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Competition in the Korean Internet Portal Market: Network Effects, Profit, and Market Efficiency

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Abstract
Internet portals serve as platforms that coordinate advertising and user markets, and the portal market features network effects within and between both sides. We model the market structure in order to explain network effects and other factors of competition such as prices for advertisements, contents, and differentiated services offered. We empirically identify these effects with data from South Korea and analyze the role of the effects in terms of profit and market efficiency. The results indicate that a negative indirect network effect exists in the user market but is prevailed over by the direct network effect. This explains how Internet portals make profits by increasing user visits. Further, we show the existence of network effects causes consumer's surplus not to decrease with market concentration.

JEL classification: L82

Keywords: Internet Portal Industry, Network Effect, Two-sided Market, Market Efficiency

1. Introduction*

An Internet portal (portal) is a representative business model based on Internet technology as a form of new media. In 2007, the world portal market was worth approximately $21.6 billion (based on advertising spending figures from eMarketing.com), and it is continuing to grow at a fast pace. A portal's main functions are web content searching, e-mail, media for news and information, communities, and advertisements. An increasing number of people are reading news online via portals. People often set a portal as the home page of their web browsers in order to easily and promptly access the information they require. This concentration of information channeled into a web environment is becoming more evident and portals are expected to play a more important role in many aspects, including the economy, society, and culture.

The portal market can be an interesting subject in terms of economics because of its features with respect to network effects. First, a portal has characteristics similar to those of the network industry. An important feature of the network industry is the network externalities or the direct network effects (Kats and Shapiro, 1985; Fudenberg and Tirole, 2000; Ohashi, 2003). Similar characteristics can be found in most public utilities, broadband communication, telephone, mobile telecommunication industries, etc. In addition, a large number of Internet-based business models have exploited the network effect by attracting users by providing free content. In particular, this effect is claimed to have experienced dramatic growth recently with the concept of user-created contents (UCC) or Web 2.0, which can generate positive circles of user participation.

Second, a portal is a typical example of a two-sided market where a key characteristic is the indirect network effect between counterpart markets (Rochet and Tirole, 2003; Caillaud and Jullien, 2003; Armstrong, 2006). According to this model, a portal acts as a platform between a user and advertiser markets. Rochet and Tirole (2003) argued that a two-sided market study is based on network economics and multiproduct pricing, which implies that the existence of indirect network externalities enables platforms to decide the appropriate allocation of prices in both markets according to the maximization of their own profits. Caillaud and Jullien (2003) analyzed informational intermediation in an Internet-based market. In their study, profitable business models follow a "divide and conquer" model, which implies that a platform provides a subsidy to one side and recovers the losses from the other. Accordingly, in a portal market, users are loss leaders who emphasize that the platform should subsidize, and advertisers are profit centers who use the platform to earn profits.

In this paper, we model the structure of the Internet portal market in Korea and examine the factors of competition in the market. We constructed an economic model in the context of the two-sided market where the demand of users and profits (revenues) from advertisers are affected by network effects and product differentiation. The portal determines prices for advertisements on websites (banners) and provides content and differentiated services to users. Keyword advertising[1] is also included in the model.

*** *This research has been sponsored by Ministry of Knowledge Economy, Korea (IT Research Center)**

[1] A portal exploits two types of advertising, banner and keyword. Banner advertising is also known as display advertising and is similar to that of paper media such as yellow pages. Keyword advertising differs from banners in

Thereafter, we used market data in the model and created estimates. Since portals have rather complicated interactions among various agents in the market, it is not easy to model the market with in-depth precision. This appears to be the reason that empirical studies on the portal market have been deficient thus far. Therefore, this study, as the first to empirically analyze the portal market, can contribute to related research areas including two-sided markets and the network industry.

There exist certain empirical studies with a two-sided market mechanism such as Rysman (2004), and Kaiser and Wright (2006). By analyzing the Yellow Pages market in the United States, Rysman (2004) assumed quantity competition in the advertisers market and formulated an inverse demand function that considered the profit expectation of advertisers to be constant. Kaiser and Wright (2006) used the Hotelling competition model in the magazine industry and, accordingly, selected the first- and second-ranked magazines in a sub-category for the analysis. As compared with these studies, our model is different since we introduced utility functions on both sides of the market with price competition and defined a more complex system with keyword advertising and marginal cost functions. However, we referred to these studies for numerous aspects such as deriving the first order conditions under the existence of network effects.

In particular, when analyzing the Internet portal market, we focus on direct and indirect network effects and observe how these effects are correlated with the profits and market efficiency of firms. We analyze the profit creation structure and role of network effects in the profits of the Internet portal market. Further, we derive the first order condition of banner price and contents for maximizing the portal's profit in equilibrium. The resulting effect of banner price can be confirmed by the dividing factors of price-cost margin (PCM) structure with parameter estimates from our model. PCM indicates the manner in which the portal makes profits from network effects by controlling the banner price along with providing free content and services, which attracts more users and builds up keyword revenue. The result is quite consistent with the practice of attracting users, which has been widely utilized in this industry.

The network effect is a significant factor in determining market efficiency in this industry. When direct or indirect network effects exist, market dominance by a small number of firms does not always lead to loss of market efficiency because a loss of user's surplus from monopolization can be offset by an increased positive network effect. Caillaud and Jullien (2003) indicate that if positive network effects exist, a consumer's monopoly-related surplus can be increased more easily as compared with competition in a two-sided market using assumptions such as exclusivity (single-homing) and contestability. However, unlike advertisements in the yellow pages (Rysman, 2004) or magazines (Kaiser and Wright, 2006), which are believed to be informative and are assumed to increase the utility of readers, banner advertisements are believed to have negative effects on users (Barros et al., 2002; Reisinger, 2004). Market concentration reinforces both the network effects; however, if the negative indirect network effect prevails over the direct network effect in the user market, users' surplus with monopolization could be lowered. In contrast, if the direct network effect

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that it directly provides customized advertisements based on the keyword input by users. Thus, this method offers more active and informative advertising as compared with banners. For advertisers, the price and position of keyword advertising are decided by auction (Varian, 2007). Recently, keyword advertising has contributed significantly to portal revenue.

is stronger, the surplus could increase according to market concentration. This may be inferred from similar discussions in Barros et al. (2002), whose model indicated that platforms can draw more users from competitors by higher pricing of advertisements and fewer advertisements that provide more utility to users. Thus, it is an interesting empirical challenge to identify the manner in which these various network effects work in this industry and the manner in which they affect the market. Recently, there have been growing concerns regarding oligopoly situations in Korea, in that a small number of portals are occupying the entire market. As a result, the Korean government is on the verge of regulating the top-ranked portal as a market dominant firm. However, in reality, will this policy actually be beneficial to users? The estimation results of our model can provide a few conclusions regarding this policy.

