability of network operators to appropriate part of the innovation premium from the content and service providers is relatively limited. Platform operators cannot use an access charge a^P levied on the content provider. They might be able to indirectly appropriate some surplus via the consumer access charges[a]. Under these conditions platform owners have stronger incentives to use forms of sabotage to weaken the competition in areas where access-independent services compete with their own services (for a discussion of sabotage see Beard et al. 2001).

In sum, non-discrimination rules have differential effects on content and application providers and platform operators. The strengths of these effects will depend on the specific formulation of non-discrimination rules and the sensitivity of innovation incentives to adaptation and transaction costs. Non-discrimination rules will shift the threshold of innovation projects that will be pursued outward to include projects with a lower expected return. This will include projects with high potential value that are afflicted with a higher degree of uncertainty as to their success as well as projects with lower potential value added yet a higher likelihood of success. In as far as non-discrimination rules also protect the process of entrepreneurship during the early phases of the innovation cycle they may positively influence the overall innovation rate in the sector. Stronger non-discrimination rules may shift innovation activities from platform-dependent to platform-independent services and applications. They may also reduce the incentives of platform owners to invest, especially if the act myopically. Lastly the implementation and enforcement costs of non-discrimination rules differ quite significantly. More stringent rules will typically also go hand in hand with higher cost of implementation and enforcement. This effect will have to be taken into account when assessing the overall net effect of non-discrimination rules. Overall, the plethora of counteracting effects and trade-offs renders an analytical assessment of the net effects a daunting if not impossible task.

V. Full Platform Regulation

The third principal approach to governing the relation between platform operators and content and application providers is full regulation. Although several opponents of regulation claim that full regulation is the inevitable outcome of any form of network neutrality policy, this is not necessarily the case. Nevertheless, full regulation has many potential drawbacks and is rarely promoted as a desirable policy choice. Several structural design options are available, depending on whether the platform provider is required to functionally or structurally separate platform and content operations. Full regulation will apply to conditions of service provision and prices. Price regulation may entail further regulation of business aspects, including conventions for dealing with different cost components, depreciation, goodwill, and so forth.

If network providers are required to functionally separate their accounts for platform and services several challenges arise. One is the cost structure of broadband technology, where a large percentage of

costs are shared and common. Attribution of such costs to the multitude of service offered is increasingly challenging the more services are being offered. To prohibit firms from unfair pricing of downstream services, imputation rules have been used to establish price floors. In broadband environments platform operators have many opportunities to evade such regulations (see Beard et al. 2003 for a general discussion of imputation). The challenges for full price regulation are multiplied in the present context. For one, regulation would have to consider explicitly the dynamic effects of pricing policies but not only for the regulated segment but also the spill-overs on innovation in content and applications. Theoretical foundations and regulatory practice in this regard are very limited. The problems would be mitigated if innovation at the content and application level were independent of the platform level. In this case, only considerations at the platform level would have to be made and one could design a second-best policy for the pricing of network platform access. However, if the two are interdependent as is claimed in this paper, the problems of finding efficient prices are compounded. Past regulatory practice does not give great hopes that the problem could be solved satisfactorily.

In a framework of structural separation, the platform owner could be allowed to enter vertically related markets via a separate subsidiary or it could be prohibited from doing so entirely.[2] Structural separation would create clear-cut incentives if innovation processes at the platform and content/application layers were separate. In as far as innovation at the content and application layer increases demand for access to broadband platforms, the incentives of the platform operators and the content providers are aligned. Thus platform operators will be willing to cooperate with content providers. If innovation processes are interdependent, platform operators will need to capture part of the surplus at the content and application layers via appropriately set access and/or subscriber fees. Such price regulation raises the same regulatory challenges as mentioned in the functional separation scenario above. In both cases of functional and structural regulation, if prices for platform access are set too low, incentives for platform investment are reduced but incentives for innovations in content and applications are strengthened. At the same time, the incentive for platform operators to compete fiercely will be increased. If prices are set too high, incentives for platform innovation are increased but incentives for service and application innovation are reduced (see Bauer 2005 for a discussion of similar issues in the case of unbundling policy).

Overall, full platform regulation, although it would allow setting clear rules, would face many daunting issues. The cost structure of next-generation networks, the speed of technological change, and the complex interactions between the content and the platform layers greatly complicate the setting of appropriate prices.

