info

The effects of network neutrality on the incentive to discriminate, invest, and innovate: a literature review

Daeho Lee Dong-Hee Shin

The effects of network neutrality on the incentive to discriminate, invest, and innovate: a literature review

Daeho Lee and Dong-Hee Shin

Daeho Lee is Assistant Professor at the Department of Interaction Science, Sungkyunkwan University, Seoul, Republic of Korea. Dong-Hee Shin is Full Professor at the School of Media and Communication, Chung-Ang University, Seoul, Korea.

Abstract

Purpose – *The purpose of this study is to categorize network neutrality according to its issues under debate and assess the state of the debate based on such organization. In addition, the study discusses the reasons that network neutrality is so difficult to solve and the future research directions that would do so.*

Design/methodology/approach – *This study presents a critical review of the current network neutrality issues and summarizes the economic background of each position in the debate. The relevant literature is organized by issue to examine the reasons that the network neutrality debate is so difficult to solve and determine the further study required to solve it.*

Findings – *An analysis of the relevant literature suggests that the proponents and opponents of network neutrality disagree on the best methods of developing the Internet. Therefore, future research and regulatory and practitioners' applications would greatly benefit from a comprehensive review of that literature.*

Originality/value – *Network neutrality regulation is receiving increased attention because the development and significant influences of the Internet are becoming more apparent.*

Keywords *Innovation, Vertical integration, Government regulation, Network neutrality*

Paper type *Research paper*

1. Introduction

Network neutrality (also referred to as "net neutrality" or "Internet neutrality") is a principle proposed for access networks on the Internet that advocates no restrictions on content. It proposes that data on the Internet be moved blindly and impartially, irrespective of content, destination or source. Network neutrality is a sensitive issue worldwide, and numerous studies have explored its costs and benefits (Shin, 2014). For example, Crocioni (2011) investigates the status of the regulatory debate in Europe and provides an economic regulation framework. Shin and Han (2012) review Korean information policy and propose a combination of legal regulations and transparency. Moreover, Carter *et al.* (2010) compare the approaches used in the USA, Japan and the European Union.

An analysis of the relevant literature suggests that the proponents and opponents of network neutrality currently disagree on the best way to develop the Internet to maximize consumer gains. Proponents assert that the market power of vertically integrated Internet service providers (ISPs) will spillover from the network layer into the application layer when the ISPs discriminate between non-integrated application service providers (ASPs) and content providers (CPs). They insist that governmental network neutrality regulation is essential because ISP discrimination will deter the development of the Internet and harm consumers and entire societies by limiting network investment incentives and stifling innovation at the application layer. Conversely, opponents argue that vertical integration increases efficiency in the market and that network neutrality regulation is unwise because it reduces network investment incentives and deters innovation. They further claim that

Received 16 December 2015
Revised 4 February 2016
Accepted 2 March 2016

authorizing ISPs to manage networks will lead to the optimized development of the Internet industry.

Ongoing debate on the issue has narrowed the gap between the positions of proponents and opponents of network neutrality. However, the two sides have not reached an agreement and researchers approach the issue from a variety of standpoints (Shin and Shim, in press). Some researchers support or oppose network neutrality from the perspective of innovation and investment, whereas others support or oppose it based on vertical integration and discrimination. Therefore, it is important to review the literature on this issue to clarify the current state of theory and research and provide a reference for researchers and practitioners.

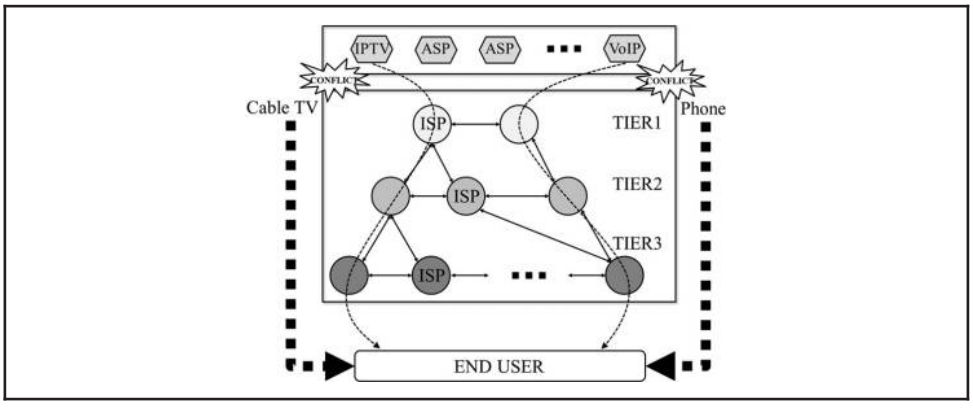
This paper presents a critical review of the current network neutrality issues and summarizes the economic background of each position in the debate. The relevant literature is organized by issue to examine the reasons that the network neutrality debate is so difficult to solve and determine the further study required to solve it. Although Schuett (2010) and Faulhaber (2011) survey the economic literature on network neutrality, their coverage is limited to the key papers on the topic. This review broadens the scope of the literature previously reviewed by including papers from the legal field and engineering and an expanded survey of the economics' literature that incorporates additional, particularly recent, articles.

The rest of this paper is organized as follows. The next section provides the economic background of the debate on vertical integration and fair competition and this study's organization of the relevant articles on network neutrality related to that debate. In Section 3, the network neutrality debate is located in the context of innovation, Section 4 considers it in light of ISP profit and network reinvestment and Section 5 assesses it regarding the effects of network neutrality. Section 6 explains the relationships among the topics introduced in Sections 2 through 5, and Section 7 outlines policy proposals that previous articles have offered to solve the network neutrality problem. The final section summarizes and offers conclusions.

2. Incentives for discrimination

The network neutrality debate grew out of concerns that oligopolistic ISPs would discriminate against relatively small ASPs or end-users using the ISPs' market power (Shin, 2016). Most ISPs are vertically integrated with cable television or telecommunications companies. Figure 1 illustrates the market structure, showing that ISPs' interests conflict with new applications' services, such as IPTV and VoIP because IPTV (VoIP) can be substituted for cable television (wired/wireless phones).

Figure 1 Market structure of Internet industry



However, the principle of internalizing complementary efficiencies (ICEs) (Farrell and Weiser, 2003) and the two-sided market model imply that an ISP vertically integrated with an ASP has a weak incentive to discriminate against other ASPs. According to the principle of ICE, a monopoly in Market A has no incentive to place constraints on competition in Market B when Products A and B are complementary because its monopoly in Market A can benefit from the vitalization of competition in Market B. This implies that when innovation and competition in the Internet content and application markets are at high levels or when competition in the Internet content and application markets can elevate the value of services, a monopolistic ISP can increase profits by internalizing the complementary values. These complementary values are internalized by sustaining the open structure instead of using the spillover of its market control power and discriminating against other ASPs.