As an empirical result, we identify direct and indirect network effects that are statistically significant as well as effects of differentiated services. Users dislike banner advertising but prefer increasing content and number of users. Moreover, a greater number of users can increase the utility of advertisers and keyword revenue. This mechanism of a two-sided market enables portals to provide free content and various services to users and make profits from the advertisers through banner and keyword advertising. When we compute welfare on the basis of this estimation, it is revealed that the welfare and market concentration do not have an inverse relationship.

This paper organized as follows. An overview of the Korean market is presented in the next section and our portal market model is presented in section 3. Data and estimation techniques are explained in section 4, and the results are outlined in section 5, followed by a conclusion.

2. Overview of the Korean Internet portal market

The Korean portal market has grown rapidly in recent times. In 2007, the total market size was slightly over $1 billion. Fig. 1 indicates that the Internet advertising market is growing dramatically (25,024% growth since 1995), while Korea’s overall advertising market has stagnated recently. The rapid growth is due to the growth of both banner and keyword advertising. In the initial stages, banner advertising accounted for all the revenue; however, the revenue share of keyword advertising has now become greater than that of banners. Fig. 1 presents the changes in revenue growth according to advertising techniques.

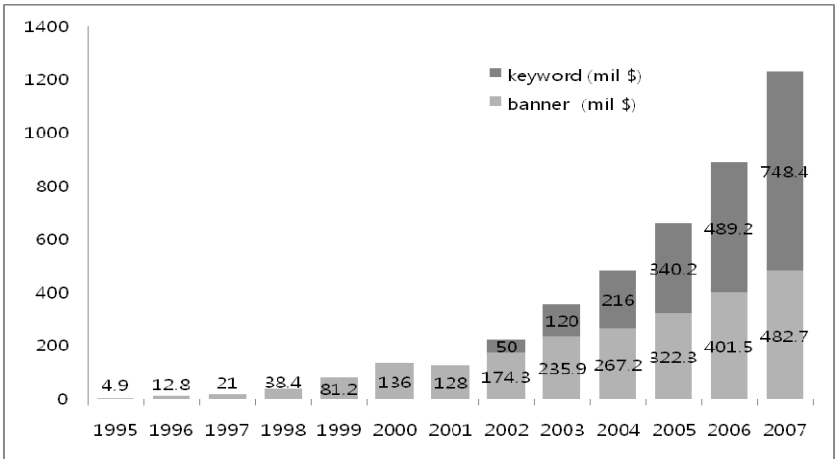

Fig. 1. Revenue from banner and keyword advertising in Korea

Source: Internet Marketing Council of Korea (IMCK), 2007. 12.

The user market of portals can be identified on the basis of user visit records. Fig. 2 presents the change in the relative share of six portals in Korea from 2003 to 2005 in terms of visits. Although this refers to a different period from that of our study, it is a good illustration of the dynamics of those portals. After mid-2004, it is evident that two portals—Naver.com and Nate.com—have grown faster, and one portal—Daum.net—which was the largest, has begun to decrease. Naver.com grew after launching an interactive encyclopedia service, and Nate.com increased on the account of its "Cyworld" service, which is a mini-homepage. At the end of 2004, Paran.com entered this market.

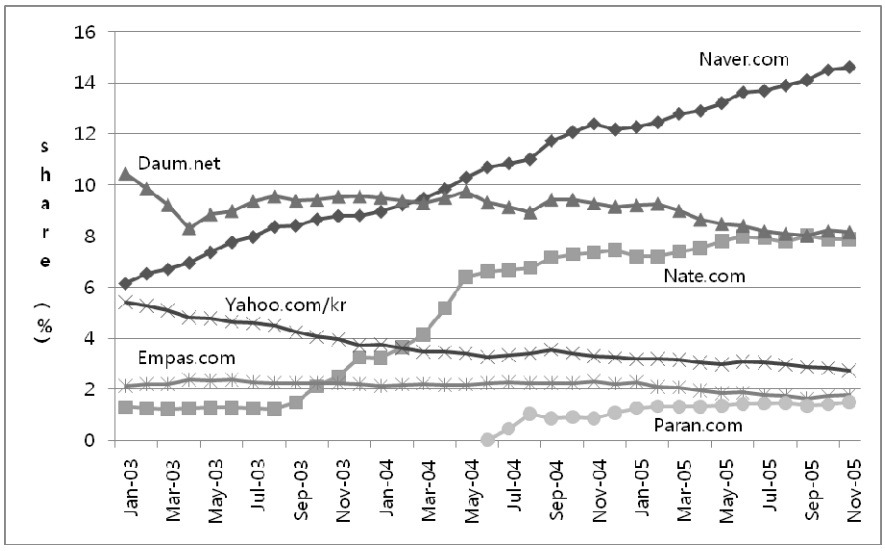

Fig. 2. User share of the top six portals in Korea.

Source: Reconstructed data from Rankey.com

Daum.net first offered a free e-mail service in Korea in 1997 and became popular by

providing community and e-commerce services. Initially, Naver.com's share was smaller than that of Daum.net; however, after merging with a game service company and launching an interactive encyclopedia service, it grew faster and assumed the top position in 2004. Initially, Yahoo was ranked first due to its worldwide popularity; however, it declined with the growth of competitors in the Korean market. Currently, Naver.com is not only sustaining its top position but also increasing its share in terms of advertising revenue and user visits, which provides it with stronger market concentration.

3. The model

The central agents in our model are portals, users, and advertisers[2]. Fig. 3 presents the interactions among these agents in a portal market. A portal serves as a platform between two markets, user and advertising, by controlling banner price and providing content and services. Advertisers are affected by changes in banner prices, and users value content and services. There exists a direct network effect (network externalities) in the user market since it is expected that users prefer larger portals that can accommodate more users (installed base). The demand of both markets, indicated as number of banners and user visits, also affect each other (dotted lines in Fig. 3), and these are termed indirect network effects. Portals create revenue through two advertising methods, banner and keyword[3]. Keyword revenue increases with user visits and competition of advertisers. In order to maximize these profits in an equilibrium state, a portal controls banner price and content. In our model, these structures will be explained in this section with the specification of each function, user demand, banner advertising demand, keyword advertising revenue, and banner price equations. The empirical framework in this paper is based on the models for oligopolistic competition and discrete choices of consumers with product differentiation. Berry (1994), Berry et al. (1995), and Nevo (2001) provided related methodologies and estimation techniques.

[2] Content providers are assumed to be subordinate to portals, and we did not consider them in our analysis.
[3] We assumed that there are two types of advertisers in two different groups—banner and keyword.