VI. Comparative Analysis and Implications

The innovation system described in sections III through V is extraordinarily complicated. All the relevant stakeholders have many options to respond to the uncertainty inherent in the system. Several historical precedents exist in the United States and abroad where similar decisions as to the neutrality of a

[2] This solution has recently been adopted for the local access networks of BT in the United Kingdom.

platform technology had to be made. Some limited historical evidence is thus available. In more recent times, these include the experience with the dial-up Internet in the United States but also information on innovation and diffusion patterns in mobile Internet access. One problem is that the large number of variables and strategies available to stakeholders render direct comparisons difficult. Certainly, given the limited number of observations, it is not possible to empirically test hypotheses. The researcher can at best formulate what Scharpf (1997) termed "sometimes true theories" because the environmental and other relevant variables rarely are fully comparable.

The experience with the dial-up Internet would suggest that open and neutral platforms are conducive to innovation in content and applications. This is most clearly visible in international comparisons. The dial-up Internet was introduced earliest and developed in the most vibrant way in the United States, which, by accident rather than design, had adopted rules that secured an open and neutral platform. By contrast, Internet growth in other nations was slower and content industries also developed much later and slower.

Mobile Internet access offers a second case in point but with somewhat different lessons. It is most widespread in Japan and South Korea with Europe and the United States lagging behind (Fransman 2006). Although many relevant external conditions are different between these regions, they can hardly explain the full magnitude of the gaps. It is increasingly recognized that the specific business choices made in the three regions help explain the differences. In Japan and Korea, network operators, spearheaded by NTT DoCoMo and SK Communications, have adopted collaborative business models with content and application/service developers. Network providers act as a kiosk, collect revenues for selected service providers and flow 91% of the service revenues back to the content and application developers. (In addition, network operators retain the revenues paid by the subscribers for using mobile data connections.) Although the group of preferred content and application providers is limited (in Japan to about 3,000), it is an open group in which success determines whether the relation continues or not. Other service providers can be reached from mobile devices. However, customers cannot rely on the kiosk system but have to arrange for transactions themselves. In the United States and in Europe, network providers were and are reluctant to similarly open their networks to a wide range of content providers and to adopt comparable sharing models for service revenues. This example demonstrates that platform operators do have incentives to collaborate with content and application owners. However, it is far from certain that network providers will not act myopically and fully recognize the interdependence between content and platforms.

Both cases are somewhat different than the present case. The infrastructure platform for the dial-up Internet was largely in place and no significant network upgrade investment in the core network was required. Investment thus could focus on the incremental ISP plant. Likewise, the mobile Internet could initially utilize and upgraded network infrastructure and subsequently migrate to more advanced networks. Nevertheless, neither the case of the dial-up Internet nor the case of mobile Internet supports (or fully refutes) the thesis that unregulated markets are superior to other approaches.

Due to the many feedbacks and non-linear relations between the variables, the overall system behavior can only be simulated. Even if the system behavior could be modeled analytically, it is doubtful

whether equilibrium-based solutions would capture the main features of the dynamic interactions, which are often adaptations to disequilibrium situations. For this reason, a simulation approach could be very useful in exploring the implications of alternative rule specifications (including the absence of any specific neutrality rules). A key, hitherto unresolved, problem is that data that would allow calibrating the relevant relations in the model — or at least narrowing the range of parameter values — is not available. This does not mean that it is impossible to build simulation models, but more research is required.

VII. Conclusions

This paper developed a stylized model of the innovation incentives in next-generation networks. Its central claim is that alternative specifications of the rules governing the interactions between network platform operators and content/application providers constitute different innovation systems with characteristic dynamics. The paper compares three prototypes of governance structures: reliance on antitrust, non-discrimination rules, and full regulation. It identifies multiple interdependencies between content and platform layers, innovation opportunities, innovation incentives, transaction costs, and adaptation costs. Even unregulated platform providers will recognize these interdependencies. However, it is possible that actions to appropriate some of the innovation premiums at the content layer have the unanticipated consequence of reducing innovation activity at that layer. Multiple innovation processes are possible at the content layer, some of which might benefit from differentiated access but others may be harmed. Similarly, under certain conditions network neutrality rules may slow investment and innovation in platforms. Given incomplete knowledge as to the net effect if these complex interactions, the level of uncertainty and rapid technological dynamics of the industry, a full set of network neutrality rules is nearly impossible to design. However, some safeguards to allow continued open access to the network platform seem appropriate. At this point in time, a credible threat to address abuses swiftly and if necessary to promulgate rules in case of prolonged abuse would appear to be the best immediate step forward. This could best be achieved by enhancing the authority of the FCC to adopt such measures.

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