Applying the two-sided market model to the Internet shows that an increase in the number of ASPs increases the value of Internet access for end-users, thereby causing greater demands for Internet access. An increase in the number of end-users leads to an increase in the value of Internet access for ASPs. This means that the ISP has sufficient incentive to keep the content and application market open because doing so will lead to positive feedback, more ASPs, investment in content and application and the ISP's profits.

For this reason, most opponents of network neutrality maintain that ISPs have no incentive to discriminate against ASPs (Speta, 2000a, 2000b). Even though ISPs discriminate against ASPs, Weisman and Kulick (2010) argue that price discrimination increases static efficiency because the broadband market is two-sided and increasingly competitive. These authors point out that ISPs will reduce prices on the consumer side to increase surplus on the ASP side because ISPs extract relatively more value from ASPs. Accordingly, price discrimination increases social welfare because charging lower prices on the consumer side increases the number of transactions between ASPs and consumers.

Crowcroft (2007) disagrees that network neutrality regulation is necessary because the static neutrality regulation will not be able to capture the essential dynamics of Internet applications and traffic. However, the author agrees that some ISPs can block a specific application or degrade the performance of an application for which overlay services are crucial. According to Crowcroft (2007), last-mile operators who own and want profit from long-haul networks have sufficient incentive to provide a walled garden (ISPs' restriction of convenient Internet access to non-integrated ASPs) by bundling with higher-level services or by providing faster lanes to their own services. However, the author disagrees with the notion that additional network neutrality regulation is necessary because the present regulations sufficiently regulate the monopolistic process of the last mile.

Conversely, most proponents dismiss this view and predict discrimination. Rubinfeld and Singer (2001) analyze the vertical integration between an ISP with significant downstream market power and an upstream broadband portal and explain that a vertically integrated firm can utilize two different types of market foreclosure – content discrimination against upstream competitors and conduit discrimination against downstream competitors. They find that the vertically integrated firm will often find it profitable to carry out content discrimination to sustain and expand its market power.

In general, economic theories forecast that an operator's long-term interest equals that of the public and should be enough to provide the best applications on the operator's neutral platform. However, Wu's (2003) study investigates the interests of network operators by conducting a survey and finds that ISPs tend to favor short-term results and restrict some applications, structurally and contractually. Wu (2004) insists that platform providers will attempt further monopolization using their monopolistic market power and emphasized that two conditions are needed to sustain the unregulated vertically integrated monopoly:

1. the incentive to discriminate against ASPs; and
2. the incentive to compete with potential platform competitors.

Based on that, Wu (2003) concludes that network neutrality regulation is necessary.

In addition, van Schewick (2007) analyzes the Internet service market using an economic benefit–cost analysis. Assuming that ISPs offer content/application/portal services that are complementary to the ISP service, van Schewick (2007) finds that ISPs have an incentive to discriminate against competitors in the complementary market. Specifically, this concept holds that packet discrimination can occur based on the origin or destination of the packet. Moreover, van Schewick (2007) emphasizes that the threat of discrimination is more serious than expected because the Internet industry has more exceptions than previously identified by Farrell and Weiser (2003). Moreover, contrary to the common assumptions, van Schewick (2007) maintains that discrimination can be a better strategy for an ISP even when it does not manage an ASP. Kocsis and de Bijl (2007) also claim that ISPs have an incentive to horizontally differentiate their networks. By entering into exclusive deals with application providers, ISPs can distinguish themselves from one another by origin or destination of the packet.

Knieps (2011) introduces market-driven network neutrality, in which there are no incentives for ISPs to discriminate against ASPs. According to the author, management of Internet traffic is required in broadband Internet because the traditional best-effort transmission control protocol creates discrimination potentials. Knieps (2011) proposes an economic framework for market-driven network neutrality consisting of quality of service differentiation and congestion pricing that any application is charged based on the opportunity costs of traffic capacities. Cheng *et al.* (2011) model network congestion to address network neutrality and find that network congestion is the basic underlying source of discrimination that the ISPs hope to exploit.

In general, proponents tend to insist that the vertical integration of ISPs will impede the development of the entire Internet industry because it will lead to ISP discrimination against ASPs. They praise the considerable evolution brought about by the open structure of the Internet, whereas opponents emphasize the redundancy of regulation by arguing that vertical integration improves efficiency and that vertically integrated ISPs have no reason to discriminate against ASPs. According to Guo *et al.* (2010), who analyzed the issue using a game-theoretic model, social welfare may decrease or increase with vertical integration, depending on the parameter values. The network neutrality debate can, thus, be understood as a process of questioning whether vertical integration or an open structure is more efficient for the Internet industry and whether vertically integrated ISPs will discriminate against ASPs.

3. Innovation

With regard to innovation and network neutrality, supporters of deregulation (deregulationists) argue that large firms play a key part in destructive construction, a view put forth by Schumpeter's Mark II, whereas those who support openness (openists) focus on start-up firms, as does Schumpeter's Mark I (Wu, 2004). Similarly, Reggiani and Valletti (2011) introduce the arguments between openists who support the innovation of small start-up ASPs (at the edge of the Internet) and deregulationists who stress the innovation and expansion of the capacity of the network (at the core of the Internet). Reggiani and Valletti (2011) create a mathematical model to consider decisions at the core, as well as at the edge of the Internet and formalize prioritization, identifying the conditions under which prioritization increases network investment and enhances welfare.

Yoo (2005) opposes all network neutrality regulation because he argues that it would depress last-mile competition. Yoo (2005) claims that there is no evidence that innovations operating at the network's edge should be preferred over innovations in the network's core, although proponents insist that innovation in ASPs is more important and that network

neutrality is necessary to promote and preserve Internet innovation. The author insists that broadband policy should focus on promoting competition, not in the content or application, but in the last mile. Later, Yoo (2006a) emphasizes that no one can ensure CP or ASP innovation without the guarantee of Internet access, arguing that network neutrality is unnecessary and innovation occurs more efficiently in open architectures because, within them, ISPs maintain their own neutrality.

Farrell and Weiser (2003) insist that vertical integration in the Internet market is relatively more likely to improve market efficiency because it eliminates the hold-up risk of a contract between service providers. Hold-up risk is a situation where Agent A does not make a contract with Agent B even though Agent A can profit by making the contract because Agent B may have bargaining power. Farrell and Weiser (2003) argue that the hold-up risk eliminates and innovation is facilitated through vertical cooperation. The authors agree that the open structure of the Internet has several advantages. For example, it accelerates component innovation, facilitates market entry, keeps service fees low and promotes development through the trial-and-error processes of many market participants. However, the efficiencies of price setting, innovation and marketing decrease with the separation of two firms producing complementary products because neither firm considers the effects of its business strategy on the other.