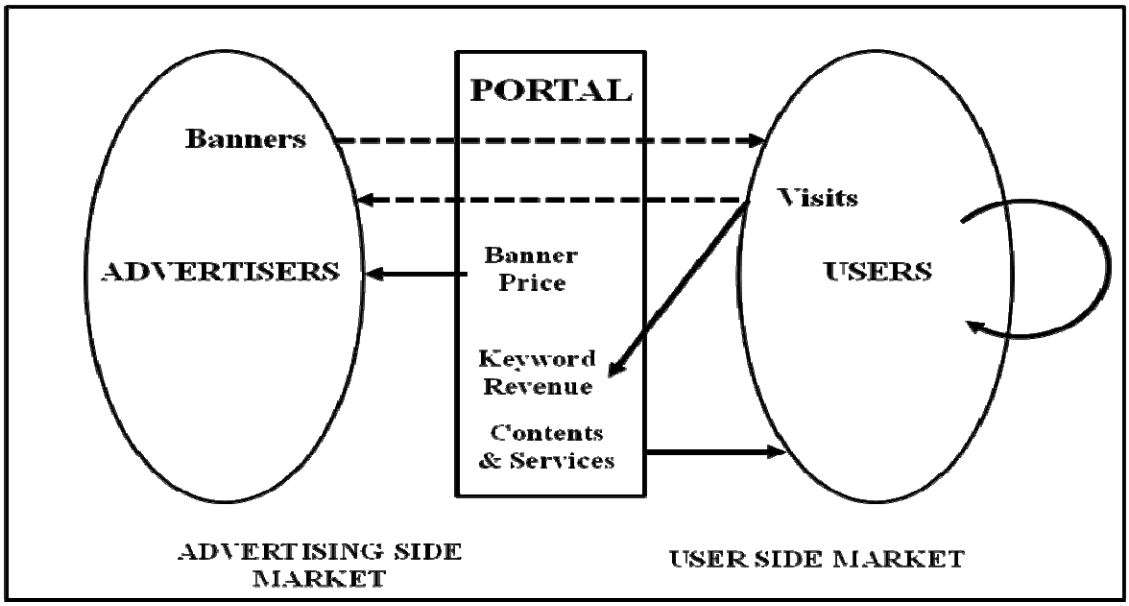

Fig. 3. The portal market structure in our model.

3.1. Demand functions in user and advertising markets

A discrete choice model based on consumer preference is used in order to estimate the aggregate demand function in a differentiated products market (Berry et al., 1995; Nevo, 2001; Ohashi, 2003)[4]. In order to apply the network effect factor in our model, we refer to literature on the subject of network economics. Fudenberg and Tirole (2000) developed a model of consumer preference in markets with the network effect. In their model, the term network effect is included linearly as the importance of the network effect multiplied with network size. A majority of the empirical research measures the network effect in this manner. A couple of examples are Ohashi (2003) and Iimi (2005). In addition, the product differentiation term comprises exogenous characteristics and certain endogenous factors such as prices and content provisions. We specify the *i*th user's utility when using the *j*th portal as follows:

$$u_{ijt}^{u} = x_{jt}^{u}\beta^{u} + \alpha^{u}N_{jt}^{b} + \phi^{u}N_{jt}^{c} + \eta^{u}V_{jt}^{u} + \xi_{jt}^{u} + \varepsilon_{ijt}^{u}, \qquad (1)$$

where x_{jt}^{u} are the observable characteristics of the *j*th portal in market *t* including constant and content provisions, N_{jt}^{b} is the number of banner advertisements, N_{jt}^{c} is the amount of content provision, and V_{jt}^{u} is the number of users in the same portal. ξ_{jt}^{u} is the unobserved characteristic of the *j*th portal. ε_{ijt}^{u} is the heterogeneity (error term) in the utility of users and is assumed to be independent and identically distributed in extreme value distribution, which implies that our demand can be derived as a form

[4] The assumptions of this model are as follows: consumer preference comprises exogenous product characteristics, consumers can select goods from outside the market, and one consumer purchases only a single product. In user demand, a single-purchase assumption is plausible when we assume that a user accesses no more than one portal at any given time. Since transaction time in a portal is shorter than other websites such as online shopping sites and user visits were counted hourly, not daily, a single-homing assumption can be confirmed. In case of advertising demand, we assumed single banner advertisement as a decision unit. This enables the single-homing assumption in the advertising market.

of logit model. N_{jt}^{b} reflects the indirect effect of the advertising market on user demand, and V_{jt}^{u} indicates the direct network effect on demand. The mean utility (δ_{jt}^{u}) of this logit model can be derived when averaging the user-specific error term, and the following demand function can be constructed (Berry, 1994):

$$\ln s_{jt}^{u} - \ln s_{0t}^{u} = x_{jt}^{u}\beta^{u} + \alpha^{u} N_{jt}^{b} + \phi^{u} N_{jt}^{c} + \eta^{u} V_{jt}^{u} + \xi_{jt}^{u}, \quad (2)$$

where s_{jt}^{u} is the share of user demand of the *j*th portal and s_{0t}^{u} is the share of outside goods in market *t*. Like the user's utility, the utility (profit) of the kth advertising decision is modeled in the following manner:

$$u_{kjt}^{a} = x_{jt}^{a}\beta^{a} + \alpha^{a} p_{jt}^{b} + \gamma^{a} N_{jt}^{u} + \xi_{jt}^{u} + \varepsilon_{kjt}^{u}, \qquad (3)$$

where x_{jt}^{a} represents the exogenous observed characteristics of an advertisement in portal j, p_{jt}^{b} is the advertising banner price, and N_{jt}^{u} is the amount of user demand for the *j*th portal in market *t*. ξ_{jt}^{u} is the unobserved characteristic of advertising demand for the portal. ε_{kjt}^{u} is the error term in utility of advertising with i.i.d. extreme value distribution. The advertising demand function can be derived in the same manner as user demand:

$$\ln s_{jt}^{a} - \ln s_{0t}^{a} = x_{jt}^{a}\beta^{a} + \alpha^{a} p_{jt}^{b} + \gamma^{a} N_{jt}^{u} + \xi_{jt}^{a}, \qquad (4)$$

where s_{jt}^{a} is the share of advertising demand of the *j*th portal and s_{0t}^{a} is the share of outside goods in market *t*.

3.2. Keyword advertising revenue

Keyword advertising contributes a significant amount to a portal's revenue in the study period. Although there are several methods for deciding keyword advertising position and price, a majority of them are based on auction[5]. Accordingly, we believe that portal firms take prices given by the auctions, but we assume that the attributes of portals and number of advertisers are related to the price. In this case, the attributes of portals can be sources of product differentiation and market power. For example, if one portal has more user visits than another, keyword advertisers would expect that the portal could provide greater advertising efficiency. When it comes to keyword advertisers, the greater the number of competing advertisers, the higher the price and revenue will be for a keyword, according to the rule of auction.

