VERY FIRST DRAFT

DYNAMIC EFFECTS OF NETWORK NEUTRALITY

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1. Introduction

The network neutrality debate addresses fundamental policy issues with potentially very far-reaching effects on the future development of communication industries. As the discussion is forward-looking, the core claims of proponents and opponents of net neutrality are difficult to test systematically against historical empirical evidence. Some analogies may be drawn from the earlier experience with the telephone network, the dial-up Internet, or mobile Internet services, but there are important differences between these technologies and the present and future environment. Consequently, the net neutrality debate, although it has made significant advances, remains inherently conceptual (see, for example Wu 2003; Yoo 2005; Windhausen 2006; van Schewick 2007; Herman forthcoming).

Given the difficulty of the issues and the perceived magnitude of the stakes the discussion 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 (see, for example, Dixon, Gifford et al. 2006; Ford, Koutsky et al. 2006; Hahn and Wallsten 2006). While there is a risk that network neutrality policy might deteriorate and have these effects, these angles are to a certain degree decoys that distract attention from the real issues at the heart of the debate: to what extent platform owners should be allowed to discriminate against applications and content providers that are dependent on access to these platforms to reach customers.

Platform owners will have different incentives dependent on whether or not they are vertically integrated. Their incentives will also be influenced by the rules established for their operations. In the most generic sense, the network neutrality debate attempts to determine which regime governing the relations between platform owners and vertically related application and content providers will have the most desirable efficiency and welfare effects. A wide spectrum of arrangements to structure this relation is possible

ranging from minimally constraining to highly constraining rules and regulations. At the minimally constraining end of the spectrum would be a pure antitrust approach, granting full freedom to network providers to differentiate platforms, services, and prices as long as they do not violate pertinent competition law. 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 platform. In between these extreme solutions is a range of options to specify non-discrimination rules that constrain but do not fully eliminate network platform providers' ability to discriminate.

Ideally, a choice between these different governance options would be based on a detailed evaluation of their static and dynamic efficiency implications. A 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. Section six explores the use of historical and computer-simulation approaches. As the overall dynamics of innovation are critically dependent on relative parameters, additional work will have to be undertaken to narrow their possible range. Overall, the discussion indicates that no panacea exists to address the problems raised by the network neutrality debate. A strategy of waiting combined with the willingness to intervene is necessary seems the most appropriate immediate way forward.

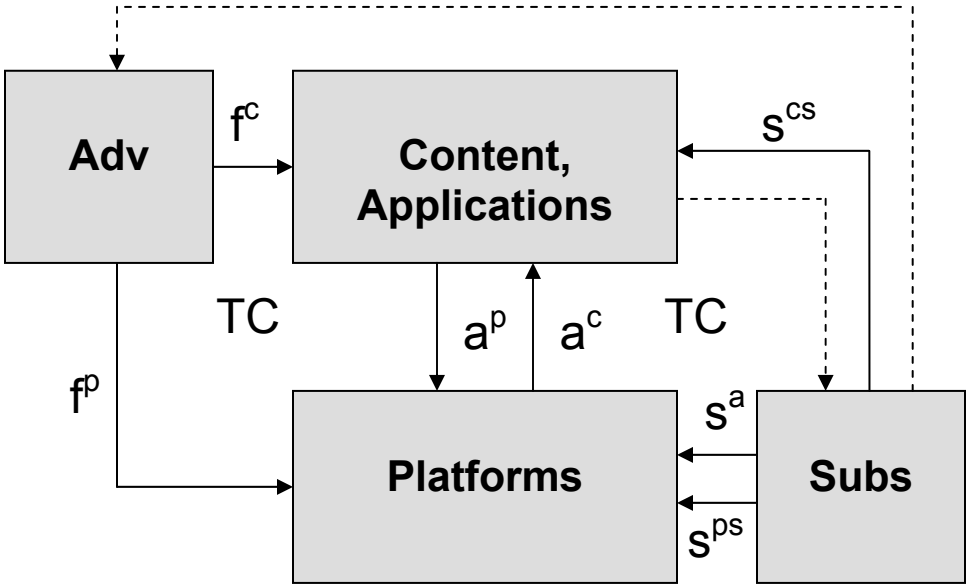
2. A stylized model

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. It is not always straightforward to differentiate layers 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 as well as an application and content layer. To simplify matters, the latter will be pooled into one layer. At each layer, entry barriers exist and the industry structure shows some degree of concentration. Moreover, not all stakeholders have the financial and other resources 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 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. In this case, profit maximization is equivalent to revenue maximization. Platform owners may derive revenues from different sources: subscriber access payments (s^a), subscriber service payments (s^{ps}), access fees paid by content providers (a^p), and revenues from advertisers (f^p). Content providers receive revenues from advertisers (f^c), payments for services from subscribers (s^{ps}), and possibly payments from platform owners who would like to get access to content (a^c). Subscribers base their decisions on the value derived from platform access. The lower the price of access, the more subscribers will sign up. Likewise, 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^a ..... subscriber access payments
s^{ps} ..... subscriber service payments
s^{cs} ..... subscriber service price to C/A
f^c, f^p …. advertising fees to C/A, P
a^p, a^c .. . platform, content access prices
TC …. transaction costs

There are multiple interdependencies between the revenue streams of platform providers and content providers. Not all of the possible revenues 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, s^{CS}=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. Platform owners, in turn, will have an interest in

appealing content 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 incentives, which are at the heart of this paper. Whereas many factors influence the incentive of a firm to innovate, it critically depends on the available innovation opportunities, the appropriability of an innovation premium (or an innovation quasi rent), and the degree to which such premiums are contested by competitors. The importance of innovation quasi rents has been clearly recognized by Schumpeter and the subsequent innovation literature (see, Schumpeter 1934 and the voluminous subsequent literature). Innovation opportunity is, to a certain degree, external to the innovating firm. 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 related to the degree of contestability of a market. The less contested a market, the lower the innovation incentive. In combination, these two effects result in a non-linear relation between market structure and innovation incentive, with low innovation incentives in perfectly competitive and monopoly markets. Other factors equal, the highest innovation incentive generally exists in loose oligopoly market structures.