Hahn and Wallsten (2006) insist that maximum price flexibility provision to ISPs to encourage innovation. The Internet broadband market consists of end-users on one side and content and application on the other side in a two-sided market structure. If they are not allowed to internalize positive externalities yielded by both sides, then ISPs can underinvest in the platform, which will deter innovation of Internet applications and services (Hahn and Wallsten, 2006). According to Zhu (2007), it is important to sustain ISPs' incentive to invest because the innovation of Internet applications is stifled without meaningful bandwidth. The author further argues that traffic prioritization promotes and coexists with Internet innovation but endorses minimal regulation to prohibit the overuse of market power and discrimination.

On the other hand, proponents contend that network neutrality regulation accelerates innovation by facilitating the expansion of the network infrastructure and guaranteeing the transmission of time- and quality-sensitive services. Roycroft (2006) points out that Yoo's (2006b) assertion is not appropriate because it does not consider innovation and economic development caused by network neutrality. Other scholars in addition to Roycroft (2006) stress that innovation in terms of application at the edges is more important than centralized network innovation (Kocsis and de Bijl, 2007).

Moreover, van Schewick (2007) maintains that the threat of discrimination considerably decreases the number of innovators at the application level by reducing innovation incentives for isolated developers. Although discrimination gives network providers the incentive to participate in innovation at the application level, reductions in the number of isolated developers are much greater than that of network providers because the number of network providers is lower than that of complementary isolated Internet developers. Hogendorn (2010) shares this perspective and stresses the dynamic, public values of the Internet. The author describes the Internet as "general purpose technology" and the Internet as a platform for various innovations; therefore, applications above the platform become a source of further innovation. Accordingly, Hogendorn (2010) emphasizes that the social value of maintaining network neutrality and opening the Internet is greater than the value gained from price discrimination by ISPs and governmental policies that degrade content quality.

Moreover, Lessig (2006) states that the current Internet structure should be sustained because the Internet's end-to-end framework provides the best conditions for Internet innovation. Economides (2010) analyzes the network neutrality issue under the assumption that ISPs charge ASPs a termination fee. According to Economides (2010), when ISPs

charge termination fees, those ASPs that are already paying fees at marginal cost levels should, in a properly operating market, be paying much more, which suppresses content and application production, as well as edge-of-network innovation. Moreover, when ISPs impose paid prioritizations, the winner of the service market will be the entrepreneur who has paid for prioritization, and the firm that attains market penetration is likely to sustain its market power for a long time because of the network effect of the Internet market. Economides (2010) is concerned that paid prioritization will ultimately deter innovation and he, therefore, endorses network neutrality.

In sum, the proponents and opponents of network neutrality assert innovation in ways that are consistent with the terms of Schumpeter's Mark I and Mark II, respectively. This difference can be formulated according to Wu and Yoo (2007, p. 10):

> A lot of the difference between Christopher's view and my (Wu) own stems from how we think the process of innovation occurs. Christopher, rather like Joseph Schumpeter in his later years, believes that large firms [. . .] drive telecommunications innovation [. . .] Christopher thinks incumbents like AT&T will rarely or perhaps never threaten innovation. Instead, he views them as the driving force of the technologies of tomorrow [. . .] I (Wu) think [. . .] that in general, incumbents, particularly in a monopoly position, have a strong incentive to block market entry and innovative technologies that threaten their existing business model. My faith is that economic growth is driven by market entry [. . .]

The economic relationships among a firm's characteristics, such as firm size and innovation, are difficult to understand. For this reason, new concepts that emphasize the systemic characteristics of innovation have recently received attention, and many studies have been conducted from this perspective (Freeman (2002) and Lundvall *et al.* (2002)). Research on innovation systems involves innovation as interaction for knowledge creation, propagation and utilization among various innovators (Lundvall, 1992; Nelson and Rosenberg, 1993). In other words, innovation is achieved through interaction among relevant innovators rather than by a single firm (Edquist, 1997; Malerba, 2002) because innovation is characterized by high uncertainty and complicated interactions, which are necessary to accumulate knowledge for innovation (Lundvall, 1992; Patel and Pavitt, 1994). Likewise, close cooperation and adjustments among government, network providers, device providers and content service providers are required to achieve innovation in the Internet industry.

From the perspective of the innovation system, innovation in the ASP market spills over into the ISP market in various ways, and innovation in the ISP market similarly spills over into the ASP market. It is difficult to determine which type of innovation is more important because both types of innovation affect each other and are important for the development of the Internet industry. In other words, it is difficult to determine whether network neutrality should be regulated as proponents argue (that innovation of the ASP market is more important and network neutrality should be regulated to promote it), whereas opponents focus on innovation of the ISP market.

4. Internet service provider profit and reinvestment in the network

Investment in the Internet industry, which requires a high initial outlay, is more important than in any other industry. Hahn and Wallsten (2006) underscore the importance of this in their discussion of the two-sided market. According to them, the government should impose pricing rules so that broadband service providers have enough incentive to invest in and create innovation with their own networks by earning at least as much as their costs. In a two-sided market, the price is not equal to the marginal cost, and one side often subsidizes the other side (Rochet and Tirole, 2003). Moreover, when demand is uncertain and the players are interdependent, it is more difficult for prices to cover the marginal costs (Evans, 2003).

Another characteristic of the two-sided broadband market is the existence of direct and indirect network externalities, which are positive unless end-users or applications induce

network traffic congestion (Hagiu, 2006). Furthermore, the Internet industry cannot internalize the benefits of these externalities without sufficient investment in the broadband platform. Consequently, a regulation policy that induces continuous investment in the broadband platform is necessary for the continuous and effective development of the Internet.

Because regulation profoundly influences a firm's financial decisions over the long term, it is considered the key determinant of investment incentive (Cambini and Jiang, 2009). One of the main purposes of regulation is to increase social welfare by promoting competition. However, regulation that promotes competition sometimes reduces a firm's incentive to invest (Cambini and Jiang, 2009). Thus, it may conflict with individual gains. Moreover, there usually is a trade-off between promoting competition to improve social welfare after the stabilization of infrastructure and encouraging incumbents to invest in and maintain that infrastructure (Laffont and Tirole, 2000).