Since the price and quantity of keyword advertising are difficult to define and measure, we have constructed a keyword revenue equation using Cobb-Douglas specifications that include the number of visitors and advertisers as well as the characteristics of the portals. Applying logarithms, a linear equation is derived for the estimation:

$$\ln R_{jt}^{k} = x_{jt}^{k}\gamma_{jt}^{k} + \alpha^{k} \ln N_{t}^{k} + \beta^{k} \ln N_{jt}^{u} + \xi_{jt}^{k}. \qquad (5)$$

[5] There are discussions regarding issues with keyword auctions. See Varian (2007).

where R_{jt}^k is the keyword advertising revenue of portal *j* in market *t*, x_{jt}^k is each portal's characteristics, N_{jt}^u is the number of visitors, and N_t^k is the number of competitors (potential advertisers). ξ_{jt}^k represents unobserved factors in generating revenue and is assumed to be normal distribution. The above equation indicates the portion of revenue that is generated by indirect network effects from the user market. That is, the number of users can promote the portal's total revenue through keyword advertising and can also affect the portal's market power in banner advertising.

3.3. Costs and profit maximization

A portal's cost, C_{jt}, is assumed to be a function of banners and contents. We have also assumed that the marginal cost of keyword advertising would be almost zero after an automatic auction system has been installed on the website. With the cost function, the profit of a portal can be developed by subtracting costs from banner and keyword advertising revenue. Thus, each portal *j*'s profit in market *t* can be expressed as follows:

$$\pi_{jt} = R_{jt}^b + R_{jt}^k - C_{jt} = p_{jt}^b N_{jt}^b + (N_t^k)^{\alpha^k} (N_{jt}^u)^{\beta^k} e^{x_{jt}^k \gamma_{jt}^k} - C_{jt}. \qquad (6)$$

The objective of a portal is to maximize Eq. (6), and, in order to do this, a portal controls banner prices in the advertising market and the amount of content provision in the user market. Adjustment of the banner prices enables a portal to control the number of banner advertisements and this affects user demand. In addition, content provision affects user demand, and again this affects the demand for banner advertising. In order to arrive at a state of equilibrium, derivatives of variables with a network effect, such as the amount of banners and user visits, are required. We have assumed that $N_{jt}^u = N_{jt}^u(x_{jt}^u, N_{jt}^b, N_{jt}^c, V_{jt}^u, \xi_{jt}^u; \theta^u)$, where $\theta^u = [\beta^u \; \alpha^u \; \phi^u \; \eta^u]$, and $N_{jt}^b = N_{jt}^b(x_{jt}^a, p_{jt}^b, N_{jt}^u, \xi_{jt}^a; \theta^a)$, where $\theta^a = [\beta^a \; \alpha^a \; \gamma^a]$. This implies that the number of user visits and amount of banners are affected by each other and also by the portal's observable and unobservable characteristics, given each demand parameter. If we calculate the total derivatives of N_{jt}^u and N_{jt}^b, we must consider the indirect network effect between the two variables since it includes the counterpart variable in the specification of each variable, that is, N_{jt}^u includes N_{jt}^b and vice versa.

We have also assumed that the marginal cost of a banner, mc_{jt}^b, is a linear combination of the observed and unobserved characteristics of a portal.

$$mc_{jt}^b = \partial C_{jt} \big/ \partial N_{jt}^c = x_{jt}^c \beta^c + \xi_{jt}^c, \qquad (7)$$

where x_{jt}^c and ξ_{jt}^c are the observed and unobserved characteristics affecting the marginal cost of banner advertisements, respectively, which implies that the marginal cost comprises exogenous characteristics in a linear form similar to the method of modeling and estimating a cost function in Berry et al. (1995)

The first order condition for profit maximization on price can be derived using the total derivative of N_{jt}^b by p_{jt}^b:

$$p_{jt}^{b} = x_{jt}^{c}\beta^{c} - \frac{1}{\alpha^{a}(1-s_{jt}^{a})} + \frac{\gamma^{a}N_{jt}^{u}}{\alpha^{a}}\alpha^{u}N_{jt}^{b}(1-s_{jt}^{u}) - \alpha^{u}\beta^{k}(1-s_{jt}^{u})R_{jt}^{k} + \xi_{jt}^{c}. \qquad (8)$$

In Eq. (8), the second term in the RHS implies the differentiation effect of the portal, and the third and fourth terms represent the network effect that is generated indirectly from user demand. The third term indicates the manner in which a change in user demand according to an increase in advertisements, $\alpha^{u}N_{jt}^{b}(1-s_{jt}^{u})$, affects advertising market power. If α^{u} is positive, user demand would increase along with an increase in advertisements, and in order to increase advertising, portals would lower the banner advertising prices. If α^{u} is negative, portals would increase their banner prices in order to increase user demand. This is consistent with discussions by Barros et al. (2002) and Reisinger (2004). The fourth term is derived by taking into consideration changes in keyword advertising revenue caused by the indirect network effect. If α^{u} is positive (negative), portals would lower (rise) banner prices in order to increase user demand, which can increase keyword revenue. Therefore, it can be explained that portals adjust their banner prices in accordance with indirect network effects.

Content provision is one of the important decision variables for portals. However, since we neither have pre-existing information regarding the functional shape of content cost, we can only estimate the marginal cost indirectly, given optimal advertising price and other estimated parameters. In a comparable study by Kaiser and Wright (2006), the marginal cost of content in a magazine is assumed as quadratic of content pages since it grows according to content size. However, it is difficult to justify this logic being similarly applicable to our study. Our measure of content is a number of sections, and it is more likely to be heterogeneous between sections, which makes it difficult to define a certain functional form. Deriving a first order condition with regard to content and applying the total derivative of N_{jt}^{u} by N_{jt}^{c}, the following equation is derived:

$$\frac{\partial C_{jt}}{\partial N_{jt}^{c}} = \left(p_{jt}^{b}\cdot\gamma^{a}N_{jt}^{b}(1-s_{jt}^{a}) + \frac{\beta^{k}R_{jt}^{k}}{N_{jt}^{u}} \right) \cdot \frac{\phi^{u}(1-s_{jt}^{u})}{1-\alpha^{u}\gamma^{a}N_{jt}^{u}(1-s_{jt}^{u})N_{jt}^{b}(1-s_{jt}^{a})} N_{jt}^{u}. \qquad (9)$$

We can interpret from Eq. (9) that the marginal cost of content has a positive correlation with increments of banner revenue— $p_{jt}^{b}\cdot\gamma^{a}N_{jt}^{b}(1-s_{jt}^{a})$ —and keyword— $\frac{\beta^{k}R_{jt}^{k}}{N_{jt}^{u}}$ —according to user augmentation, which corresponds to the elasticity of user demand for the content amount. This implies that in the equilibrium state of our model, content cost that increases with user demand can grow until it meets revenue creation.