On each layer, the innovation premium is also affected by the level of transaction costs 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 and content. They may also exist between activities as the network and content layers although they are directly affected by the regulatory framework. 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 owners are able to discriminate, content owners may be forced to negotiate numerous contracts to be carried on a specific access network. Other things equal, the higher transaction costs are, the lower the innovation incentive. An intuitive understanding is that transaction costs reduce the option value of an innovation. Moreover, adaptation costs have a similar effect.

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 is also dependent 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 most likely 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 most likely 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 section of the paper.

3. 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 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 the availability of a close substitute platform in close proximity. 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 or via the market.

A platform monopolist may elect to serve as a wholesaler 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 content is clearly 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 efficiencies (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 owners 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 owners 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 owners 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 owners 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 provider and not fully suppress such activity. It is hence not likely that platform owners will block access to alternative content altogether. There will be a broad range of content that is complementary to the platform owners 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 owners to appropriate the innovation rents of higher layers will be further reduced if content providers are offering highly valued services. Platform owners 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. Furthermore, the high value added will most likely be more difficult to imitate by the platform owner, also weakening the options 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 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 or rivalry. Compared to the monopoly scenario, assuming that collusion is not possible, the

ability of rivaling platform owners to appropriate innovation premiums from the content and application layers will be somewhat constrained.

In a situation with platform rivalry, 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 owners. 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 of importance (Gottinger 2003). The larger the 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 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.

4. 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 partial non-discrimination rules, although as private carriers they have much broader discretion over their networks. Most franchise agreements contain provision 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.

On the Internet, non-discrimination rules emerged as conventions from decentralized coordination efforts by web pioneers. In this sense, they are similar to common carriage principles. Often referred to as the "end-to-end" design, they implied that packets would be transported without modification in a best-effort fashion (see Blumenthal and Clark 2001 for a critical discussion). They 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 lower 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 4 above, 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 owners to

appropriate innovation rents of content and application providers will be reduced. It will be more difficult to leverage control of the network for the creation of entry barriers for competitors. Similarly, network owners 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 bias innovation activity in favor of projects that benefit from differentiation of the service platform.

In as far as the incentives of platform owners 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 of 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 staged 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 (Bauer and Calantone 2006). Larger firms may arguably 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 owners 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 takeover price will typically allow entrepreneurs to appropriate the 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 owners to appropriate part of the innovation premium from the content and service providers is relatively limited. Platform owners 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 charge s^a. Under these conditions, there is an increased incentive for the platform owner to use forms of sabotage to weaken the competition in areas where access-independent services compete with own services (for a discussion of sabotage see Beard, Kaserman et al. 2001).

In sum, non-discrimination rules have differential effects on content and application providers and platform owners. 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. The implementation and enforcement costs of non-discrimination rules differ quite significantly. Thus, whereas more stringent rules may have stronger effects on innovation activity, they typically will also go hand in hand with higher cost of implementation and enforcement.

5. Full platform regulation

The third principal approach to governing the relation between platform owners 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, full regulation is rarely promoted as a desirable policy choice. Three structural design options are available, depending on whether the platform provider is required to functionally or structurally separate platform and content operations and whether, in the latter case, it is prohibited from competing in vertically markets altogether. 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 owners

have many opportunities to evade such regulations (see Beard, Kaserman 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 is 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.[1] 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 owners and the content providers are aligned. Thus platform owners will be willing to cooperate with content providers. If innovation processes are interdependent, platform owners 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 owners to compete fiercely will be increased. If prices are set too high, incentives for platform innovation are increased but incentives for service

[1] This solution has recently been adopted for the local access networks of British Telecom in the United Kingdom.

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.

6. Comparative simulation

The innovation system described in sections 3 through 6 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 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 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. The case of mobile Internet access offers a second case in point but with somewhat different lessons.

Mobile Internet access is most widespread in Japan and South Korea and lags far behind in Europe and the United States. Although many relevant external conditions are different between these regions, they can hardly explain the full magnitude of the difference. It is increasingly recognized that the specific business choices made in the three regions help explain the differences.

In Japan and Korea, network service providers, spearheaded by NTT DoCoMo and SK Communications, have adopted collaborative business models with content and application and service developers. Network providers act as a kiosk, collect revenues for selected service providers and flow 91% of the revenues back to the content and application developers. 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 similarly generous revenue sharing models. This example demonstrates that platform owners 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 construct, but more research will be necessary to do so.

7. 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 owners 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. Given the uncertainty and rapid technological dynamics of the industry a full set of network neutrality rules would be nearly impossible to promulgate. However, some safeguards to allow continued open access to the network platform seem appropriate. At this point in time, a continued threat to promulgate rules in case of abuses would appear to be the best immediate step forward.

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