In practice, there is considerable debate on the question of whether network neutrality regulation influences network investment positively or negatively, with proponents and opponents holding fast to their respective positions. According to Wallsten and Hausladen (2009), the European Union is trying to solve the network neutrality issue by applying local loop unbundling (LLU). However, even LLU, which is simpler than network neutrality, raises concerns; to wit, some warn that LLU lowers the incentive to invest in the network (Jorde *et al.*, 2000; Crandall and Singer, 2003; Ingraham and Sidak, 2003; Zarakas *et al.*, 2005), whereas others assert the presence of a nonnegative effect to the contrary (Spiwak, 2003a, 2003b; Willig, 2006; Christodoulou and Vlahous, 2001).

Our discussion now turns to the different views of the effect of network neutrality on an ISP's investment incentive. Yoo (2004) argues that when network service providers escape from the end-to-end principle and customize their access service to each end-user, investments in last-mile facilities will accelerate, which will prevent the broadband access market from monopolizing the market.

Hahn and Wallsten (2006) claim that the rights of broadband providers to charge users should be protected to encourage them to invest in a network. They warn that investment in a platform will be lower than the socially optimal level when broadband providers are not free to charge platform users because they will lack sufficient incentive to construct the network to internalize the network externality.

Ford *et al.* (2007) and Musacchio *et al.* (2007) analyze the network neutrality issue with an economic model. First, Ford *et al.* (2007) analyze network neutrality under monopoly and duopoly assumptions. The authors argue that network neutrality limits ISPs' differentiation of their networks from other networks, thus effectively commoditizing broadband access to the Internet, which can harm network reinvestment and development. Ford *et al.* (2007) find that network neutrality has a negative effect on social welfare; it disturbs entry by creating competition between commoditized products and declining profits. Their model demonstrates that the new entry always increases consumer surplus and network neutrality decreases consumer surplus by deterring the entry. Musacchio *et al.* (2007) investigates the way that operators' network investment incentives, network quality and consumer prices are influenced by whether network neutrality is maintained. They find that when network neutrality is not maintained, network operators realize greater profits and end-users receive larger surpluses.

Using a game-theoretic model, Njoroge *et al.* (2010) investigate a two-sided market composed of two ISPs, heterogeneous ASPs and heterogeneous consumers. The results find that ISPs' investment incentives are larger in the non-neutral regime because it is easier for ISPs to extract revenues from ASPs than from consumers. ISPs' larger investments increase ASPs' quality, and ASPs' profits and consumer surplus increase accordingly.

On the other hand, Cheng *et al.* (2011) propose an economic model to solve the network neutrality issue and to determine the winner and loser when network neutrality is not

maintained. The authors find that broadband service providers always invest in network infrastructure at the socially optimal level under network neutrality, whereas they underinvest or overinvest in the absence of network neutrality.

According to Economides (2010), paid prioritization prevents ISPs from upgrading the network and downgrades service quality. When consumers choose their content service, the relative speed of the service is more important to them than its absolute speed. Thus, content service providers are willing to pay for faster service in an effort to dominate the market, and the value of the fast lane increases with congestion in the network. Moreover, although network providers' profits increase through paid prioritization, this does not imply increased investment in the network (Economides, 2010). Network providers have fewer investment incentives because they normally have market power. Hence, their additional benefit is more likely to be embodied by shareholders' additional benefits.

Economides and Hermalin (2011) model a monopolistic ISP and ASPs and assume that an ISP allocates a portion of the bandwidth to different ASPs and that each ASP makes money by selling content to consumers. The authors derive that an ability to discriminate increases an ISP's incentive to invest. However, they find that network neutrality is still welfare enhancing when the portion of consumer utility in total welfare is greater than the ASPs' profits.

In addition, according to Dhamdhere and Dovrolis (2008), ISPs can increase their profits through appropriate strategies without violating the network neutrality rule. These scholars reject their opponents' view that ISPs' profits can be protected and invested in the network only in the absence of network neutrality. Odlyzko (2009) assert that the cost of expanding the network in response to heightened Internet traffic has been overestimated and that ISPs need not obtain extra capital through price discrimination to construct a broadband infrastructure. Moreover, historical data provided by Turner (2009) demonstrate that network neutrality does not decrease ISP investment.

In sum, opponents hold that ISPs have sufficient incentive only when they have the authority to manage their own network, and consequently, they generate adequate levels of profit. Conversely, proponents contend that additional profits do not require increased investment in the network. The way that network neutrality will influence the benefits and investment incentives of an ISP is a contentious issue that requires further empirical study.

5. Consumer surplus and social welfare

As explained above, the ultimate objective of resolving the network neutrality debate is to develop the Internet for the benefit of its consumers. In other words, this paper considers the effects of network neutrality on network investment and innovation to maximize consumer surplus and social welfare by increasing the efficiency of the Internet. Section 5 addresses the pros and cons of network neutrality regarding its influences on efficiency, consumer surplus and social welfare.

Yoo (2006a) stresses that network neutrality can shift Internet charges from heavy to light users of broad bandwidth and criticizes network neutrality on that basis. Ford *et al.* (2007) find that network neutrality negatively influences social welfare in that it disturbs entry by creating competition between commoditized products and declining profits. The model proposed by Ford *et al.* (2007) demonstrates that the new entry always increases consumer surplus and network neutrality decreases consumer surplus by deterring the entry. In terms of price regulation, network neutrality is necessary to maximize short-term social surplus but unnecessary in the long term because it does not interrupt innovative activities (Shrimali, 2008). Hermalin and Katz (2007) investigate the influence of product-line restriction using a two-sided market model. Their result implies restriction to monopoly and duopoly platforms can either be beneficial or harmful to social welfare, with the latter being the more likely outcome.

Economides and Tåg (2009) similarly use a two-sided market model under monopoly and duopoly market assumptions. However, their results find that network neutrality will increase the overall surplus, thus contradicting Hermalin and Katz (2007). According to Economides (2010), when a network operator delays the standard lane, all of the ASPs will want to use the priority lane, even when there are additional charges. This will place all ASPs in a dilemma because all of them would pay additional charges for the same service they had received without paying any additional charges. This would harm end-users, as well as ASPs and CPs.

Some scholars approach network neutrality in terms of its social cost. As Lee and Wu (2009) and Bauer (2007) contend, there is a considerable difference between no fees and small fees. If ISPs charge even a small termination fee, then each CP would need to contract with every last-mile broadband provider with which the CPs' consumers subscribe and they thereby would incur a new transaction cost (Lee and Wu, 2009; Bauer, 2007; Economides, 2010).

Clarke (2009) argues that we need a more stable and wider bandwidth that has a continuous increment in network usage because the traffic use pattern changes from e-mail and Web browsing to peer-to-peer applications and real-time services. Clarke (2009) estimates the cost of expanding network bandwidth and suggests that using multicast rather than unicast will significantly reduce the cost. However, Odlyzko (2009) argues that Clarke (2009) overestimates the adoption ratio of IPTV and ignores future cost reductions.