4. Data and estimation

4.1. Data source and description

We constructed monthly data from the six largest portals in Korea from June 2004 to February 2007. Data sets comprise three portions—the portal's website traffic, banner advertising, and characteristics during the research period. Traffic data indicates the number of users who visited and used a website. This information is collected through

an Internet-traffic surveying company called Rankey.com (http://rankey.com). Daily visitors (also called unique visitors: UV), hourly visitors (session visitors: SV), and page views (PV) are reported for the period as part of this information. UV data does not include multiple hits by a single user in a day, while the PV value increases according to the number of clicks in a single visit. SV data is in the middle of the attributes of UV and PV, and we utilized SV data for computing the share of user demand for each portal.

Banner advertising data is received from an Internet advertisements surveying company called ResearchAd (http://www.researchad.com). There are a number of banner advertisements, brands, sales campaigns, and advertisers in the data set, and banner prices and revenues are also included. Each advertisement is assumed to be a decision unit; thus, the demand share of advertising is computed on the basis of the number of banners. It is difficult to decide the price of a banner because the shape and position of banners is too diversified to organize and the price of a banner is also affected by its shape and position. In order to deal with this difficulty, we determine the price of the middle-upper banner on each portal's first page as a representative price since this position is common for most portals and is considered to be the most effective and important. In order to represent a user's average intensity, an index of SV over UV, which is usually used to indicate the characteristic of a website, was created. Keyword advertising revenue is collected by official accounting information from the Korean stock market. This accounting information is announced four times a year; thus, we expand quarterly data into monthly data, thereby accommodating its fast increasing rate.

The information on the characteristics of portals is collected by investigating each website and referring to the historic record of each, which includes the age of the portal and dummy variables for origin and differentiated services. Independent dummy (*Indep*) represents the fact that a portal originated from an independent venture firm, not from a large company. Since the number of users is the most important source of profits for a portal, various differentiated services have been devised for attracting users. In this study, six dummy variables were used to represent these services. Large e-mail service (*Lmail*) provides e-mail services with over 1GB of storage and three portals in Korea offered this service in the research period. Game service dummy (*Game*) implies that a portal provides an exclusive link to a game, or that a portal directly produces games. In both cases, it is usual to believe that a good game service would be effective for user demand. Mini-homepage (*Mhpg*) is a personalized homepage service in Korea. Two portals provide this service, and one of them—"Cyworld" from Nate.com—is a successful service that has enabled the company to become the second-ranked portal in Korea. Other dummy variables are e-commerce (*Ecom*), community (*Comm*), and messenger (*Msg*). In addition, the time a webpage takes to load and the reach rate is provided by Rankey.com, and the number of content sections is provided by ResearchAd. The total number of Internet users and potential keyword advertisers is provided by the National Statistics Office (NSO)[6]. The total number of Internet users is assumed to be a potential of UV, and the number of cyber-shops are assumed to be a potential of keyword advertisers, which is differently grouped from banner advertisers. Prior to using the data, banner price, banner revenue, and keyword revenue are deflated with the producer's price index. The descriptive statistics are presented in Table 1.

[6] http://www.nso.go.kr

Table 1. Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
UV	198	5361855	3343464	11330	1.20E+07
SV	198	1.68E+07	1.37E+07	15982	5.31E+07
PV	198	2.21E+08	2.50E+08	85358	9.45E+08
Banners	198	622.6162	390.2692	65	1949
Banner advertisers	198	120.3081	67.83955	23	304
Banner price*	198	1552049	742169.1	154291.7	2705900
Age	198	5.69697	2.455511	0	10
Loading time	198	1.916465	0.6831181	0.88	3.5
Reach rate	198	0.4582475	0.2531414	0.0008	0.9363
Content (sections)	198	18.39899	6.667399	8	36
Intensity (SV/UV)	198	2.73864	0.6758728	1.410591	4.429655
Total number of Internet users	198	1.26E+07	837173.6	1.16E+07	1.42E+07
Potential keyword advertisers	198	4055.606	435.9403	3437	4531
Keyword revenue*	198	3244400	2884048	126458.4	1.51E+07
Indep	198	0.5	0.5012674	0	1
Lmail	198	0.3434343	0.4760586	0	1
Ecom	198	0.5	0.5012674	0	1
Game	198	0.3333333	0.4725995	0	1
Comm	198	0.8333333	0.3736227	0	1
Mhpg	198	0.3232323	0.4688962	0	1
Msg	198	0.5808081	0.4946776	0	1

* Monetary variables are deflated to real values.

4.2. Estimation

Our objective has been to simultaneously estimate four equations, Eqs. (2), (4), (6), (8), which model the demand and supply of the portal market. We apply a generalized method of moments (GMM), following Hansen (1982), for the following reasons. First, the estimation of a simultaneous equation is required because there may be correlations between both demands ($\xi_{jt}^{u}, \xi_{jt}^{a}$) and between demands and cost (ξ_{jt}^{c}). Second, in the equations for estimation, the number of banners (N_{jt}^{b}), content (N_{jt}^{c}), visitors (N_{jt}^{u}, V_{jt}^{u}), and price (p_{jt}^{b}) are all endogenous variables. Since the unobserved characteristics of portals can affect the choice of banners, content, visitors, and banner price, these variables are likely to be correlated with unobserved characteristics. Third, Eq. (8) has a non-linear combination form with parameters such as α^{u}, α^{a}, γ^{a}, and β^{k}.

For the estimation, appropriate instruments are created and applied to the estimation process. The average characteristics of rival portals are introduced as instruments following Berry et al. (1995) and Nevo (2000). In addition, aggregate variables such as the total number of Internet users, lagged Internet users, potential keyword advertisers,

and other exogenous variables are applied as instruments in accordance with each equation. The determination of these variables is exogenous or at least determined prior to the revelation of user and advertiser valuation of unobserved characteristics. The GMM estimation process requires minimizing optimal distances, which involves finding parameters that satisfy the following conditions:

$$\min_{\beta} \mathbf{G}'\left[Var(\mathbf{G})\right]^{-1}\mathbf{G}, \qquad (10)$$

where $\mathbf{G} = \mathbf{Z}'\hat{\xi}$, and the matrix of exogenous variables (including instruments) is $\mathbf{Z}$.

5. Results and discussion

5.1. Basic results

Parameter estimates for Eqs. (2), (4), (6), and (8) are presented in Tables 2 and 3. The parameters of key variables in our model such as banners, visits, prices, and content are estimated with statistical significance. In the user demand equation, the result that the amount of banners has a negative relationship with user demand demonstrates the fact that users feel a certain discomfort with banners. In addition, this implies a negative indirect network effect from the advertising market to users. This result is consistent with models of mass media such as television and radio (Barros et al., 2002; Reisinger, 2004) and is in contrast with yellow pages (Rysman, 2004) and magazines (Kaiser, 2006). One of the important results is that an increase in UV raises the choice probability of a portal. This trend, known as "path dependence," is an evidence of a direct network effect in the user market. Akin to other network industries, a portal's market size can be boosted in proportion to its current users or installed base (Kats and Shapiro, 1985; Fudenberg and Tirole, 2000; Ohashi, 2003; Iimi, 2005). Moreover, in user demand, content provision—as an important factor for attracting users—reveals a positive effect on the utility of users, as we expected in the model.

