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Empirical evidence of network neutrality – The incentives for discrimination

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ABSTRACT

For the past few years, the network neutrality debate has been a burning international issue, and many researchers have provided various solutions to solve the network neutrality debate in a short time. So far, however, both the proponents and opponents of network neutrality have not provided the empirical evidence necessary to prove their assertions. This study collected data using surveys and estimated usage rates of end users while changing the QoS level of each application. Based on the estimation results of the willingness-to-pay (WTP) and usage rates of end users, this study investigates whether Internet service providers (ISPs) have the incentives to discriminate against application services and whether those incentives change according to various conditions. As a result, ISPs have the incentive to provide a low QoS level for costly application services, and the incentives change according to conditions such as regulatory regimes, the cost of the Internet access service from the ISP, the WTP of the end users, and the degree of competition among the ISPs.

1. Introduction

Through active ongoing debate, proponents and opponents of network neutrality have steadily narrowed the gap in their difference of opinion. According to Lee and Hwang (2011a), network neutrality debates can be categorized into several different kinds of debates: discrimination, vertical integration, re-investment, innovation, and social welfare. However, as the authors point out, those categories are connected with each other and it is more important to analyze whether an Internet service provider (ISP) has the incentive to discriminate against application service providers (ASPs) because this is the cause of the other debates.

About incentives for discrimination, the proponents maintain that the network is neutral; therefore, no packet that travels on the Internet infrastructure can be treated unequally. In other words, the network is supposed to be neutral. However, Wu (2003) and van Schewick (2007) argue that ISPs have sufficient incentive to discriminate among Internet packets based on the origin, destination, and content of the packet.

On the contrary, the opponents assert that there is no reason for ISPs to discriminate against ASPs. From a viewpoint of economic theory, the principle of internalizing complementary efficiencies (ICE) and the two-sided market model commonly imply that ISPs, when vertically integrated with ASPs, have a weak incentive to discriminate against other ASPs (Lee and Hwang, 2011a).

Far from being solved, the debate on network neutrality and incentives for discrimination are alive and well since no evidence based on economic theory for any one

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assertion has been forthcoming. Providing empirical evidence is more important than making assertions based on theories in this case. However, no study has yet used data that corroborate the assertions of either the proponents or the opponents of network neutrality. Even though many economic studies such as Cheng et al. (2011), Choi and Kim (2010), Lee and Wu (2009), and Musacchio et al. (2009) demonstrate the network neutrality problem using economic models and give many insights, it is hard to say whether those studies provide absolute evidence to support or oppose network neutrality. Confirmation using genuine data is the only way to substantiate an assertion since there is no dominant economic theory presiding over the network neutrality argument.

Accordingly, this study collects data using surveys and estimates the usage amount of five different applications (file transfer protocol (FTP) service, video on demand (VoD), web browsing (hereafter, WEB), voice over Internet protocol (VoIP), and Internet protocol television (IPTV)) for end users while changing the QoS level for each application, respectively. Based on the estimated results and end users' willingness-to-pay (WTP) for Internet access service estimated by Lee et al. (2011), this study investigates whether network neutrality regulation is necessary using computational experiments. Specifically, this study focuses on the incentives of ISPs to discriminate against ASPs with different latency-sensitivities and bandwidth-usages. In addition, this study does computational experiments to test whether the incentives vary or not while changing the cost of the Internet access service from the ISPs, end users' WTP, and the degree of competition among the ISPs.

The remainder of this study is organized as follows. The next section provides a description of the end users, ISPs, and ASPs, which are the players of the game. Section 3 describes the game used to achieve the aims of the research. In Section 4, simulation scenarios and results are explained, and the final section summarizes and concludes the study.

2. Description of the players

Four different kinds of players participate in this game: the government, ISPs, ASPs, and end users. At first, the government decides whether to regulate ISPs through the network neutrality principle. In this study, it is assumed that the government does not regulate ISPs so it can be determined whether ISPs have the incentive to discriminate when there is no network neutrality regulation.

2.1. ISPs

To investigate whether an ISP has an incentive to discriminate against ASPs, it is necessary to know the cost and profit function of the ISP.

2.1.1. Cost

Mackie-Mason and Varian (1994) argues that it is necessary to consider the five categories below to precisely estimate the cost of the Internet access service:

1. The incremental costs of sending extra packets (If the network is not congested, this is essentially zero).
2. The social costs of delaying other users' packets when the network is congested.
3. The fixed costs of providing the network infrastructure.
4. The incremental costs of connecting to the network.
5. The cost of expanding the capacity of the network.

Considering the five categories above, one can see that it is very hard to estimate the cost of the Internet access service. For that reason, Fishburn and Odlyzko (2000) states that there is no simple formula representing the costs of communication networks. This study assumes the cost for application type A in a period with the amount of bandwidth used λ_A to be as follows:

$$\text{Cost of } A = \lambda_A^s \tag{1}$$

where $A \in \{\text{FTP, VoD, WEB, IPTV, VoIP}\}$, and s is the economy-of-scale parameter. Based on the data from UUNet Access Services,[2] Fishburn and Odlyzko estimated that a value in the range of 0.5–0.7 is proper for the economy-of-scale parameter, s, when the speed of the Internet access service is between 56 Kbps and 45 Mbps. For comparison, Harms (1994) uses a value of 0.5 for s, and Irvin (1993) uses 2/3 for long distance phone calls.

In this study, the computational experiments used a value of 2/3 for s at first, and then, the experiment is repeated while changing the value of s. This study uses the usage rate estimated in Section 2.3.2, and Table 1 shows the value of λ_A used in the computational experiments for each application.

2.1.2. Profit

Based on the decision of each end user, the profit of the ISP can be calculated as follow:

$$\begin{aligned}\pi_{\text{ISP}} &= P_{\text{ISP}} * (\#\text{ of subscribers}) - \text{Cost of } A \\ &= P_{\text{ISP}} * (\#\text{ of subscribers}) - \left[\sum_{i=1}^{\#\text{ of subscribers}} \sum_{A} X_{iA} * \lambda_A\right]^s\end{aligned} \tag{2}$$

where $A \in \{\text{FTP, VoD, WEB, IPTV, VoIP}\}$, λ_A is the bandwidth usage of application A, and X_{iA} is usage rate of subscriber i for application A. The ISP can determine the price of Internet access service and the QoS level for FTP, VoD, WEB, VoIP, and IPTV. This study designates the set of strategic decisions of an ISP as the 'strategy set.' The ISP chooses the best strategy set that maximizes Eq. (2) by repeating computational experiments until ISP cannot increase its profit by changing given strategy set.

2.2. ASPs

When there is no network neutrality regulation, ISPs can set the price and packet priority for their own Internet service.

[2] UUNet Access Services, available at http://www.us.uu.net/html/access-services.html1/4.