6. The connection between vertical integration, discrimination, innovation and reinvestment

This paper categorized the network neutrality literature into four groups and separately reviews them in Sections 2 through 4. However, network neutrality, vertical integration, discrimination, innovation and reinvestment are closely inter-related.

According to Rey and Tirole (2007), ISPs' vertical integration increases the incentive for discrimination because when a firm that own bottleneck products (an essential facility) integrates a firm in the complementary segment, the former might foreclose or discriminate against the complementary market. If an ISP could discriminate against complementary competitors, then it could reduce the amount of innovation at the application level (van Schewick, 2007). According to van Schewick (2007), discrimination increases the incentive for ISPs to participate in application-level innovation, but this increment cannot offset the isolated producers' decrements in innovation.

From another perspective, price discrimination leads to inefficiency in the market and decreases the incentive to invest in the network (Economides, 2010). Thus, van Schewick (2007) argues that network neutrality is beneficial in that it increases the amount of application-level innovation but decreases the incentive for ISPs to invest in the network. In the case of the Internet, a general-purpose technology, increasing co-invention, is more important than the increment of innovation in the general-purpose technology itself. According to van Schewick (2007), the term "co-invention" can be defined as the innovative activity associated with identifying and realizing potential uses of the general-purpose technology in particular sectors of the economy. That is, network neutrality regulation increases social welfare because the increment in application-level innovation is more important than the decrement in investment (van Schewick, 2007).

In contrast, opponents stress that network neutrality decreases the levels of investment and innovation in networks and thereby harms consumers and the society. Hahn and Wallsten (2006) voice concern that network neutrality could decrease the investment incentive, distort innovation and eventually harm consumers. According to Sidak (2006), a non-regulatory environment encourages investment in the network, and this investment induces innovation at the edges of the network. Shrimali (2008) finds that over the long term, price discrimination does not deter innovation or decrease social welfare. In terms of

price regulation, network neutrality is necessary to maximize short-term social surplus but unnecessary in the long term because it does not interrupt innovative activities (Shrimali, 2008).

In sum, proponents argue that ISPs have sufficient incentive to discriminate against ASPs when there is no network neutrality regulation, and vertical integration further increases the incentive to discriminate. When ISPs discriminate against ASPs, application innovation will clearly decrease, finally decreasing the efficiency of the Internet industry and the welfare of the entire society. In contrast, opponents insist that network neutrality reduces the incentive to invest in the network and leads to a decrement in innovation at the network infrastructure level. Thus, the four categories elucidated in Sections 2 through 4 are inter-correlated such that each can have simultaneous multiple cause-and-effect relationships with the others and some of the related issues can be structurally resolved only when all of them are resolved.

7. Policy proposals to solve the network neutrality problem

7.1 Open access

Early proponents believed that open access could solve the non-neutral network problem and that the concepts of open access and network neutrality are not very different. Open access demands that operators who have the facilities to provide broadcasting and telecommunication services share the facilities with those who do not.

However, as the network neutrality debate progressed, the view emerged that open access could not quell the network neutrality debate and that the concept of network neutrality itself had changed. According to Wu (2003), open access is potentially counterproductive because broadband operators will try to block the provision of QoS with the cooperation of ISPs when open access is enforced. Moreover, operators will keep trying to control Internet use even after open access is enforced. Consequently, Wu (2003) warns that a structural remedy such as open access could harm the neutrality of the network.

In addition, open access opens conduits (such as cable or DSL) for intermediaries such as America Online, whereas network neutrality opens up a network to content (Hogendorn, 2007). According to Hogendorn's (2007) model, open access cannot encourage access to content and, therefore, cannot be a substitute for network neutrality. For this reason, if the main aim of regulation were the opening of the network for content, then it is a better option to consider some type of network neutrality that also regulates intermediaries. Bauer (2007) tests the innovation incentive using an economic model under three different scenarios: no network neutrality, non-discrimination (including open access) and full regulation. He concludes that no scenario resolves the fundamental issue of network neutrality.

7.2 Vitalizing competition

Most opponents voice disapproval of governmental regulation to solve the network neutrality issue. Instead, they believe that vitalization of the competition at the network level could eliminate the incentive for discrimination and naturally solve the network neutrality problem. This paper now turns to a discussion of the vitalization of competition as a possible solution to the network neutrality issue.

According to the Reynolds (2007), only when an ISP has sufficient market power in the Internet access market can that power spill over. Accordingly, if the competition between ISPs were sufficiently intense, then there would be no debate. Reynolds (2007) emphasizes that the vitalization of competition between operators in the broadband Internet market most effectively guarantees fair competition. Sidak (2006) also suggests that the network neutrality debate would be meaningless if the ISP market were adequately competitive and that intensifying competition in the ISP market would solve the network neutrality problem. Kocsis and de Bijl (2007) stress the importance of network competition and forecast that such competition would eliminate the negative effects of discrimination. However, they add

that it is unclear how much competition would suffice. In Wu and Yoo (2007), Yoo insists that network neutrality focuses on maintaining competition at the application and content layers, which he argues is the wrong focus because these layers are sufficiently competitive. The debate should instead focus on the effects of network neutrality on last-mile competition.

In contrast, van Schewick (2007) claims that competition could not solve the debate because ISPs will still have the incentive to prefer their own services and exclude competitors even if competition were introduced. The author presents numerous cases in which ISPs engage in discrimination against isolated ASPs or CPs over competition in the Internet service market. Musacchio *et al.* (2009) use an analytical model to compare the economic benefits of one-sided and two-sided pricing. The result suggest that the negative effect of network externalities increase as the number of ISPs increase under a two-sided pricing regime because an ISP will ignore the fact that charging CPs harms the end-users of every ISP by decreasing CP investment. The result implies that increasing the number of ISPs would not solve the network neutrality problem, but it would harm social welfare.

Conversely, some studies investigate the effect of network neutrality on the vitalization of competition. For example, Economides (2010) maintain that termination fees and paid prioritization distort the competitive environment and raise the entry barrier. On the other hand, Yoo (2006a) argues that network neutrality fixes the current monopoly of the network market by interrupting the entry of new entrepreneurs.

7.3 Other proposals

In addition to open access and the vitalization of competition, the proponents and opponents of these views have proposed numerous other solutions. The network neutrality principle proposed by Wu (2003) allows operators to manage their own network provided this does not adversely influence broadband users. Hence, broadband operators should not constrain end-users from accessing the Internet, except when necessary to protect the hardware, quality and security of the network. On the other hand, Yoo (2006b) proposes a type of network diversity that will give end-users the benefits of a variety of products and easily accommodate technical dynamics.