In the advertising demand equation, the advertiser gains a positive effect from SV because this can be a potential for profit (Rysman, 2004; Kaiser, 2006). This is an indirect effect that is generated on the user side but affects the advertising side. The existence of indirect effects on both sides demonstrates the two-sided market property of Internet portals. In other words, the number of banners has an effect on user demand, which in turn affects demand for banner advertising, etc., as long as the network effect is non-explosive.

Non-explosiveness is an important condition for deriving the equilibrium state of a two-sided market (Kaiser, 2006). The determinant of explosiveness can be computed as $1-\gamma^{a}N_{jt}^{b}(1-s_{jt}^{a})\cdot\alpha^{u}N_{jt}^{u}(1-s_{jt}^{u}) > 0$, which is shown in the course of total differentiation when the first order condition is calculated. Since network effects from the user ($\partial N_{jt}^{b}/\partial N_{jt}^{u}$) and advertising markets ($\partial N_{jt}^{u}/\partial N_{jt}^{b}$) have opposite directions, which can be confirmed with a negative value of α^{u} and a positive value of γ^{a}, the condition must always be positive. This implies that there is no possibility of explosiveness of an indirect network effect, unlike that in yellow pages (Rysman, 2004)

and magazines (Kaiser, 2006)[7]. Therefore, it may be stated that the negative effect of banners on users enables the entire portal market to avoid the explosion.

Table 2. Estimated result of user and advertising demand

	User demand				Advertising demand (banner)			
Variable	Coef.		Std. Err.	P-value	Coef.		Std. Err.	P-value
Constant	10.062	***	3.543	0.005	–27.556	***	4.812	0.000
Age	–0.180		0.436	0.680	–3.078	***	0.649	0.000
Age^2	0.019		0.041	0.642	0.227	***	0.047	0.000
Loading time	0.031		0.281	0.912	–0.719		0.511	0.160
Intensity	–3.871	**	1.756	0.028	12.832	***	1.230	0.000
Indep	12.369	***	2.733	0.000	–35.311	***	4.923	0.000
Lmail	2.429	**	1.147	0.034	–5.404	***	1.055	0.000
Ecom	–9.250	***	2.405	0.000	34.437	***	5.023	0.000
Game	4.324	***	1.039	0.000	–7.726		4.764	0.105
Comm	–16.612	***	3.425	0.000	53.358	***	10.148	0.000
Mhpg	2.948	***	0.839	0.000	–1.814		5.379	0.736
Msg	–0.888		0.795	0.264	6.898	***	1.586	0.000
Banners	–0.003	***	0.001	0.000				
Content	0.260	**	0.110	0.018				
UV	1.556E-06	***	5.743E-07	0.007				
SV					1.498E-08	**	6.871E-09	0.029
Banner price					–0.027	***	0.001	0.000

Keyword advertising requires advertisers to participate in auctions in order to receive a good advertising position. In addition, portals with more visitors can offer higher prices than others (this process actually takes place automatically by calculating the number of user requests for the information). Therefore, an increasing number of advertisers and users can generate higher revenue and profits from keyword advertising on a portal. The result in Table 3 supports this expectation by indicating the positive effects of the potential of keyword advertisers and UV.

Table 3

[7] If the determinant is negative, which implies that $\partial N_{jt}^{u} / \partial N_{jt}^{b}$ and $\partial N_{jt}^{b} / \partial N_{jt}^{u}$ have the same sign and that the product of two is greater than 1, the network effect would become increasingly larger through each market and a state of equilibrium could not be achieved.

Estimation result of keyword revenue and banner cost

	Keyword revenue				Banner cost			
Variables	Coef.		Std. Err.	P-value	Coef.		Std. Err.	P-value
Constant	–24.157	***	7.040	0.001	–1158.985	***	252.077	0.000
Intensity	–0.599	**	0.295	0.042	308.127	***	48.207	0.000
Indep	–0.422		0.390	0.279	–1680.513	***	254.118	0.000
Lmail	–0.893	***	0.181	0.000	–250.847	***	45.539	0.000
Ecom	0.288		0.342	0.399	1471.718	***	251.478	0.000
Game	0.223		0.229	0.329	–433.538	*	261.624	0.097
Comm	–0.411		0.490	0.402	2490.380	***	523.641	0.000
Mhpg	0.082		0.161	0.608	–278.123		282.807	0.325
Msg	0.359	**	0.157	0.022	268.360	***	67.478	0.000
Loading time					–22.091		20.609	0.284
Banner advertisers	0.002		0.002	0.280				
Internet users (–1)	2.387E-07	***	6.813E-08	0.000				
Ln (keyword advertisers' potential)	1.935	***	0.486	0.000				
Ln (UV)	0.972	***	0.357	0.006				

Indep, which indicates whether a portal originates from an independent venture or from a large cooperation, is positive for users but negative for the banner advertising market. A majority of the portals born in nascent periods in the 1990s began as ventures, and large companies go after them as late starters. Thus, independent portals appear to have a few advantages as first movers in a user market. The negative effect of *Indep* on advertising demand can be explained as portals based on large firms utilized their resources for attracting advertisers such as providing advertisements for their own companies or price discounts.

In terms of user demand, *Lmail*, *Game*, and *Mhpg* are positively related; however, *Ecom* and *Comm* services are negatively related. As mentioned earlier, *Mhpg* is a personalized homepage service that continues to be rather popular in Korea, and it has contributed to the rapid growth of the company after the introduction of the service. *Lmail* and *Game* are useful for attracting Korean users; however, *Ecom* and *Comm* services are not. In the case of advertising demand, contrary to the user demand case, *Ecom*, *Comm*, and *Msg* services are positively related; however, the others are negative or insignificant. The positive effect of *Ecom* for advertisers appears straightforward because *Ecom* services can improve the utility of advertisers by relating advertisements to shopping. In addition, the results indicate that portals with *Ecom*, *Comm*, and *Msg* are more attractive, in the eyes of advertisers, than others. This is plausible when we consider that services with connecting people can assist more effective advertising than personalized services like *Lmail*, *Game*, and *Mhpg*. In the case of keyword revenue, only *Lmail* has significant correlation. The result of the banner cost function reveals that *Ecom*, *Comm*, and *Msg* services are positively related to marginal cost.

In order to attract more advertisers, firms must first increase UV and focus on personalized services such as *Lmail*, *Game*, and *Mhpg*. However, firms can also obtain

additional profits from increased advertisers led by high quality provision of the services that strengthen the connections between the visitors and advertisements such as *Ecom*, *Comm*, and *Msg*. In addition, it is noteworthy that three services that raise the marginal cost of banners can be classified as people-connecting services. In brief, personalized services can be effective in increasing user demand; however, people-connecting services are effective in increasing advertising demand that requires an increase in the marginal cost of a banner.