According to Crowcroft (2007), given that the Internet continuously evolves, no definition of network neutrality can explain the meaning of neutrality. Thus, Crowcroft (2007) proposes a multipart meta-definition defining network neutrality in terms of connectivity, performance, service and cross-layering. In addition, Jordan (2007) divides the Internet into two layers and proposes different regulations for each. Jordan (2007) insists that approach will maximize social welfare and trigger continuous Internet development. It would do that by applying the free market model based on Title I forbearance to the application layer and applying an open interface based on Title II to the infrastructure layer according to the layered principle.

Additionally, Hahn and Wallsten (2006) assert that the government should focus on liberalizing the allocation of the frequency in wireless communication and the vitalization of competition by lowering the entry barrier. They argue that if broadband operators were to continue to attempt market power overuse, then they should be regulated through anti-trust laws.

Speta (2009) stresses that to solve the network neutrality problem, it is most important to investigate whether ISPs have market power. In the short term, the government or regulator should regulate ISPs so that ISPs open every action-changing packet priority and not block any packet. However, Speta (2009) emphasizes that an in-depth study of ISPs' market power is necessary for the long term.

Ganley and Allgrove (2006) hold that regulation giving consumers more options is the most desirable kind, and Jordan (2009) proposes a policy that guarantees open access by controlling the US Universal Service Fund with a layered model. In addition, de Bijl and

Peitz (2008) insist that the government should consider network neutrality and ex-post regulation, whereas Shrimali (2008) emphasizes the importance of a balanced approach because the network neutrality debate is very complicated. Lee and Kim (2014) do not propose a policy, but they emphasize the timing with which regulation is introduced because the effect of network neutrality regulation depends of the level of diffusion of application.

8. Conclusion

For the past few years, the network neutrality debate has been a burning international issue. Although the proponents and opponents of network neutrality have published many research papers, they have not reached a consensus. However, although the players cannot agree on the nature of network neutrality, they agree that the Internet has a significant influence on national economies (Czernich *et al.*, 2011), that it continuously develops and that now is the time to implement governmental policies toward greater Internet openness.

The network neutrality issue has received focused attention recently because it is the key factor to the future expansion of the Internet. Moreover, the majority of the research on the issue has been carried out over a short time frame. As discussed in this paper, much of the debate has raged about whether the vertical integration of ISPs harms fair competition, whether ISPs have an incentive to discriminate against ASPs and whether network neutrality regulations increase the incentive to invest in the network. The discussion is heated because economic theory provides no clear support for any single position. Thus, both the proponents and opponents are not yielding their contrasting views on the issues of vertical integration, innovation and investment incentives. Moreover, few of the studies have used data that support the assertions of either side. For example, Lee and Hwang's (2011) empirical study finds that there is not significant enough discrimination of ISPs to decrease the efficiency of ASPs.

Using EU data, Wallsten and Hausladen (2009) demonstrate that incumbents are less invested in the optical network because the region relies more on local loop unbundling. However, they are only able to conclude that the EU's approach, which emphasizes the unbundled network as a solution to network neutrality, is uncertain, irrespective of its effectiveness. Because there is no definite economic theory governing the network neutrality debate, verification through data analysis is the only means of supporting an assertion. Finally, further investigation into reasonable network management is needed. Peha (2007) and Frieden (2006) provide permissible and impermissible traffic management practices. More precisely, Jordan and Ghosh (2009) propose a framework that divides traffic management into reasonable and unreasonable management types. However, research on reasonable network management remains limited. This area needs to be addressed.

Importantly, Wu and Yoo (2007) point out:

> Christopher believes that, at least when it comes to information networks, technology is changing the conditions for market entry in physical networking [. . .] At the risk of sounding like a dinosaur, I [Wu] am skeptical. Despite the mists and magic of the Internet, I don't think the basic economics of transportation infrastructure, and particularly telecom's last mile, have changed all that much.

Thus, even a tiny difference of opinion about the ways that technology will evolve can change a perspective on whether network neutrality regulation is proper. Proponents are correct to state that the innovation of ASPs is important. However, ASPs cannot progress without progress made by ISPs and vice versa. Just as Liebig's Law contends that the smallest inorganic component limits the growth of an entire plant, the growth of the Internet will be limited if either the ISP or the ASP is underdeveloped. In conclusion, it is important to establish a policy that can symmetrically expand ISPs and ASPs while minimizing any side effects through research results that use actual data.

References

Bauer, J.M. (2007), "Dynamic effects of network neutrality", *International Journal of Communication*, Vol. 1, pp. 531-547.

Cambini, C. and Jiang, Y. (2009), "Broadband investment and regulation: a literature review", *Telecommunications Policy*, Vol. 33 Nos 10/11, pp. 559-574.

Carter, K.R., Marcus, J.S., Peake, A.J. and Watanabe, T. (2010), "A comparison of network neutrality approaches in the US, Japan, and the European Union", *The 38th Research Conference on Communication, Information and Internet Policy (TPRC)*, Arlington, VA, October.

Cheng, H.K., Bandyopadhyay, S. and Guo, H. (2011), "The debate on net neutrality: a policy perspective", *Information Systems Research*, Vol. 22 No. 1, pp. 60-82.

Christodoulou, K. and Vlahous, K. (2001), "Implications of regulation for entry and investment in the local loop", *Telecommunications Policy*, Vol. 25 Nos 10/11, pp. 743-757.

Clarke, R. (2009), "Costs of neutral/unmanaged IP networks", *Review of Network Economics*, Vol. 8 No. 1, pp. 61-89.

Crandall, R. and Singer, H. (2003), "An accurate scorecard of the Telecommunications Act of 1996", Rejoinder to the Phoenix Center Study No. 7. Report by Criterion Economics, Washington, DC.

Crocioni, P. (2011), "Net neutrality in Europe: desperately seeking a market failure", *Telecommunications Policy*, Vol. 35 No. 1, pp. 1-11.

Crowcroft, J. (2007), "Net neutrality: the technical side of the debate – A white paper", *International Journal of Communication*, Vol. 1, pp. 567-579.

Czernich, N., Falck, O., Kretschmer, T. and Woessmann, L. (2011), "Broadband infrastructure and economic growth", *The Economic Journal*, Vol. 121 No. 552, pp. 505-532.

de Bijl, P. and Peitz, M. (2008), "Innovation, convergence and the role of regulation in the Netherlands and beyond", *Telecommunications Policy*, Vol. 32 No. 11, pp. 744-754.

Dhamdhere, A. and Dovrolis, C. (2008), "Can ISPs be profitable without violating 'network neutrality'? In applications, technologies, architectures, and protocols for computer communication", *Proceedings of the 3rd International Workshop on Economics of Networked Systems, NetEcon'08*, *Seattle, WA*, *22 August*.