User intensity represents the number of additional clicks that are generated during one visit per hour. This variable indicates a negative relationship with user demand but a positive one with advertising demand. This is because users indicate their preference by visiting (choosing) a site more often; however, requiring too many clicks in a visit can also cause negative sentiments. However, if the number of clicks by a user increases, advertising demand would increase accordingly. In case of keyword revenue, intensity has a negative effect because a user who wants to find information related to keyword advertising does not require a large number of clicks. In other words, the number of clicks made in a visit has an inverse relationship with keyword advertising efficiency. Intensity has a positive relationship with cost because more intensive visits generate more Internet traffic, which increases a portal's cost.

We can estimate marginal cost of banner advertising from parameter estimates. The mean estimate is approximately \$1,448.75 with standard deviation of \$689.04. In order to compute the value of the marginal cost of content provision, we used Eq. (9). The marginal cost for content is \$75,534.36 per section with a standard error of \$64,416.31. Since we measured section numbers as content amount, the content cost that was estimated would inevitably have a large value with a wide variance range.

5.2. Network effects and Profits

The price-cost margin (PCM) in the advertising market can be calculated from Eq. (8). According to the equation, PCM mainly comprises two factors: the degree of differentiation (negative inverse of price elasticity) and network effects. These two terms represent the market power of a portal in banner advertising. If μ_{jt}^{b} is the PCM of portal *j* in market *t*, μ_{jt}^{b} would be

$$\mu_{jt}^{b} = -\frac{1}{\alpha^{a} p_{jt}^{b}(1-s_{jt}^{a})} + \frac{\gamma^{a} N_{jt}^{u}}{p_{jt}^{b}\alpha^{a}} \alpha^{u} N_{jt}^{b}(1-s_{jt}^{u}) - \frac{\alpha^{u}}{p_{jt}^{b}} \beta^{k}(1-s_{jt}^{u}) R_{jt}^{k}. \qquad (11)$$

In Eq. (11), the first term in the RHS is the negative inverse of price elasticity. The second and third terms represent the network effect that is part of the margin. Since α^{u} and α^{a} are negative, two network terms must have a positive value. The second term can be assumed to be $\frac{1}{\alpha^{a}}\gamma^{a} N_{jt}^{u}$ multiplied by banner elasticity of user demand, $\alpha^{u} N_{jt}^{b}(1-s_{jt}^{u})$. This indicates the monetary value of user increment when banners decrease with an increase in price. The third term can also be interpreted in a similar manner. The decrease in the high price of banners attracts more users, and thus, higher keyword revenue. These two terms indicate that the existence of two factors, indirect

network effect and keyword advertising, causes banner price to become higher and reduces banner supply in equilibrium.

The values of each term divided into PCM and profits are presented in Table 4. The mean values can be calculated as 4.78% for differentiation and 4.33% for the network effect; thus, the total PCM is 9.12%. The two portions—PCM and profits—do not appear very different in terms of their average margin. When we consider the profit contributions by multiplying the advertising amount of each portal, the appearance changes. The average monthly profit is $0.25 million, and $0.08 million is generated by differentiation. However, $0.16 million is generated by the network effect, which is approximately double the differentiation portion. As seen in Table 4, three portals in the upper rank have created more profits with network effect; however, the lower three have not, thereby indicating the importance of network effects. In addition, an increase in the number of users—as a result of reduced supply of banners caused by increased banner price—contributes to growing keyword revenue (parameter estimates indicates $\frac{d \ln R^k}{d \ln N^u} = \beta^k = 0.972$); thus, the monthly average of keyword revenue is approximately $3.24 million. These results pertaining to banner and keyword advertising demonstrate the crucial role of network effects in generating profits for portals.

Table 4

Division of PCM and banner profits

	Naver.com	Nate.com	Daum.net	Yahoo.com/kr	Empas.com	Paran.com	Average
Total PCM	9.22%	4.10%	6.83%	6.62%	24.50%	3.43%	9.12%
Differentiation	2.00%	1.72%	2.02%	3.83%	16.15%	2.98%	4.78%
Network effect	7.22%	2.37%	4.81%	2.79%	8.36%	0.45%	4.33%
Banner profit	607,625	135,186	384,419	152,165	186,691	29,664	249,292
Differentiation	118,039	52,078	108,295	85,116	121,204	25,374	85,018
Network effect	489,586	83,108	276,124	67,049	65,487	4,290	164,274

Therefore, what strategy can be suggested for portals to create more profit? Since there is severe competition among portals, no one would set a price on contents and services that are currently free. Thus, as a result of the above, the goal of every strategy converges into the question of how to increase the number of users since it will generate network effects and profits. This is the “divide and conquer” strategy usually revealed in a two-sided market (Caillaud and Jullien, 2003); however, it becomes extreme since no price is charged in the user market. This corresponds to the common wisdom amongst a majority of the stakeholders in this industry that the best practice was to attract users unconditionally in the initial period. Even though content provision entails huge costs, as seen in the previous section, portals can attract users at the initial stage using this strategy. Then, portals with sufficient users can attract advertisers and earn profits, which becomes possible because of the indirect network effect. In addition, since the direct network effect in the user network enables attracting more users at this

stage, portals must adequately control banner price and content provision in order to maximize their profits. In this process, adjusting banner price and amount of content is a short-term strategy for portals. They must create a long-term plan in order to differentiate from others, as observed in portal characteristics such as *Lmail, Game, Mhpg*, etc., for growing and surviving in the market.

5.3. Network effects and Market Efficiency

Generally, market concentration produces deadweight loss and inefficiency. However, when network effects function, even the concentration of the market in one or two firms can increase a consumer's surplus. The reason for this is that increased market efficiency from network effects can offset the loss of a user's surplus from monopolization (Caillaud and Jullien, 2003). Increased market efficiency can be estimated as the total amount of network effects generated outside the market (Caillaud and Jullien, 2003; Rysman, 2004).

In the portal market, monopolization could make both the network effects, direct and indirect, stronger. However, since the indirect effect in the user market was proved to be negative on users, the sizes of both the network effects must be compared to each other. If the negative indirect network effect prevails over the direct network effect, the result will be different from the argument of Caillaud and Jullien (2003). In the advertising market, although increasing users can have a beneficial effect, the portal can extract a surplus of advertisers by controlling banner prices when monopolized. Thus, the size of banner advertising in the user market and banner prices in the advertising market must be taken into consideration when computing the welfare of both markets. Next, we compute welfare in both sides of the market and provide a graphical representation. For illustration purposes, the Herfindahl-Hirschman Index (HHI)[8] that denotes the amount of competition in the market—a higher value of the HHI generally indicates a lower level of competition (monopolization) and higher market power—will be presented in order to compare network effects.