Economides, N. (2010), "Why imposing new tolls on third-party content and applications threatens innovation and will not improve broadband providers' investment", Appendix A in Comments of Google, FCC GN Dkt. 09-191; WC Dkt.: 07-52.

Economides, N. and Hermalin, B.E. (2011), "The economics of network neutrality", The selected works of Benjamin E. Hermalin, available at: http://works.bepress.com/hermalin/5

Economides, N. and Tåg, J. (2009), "Net neutrality on the Internet: a two-sided market analysis", unpublished manuscript, New York University and the Research Institute of Industrial Economics.

Edquist, C. (1997), *Systems of Innovation-Technologies, Institutions and Organizations*, Pinter Publishers, London.

Evans, D.S. (2003), "The antitrust economics of multi-sided platform markets", *Yale Journal on Regulation*, Vol. 20, pp. 325-382.

Farrell, J.P. and Weiser, P.J. (2003), "Modularity, vertical integration, and open access policies: towards a convergence of antitrust and regulation in the Internet age", *Harvard Journal of Law and Technology*, Vol. 17 No. 1, pp. 13-21.

Faulhaber, G.R. (2011), "Economics of net neutrality", *Communications & Convergence Review*, Vol. 3 No. 1, pp. 53-64.

Ford, G.S., Koutsky, T.M. and Spiwak, L.J. (2007), "Network neutrality and industry structure", *Hastings Communications and Entertainment Law*, Vol. 29, pp. 149-156.

Freeman, C. (2002), "Continental, national and sub-national innovation systems-complementarity and economic growth", *Research Policy*, Vol. 31 No. 2, pp. 191-211.

Frieden, R. (2006), "Network neutrality or bias? Handicapping the odds for a tiered and branded Internet", *Hastings Communications and Enterprise Law Journal*, Vol. 29, pp. 171-216.

Ganley, P. and Allgrove, B. (2006), "Net neutrality: a user's guide", *Computer Law & Security Report*, Vol. 22 No. 6, pp. 454-463.

Guo, H., Bandyopadhyay, S., Cheng, H.K. and Yang, Y.C. (2010), "Net neutrality and vertical integration of content and broadband services", *Journal of Management Information Systems*, Vol. 27 No. 2, pp. 243-275.

Hagiu, A. (2006), "Proprietary vs open two-sided platforms and social efficiency", Working Paper, AEI-Brookings Joint Center.

Hahn, R. and Wallsten, S. (2006), "The economics of net neutrality", Working Paper no. RP06-13, AEI-Brookings Joint Center, available at: http://ssrn.com/abstract=943757

Hermalin, B.E. and Katz, M.L. (2007), "The economics of product-line restrictions with an application to the network neutrality debate", *Information Economics and Policy*, Vol. 19, pp. 215-248.

Hogendorn, C. (2007), "Broadband internet: net neutrality versus open access", *IEEP*, Vol. 4, pp. 185-208.

Hogendorn, C. (2010), "Spillovers and network neutrality", in Faulhaber, G., Madden, G. and Petchey, J. (Eds), *Regulation and the Performance of Communication and Information Networks*, Edward Elgar, available at: http://ssrn.com/abstract=1632491

Ingraham, A. and Sidak, G. (2003), "Mandatory unbundling, UNE-P, and the cost of equity: does TELRIC pricing increase risk for incumbent local exchange carriers?", *Yale Journal on Regulation*, Vol. 20, pp. 389-406.

Jordan, S. (2007), "A layered network approach to net neutrality", *International Journal of Communication*, Vol. 1, pp. 427-460.

Jordan, S. (2009), "A layered United States universal service fund for an everything-over-IP World", *Telecommunications Policy*, Vol. 33 Nos 3/4, pp. 111-128.

Jordan, S. and Ghosh, A. (2009), "How to determine whether a traffic management practice is reasonable", *Research Conference on Communication, Information and Internet Policy (TPRC)*, Arlington, VA, September.

Jorde, T., Sidak, G. and Teece, D. (2000), "Innovation, investment and unbundling", *Yale Journal on Regulation*, Vol. 17 No. 1, pp. 1-37.

Knieps, G. (2011), "Network neutrality and the evolution of the internet", *International Journal of Management and Network Economics*, Vol. 2 No. 1, pp. 24-38.

Kocsis, V. and de Bijl, P.W.J (2007), "Network neutrality and the nature of competition between network operators", *International Economics and Economic Policy*, Vol. 4 No. 2, pp. 159-184.

Laffont, J. and Tirole, J. (2000), *Competition in Telecommunications*, MIT Press, Cambridge.

Lee, D. and Hwang, J. (2011), "Network neutrality and difference in efficiency among Internet application service providers: a meta-frontier analysis", *Telecommunications Policy*, Vol. 35 No. 8, pp. 764-772.

Lee, D. and Kim, H. (2014), "The effects of network neutrality on the diffusion of new Internet application services", *Telematics and Informatics*, Vol. 31 No. 3, pp. 386-396.

Lee, R. and Wu, T. (2009), "Subsidizing creativity through network design: zero-pricing and net neutrality", *Journal of Economic Perspectives*, Vol. 23 No. 3, pp. 61-76.

Lessig, L. (2006), "Testimony before the senate committee on commerce, science and transportation hearing on network neutrality", 7 February, available at: http://commerce.senate.gov/hearings/witnesslist.cfm?id=1705

Lundvall, B.A. (1992), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London.

Lundvall, B.A., Johnson, B., Andersen, E.S. and Dalum, B. (2002), "National systems of production, innovation and competence building", *Research Policy*, Vol. 31 No. 2, pp. 213-231.

Malerba, F. (2002), "Sectoral systems of innovation production", *Research Policy*, Vol. 31 No. 2, pp. 247-264.

Musacchio, J., Schwartz, G. and Walrand, J. (2007), "Network neutrality and provider investment incentives", *Asolomar Conference on Signals*, Systems and Computers, Pacific Grove, CA, 4-7 November.

Musacchio, J., Schwartz, G. and Walrand, J. (2009), "A two-sided market analysis of provider investment incentives with an application to the net-neutrality issue", *Review of Network Economics*, Vol. 8 No. 1, pp. 22-39.

Nelson, R.R. and Rosenberg, N. (1993), "Technical innovation and national systems", in Nelson, R.R. (Ed.), *National Innovation Systems-A Comparative Analysis*, Oxford University Press, Oxford.

Njoroge, P., Ozdaglar, A., Stier-Moses, N.E. and Weintraub, G.Y. (2010), "Investment in two sided markets and the net neutrality debate", Working Paper, DRO-2010-05, Columbia Business School, Decision, Risk and Operation.

Odlyzko, A. (2009), "Network neutrality, search neutrality, and the never-ending conflict between efficiency and fairness in markets", *Review of Network Economics*, Vol. 8 No. 1, pp. 40-60.

Patel, P. and Pavitt, K. (1994), "The nature and economic importance of national innovations systems", *STI Review*, Vol. 14, pp. 9-30.

Peha, J. (2007), "The benefits and risks of mandating network neutrality, and the quest for a balanced policy", *International Journal of Communication*, Vol. 1, pp. 644-668.

Reggiani, C. and Valletti, T. (2011), "Net neutrality and innovation at the core and at the edge", Working paper EDP-1202, University of Manchester.

Rey, P. and Tirole, J. (2007), "A primeron foreclosure", in Armstrong, M. and Porter, R. (Eds), *Handbook of Industrial Organization*, Elsevier, North Holland, Vol. 3, pp. 2145-2220.

Reynolds, T. (2007), "Internet traffic prioritisation: an overview", No. DSTI/ICCP/TISP(2006)4/FINAL. Committee for Information, Computer and Communications Policy, OECD, Paris.

Rochet, J.C. and Tirole, J. (2003), "Platform competition in two-sided markets", *Journal of the European Economic Association*, Vol. 1 No. 4, pp. 990-1029.

Roycroft, T.R. (2006), "Economic analysis and network neutrality: separating empirical facts from theoretical fiction", *Consumer Federation of America*, pp. 4-16.

Rubinfeld, D. and Singer, H. (2001), "Vertical foreclosure in broadband access?", *Journal of Industrial Economics*, Vol. 59 No. 3, pp. 299-318.

Schuett, F. (2010), "Network neutrality: a survey of the economic literature", *Review of Network Economics*, Vol. 9 No. 2, pp. 1-13.

Shin, D. (2014), "A comparative analysis of net neutrality: insights gained by juxtaposing the US and Korea", *Telecommunications Policy*, Vol. 38 No. 11, pp. 1117-1133.

Shin, D. (2016), "Application of actor-network theory to network neutrality in Korea: socio-ecological understanding of network dynamics", *Telematics and Informatics*, Vol. 33 No. 2, pp. 436-451.

Shin, D. and Han, E. (2012), "How will net neutrality be played out in Korea?", *Government Information Quarterly*, Vol. 29 No. 2, pp. 243-251.

Shin, D. and Shim, Y. (2015), "Network neutrality in the eye of the beholder", *International Journal of Mobile Communications*, Vol. 13 No. 5, pp. 510-534.

Shrimali, G. (2008), "Surplus extraction by network providers: implications for net neutrality and innovation", *Telecommunications Policy*, Vol. 32 No. 8, pp. 545-558.

Sidak, J.G. (2006), "A consumer-welfare approach to network neutrality regulation of the Internet", *Journal of Competition Law and Economics*, Vol. 2 No. 3, pp. 349-474.

Speta, J.B. (2000a), "Handicapping the race for the last mile? A critique of open access rules for broadband platforms", *Yale Journal on Regulation*, Vol. 17, pp. 39-91.

Speta, J.B. (2000b), "The vertical dimension of cable open access", *University of Colorado Law Review*, Vol. 71, pp. 975-1010.

Speta, J.B. (2009), "A sensible next step on network neutrality: the market power question", *Review of Network Economics*, Vol. 8 No. 1, pp. 113-127.

Spiwak, L.J. (2003a), "Competition and Bell Company investment in telecommunications plant: the effects of UNE-P", Phoenix Center Policy Bulletin No. 5, available at: www.phoenix-center.org/PolicyBulletin/PolicyBulletin5.pdf

Spiwak, L.J. (2003b), "UNE-P drives Bell investment: a synthesis model", Phoenix Center Policy Bulletin No. 6, available at: www.phoenix-center.org/PolicyBulletin/PolicyBulletin5.pdf

Turner, D. (2009), *Finding the Bottom Line: The Truth about Network Neutrality and Investment*, Free Press, available at: www.freepress.net

van Schewick, B. (2007), "Towards an economic framework for network neutrality regulation", *Journal on Telecommunications and High Technology Law*, Vol. 5 No. 2, pp. 329-391.

Wallsten, S. and Hausladen, S. (2009), "Net neutrality, unbundling, and their effects on international investment in next-generation networks", *Review of Network Economics*, Vol. 8 No. 1, pp. 90-112.

Weisman, D.L. and Kulick, R.B. (2010), *Price Discrimination, Two-Sided Markets and Net Neutrality Regulation*, Mimeo, available at: http://ssrn.com/abstract=1582972

Willig, R. (2006), *Investment is Appropriately Stimulated by TELRIC*, Princeton University, available at: http://psc.ky.gov/pscecf/2003-00379/5200700_efs/04132004/MCI_ST_MTB_EX_14_04%2013%2004.pdf

Wu, T. (2003), "Network neutrality, broadband discrimination", *Journal of Telecommunications and High Technology Law*, Vol. 2, pp. 141-178.

Wu, T. (2004), "The broadband debate: a user's guide", *Telecommunications and High Technology Law*, Vol. 3, pp. 69-96.

Wu, T. and Yoo, C.S. (2007), "Keeping the Internet neutral? Tim Wu and Christopher Yoo debate", *Federal Communications Law Journal*, Vol. 59 No. 3, pp. 575-592.

Yoo, C.S. (2004), "Would mandating broadband network neutrality help or hurt competition? A comment on the end-to-end debate", *Journal of Telecommunications and High Technology Law*, Vol. 3, available at: http://ssrn.com/abstract=495502

Yoo, C.S. (2005), "Beyond network neutrality", *Harvard Journal of Law & Technology*, Vol. 19 No. 1, pp. 1-77.

Yoo, C.S. (2006a), "Network neutrality and the economics of congestion", *Georgetown Law*, Vol. 94, pp. 21-27.

Yoo, C.S. (2006b), "Promoting broadband through network diversity", White Paper, Vanderbilt University Law School, Nashville, TN, p. 56.

Zarakas, W., Woroch, G., Wood, L., McFadden, D., Ilias, N. and Liu, P. (2005), "Structural simulation of facility sharing: unbundling policies and investment strategy in local exchange markets", Report by The Brattle Group, Washington, DC, available at: www.brattle.com/_documents/UploadLibrary/ArticleReport2347.pdf

Zhu, K. (2007), "Bringing neutrality to network neutrality", *Berkeley Technology Law Journal*, Vol. 22, pp. 615-645.

Further reading

Lee, D. and Kim, Y. (2014), "Empirical evidence of network neutrality – the incentives for discrimination", *Information Economics and Policy*, Vol. 29, pp. 1-9.

Corresponding author

Dong-Hee Shin can be contacted at: dshin1030@cau.ac.kr