The consumer's surplus can be derived from our utility specification of both markets. According to Trajtenberg (1989), welfare in a discrete choice model can be computed as $\ln \sum e^{\delta_{it}^u} / \alpha$, where α is the coefficient of price. Since there is no price in a user's utility equation, we cannot transfer the effect in the user market to a monetary term; however, the dynamics are evident with any given value of a price coefficient that is actually unknown. Thus, we assume a constant λ^u that plays the role of converting utility to monetary terms. Consumer's surplus can be obtained by multiplying the number of users with the converted utility value. Then, the following can be considered as user's surplus:

$$W_t^u = \lambda^u \ln \sum\nolimits_j N_{jt}^u \exp(\delta_{jt}^u) = \lambda^u \ln \sum\nolimits_j N_{jt}^u \exp\left(x_{jt}^u \beta^u + \alpha^u N_{jt}^b + \phi^u N_{jt}^c + \eta^u V_{jt}^u \right). \qquad (12)$$

The change in HHI and user's surplus can be seen in Fig. 4. As shown, user's surplus increases along with the value of HHI in the portal market during the study period.

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[8] The HHI value ranges between $1/N$ and 1. HHI is computed in the following manner: $H = \sum_{i=1}^{N} S_i^2$.

When we compute the indirect network effect term, $\alpha^u N_{jt}^b$, and the direct network effect term, $\eta^u V_{jt}^u$, the averages are –33.19 and 50.07, respectively. Thus, the direct network effect prevails and has a positive effect on market efficiency. This indicates that if the network effect is specified in the user's utility, as in our model, it must be considered that concentration can increase the surplus in the user market.

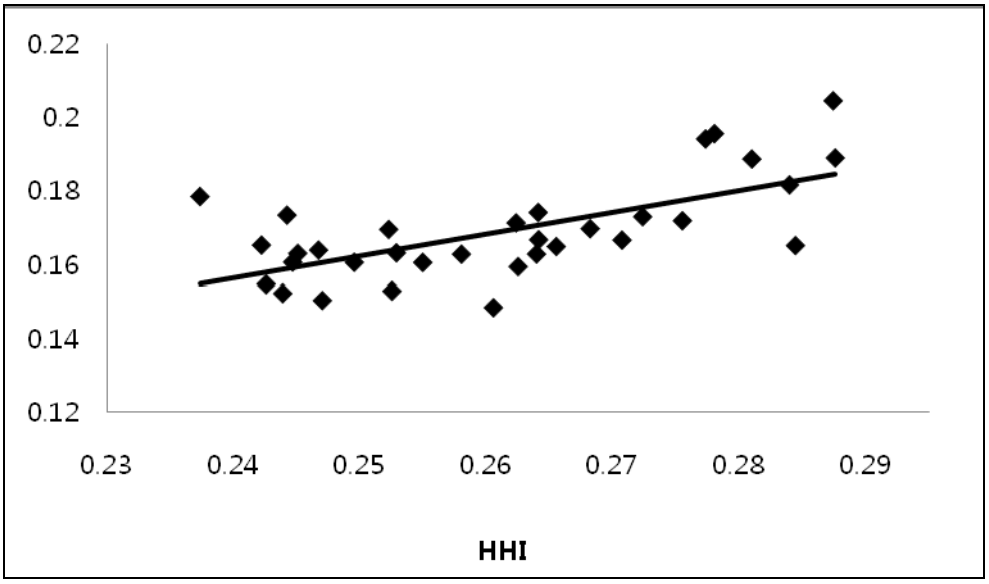

Fig. 4. HHI and User's surplus (λ^u = 0.01).

Advertising surplus also can be computed in a similar manner as $-1/\alpha^a \ln \sum_j N_{jt}^b \exp(\delta_{jt}^a)$, where δ_{jt}^a is the mean utility of the advertising market. The mean value of advertising welfare is \$481.30, which appears rather small. This is because advertising welfare does not equate with the product sales revenue of advertisers; rather, it is merely a monetary transformation of their utility specification. Real welfare could be computed together with the consideration of the sales revenue of each advertiser. However, the implication of surplus changing with portal market concentration still holds true. As we plot the result with HHI, which is presented in Fig. 5, advertising surplus can be seen as moving along with HHI. Thus, it may be stated that increasing market power does not decrease advertising surplus. From the viewpoint of the advertisers, this result is plausible since a larger portal can be more efficient in obtaining advertising effectiveness.

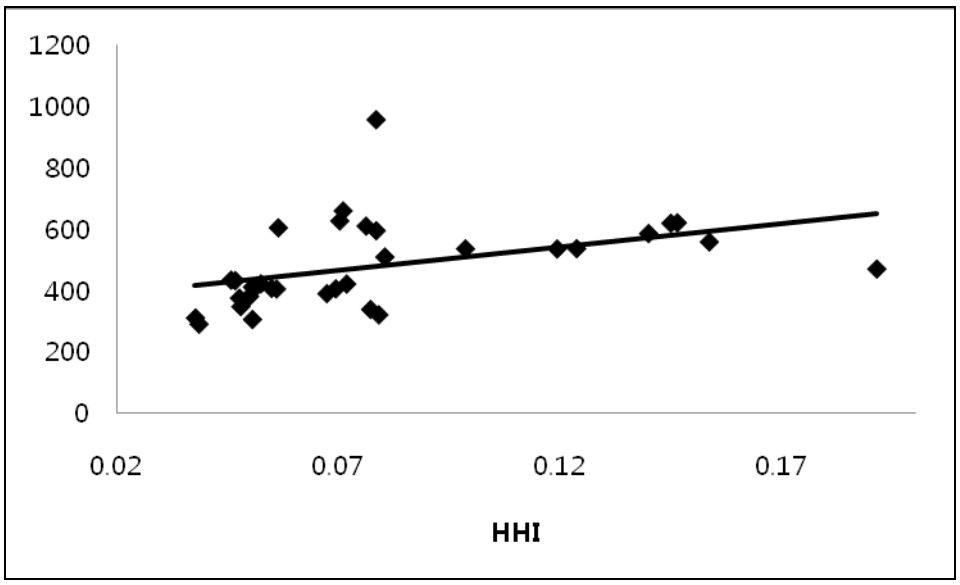

Fig. 5. HHI and advertising surplus

Figure 5 around here

In Korea, there are concerns regarding market concentration in the largest of portals. In the absence of the network effect, monopolization could be harmful to users, and the government must intervene in the market. However, with the existence of the network effect, users can enjoy more content provision, more interaction with others, etc. This result in our utility specification supports the assertion that greater concentration is beneficial to users. Regulators must consider these network effect factors when establishing policies related to this industry, even though there are numerous other problems related to the monopolization of a portal with regard to information control or information channel distortion.

6. Conclusion

We suggested and estimated a model using market data for observing the structure of the Internet portal market, with a focus on the impact of both direct and indirect network effects. The results revealed that although negative indirect network effects from advertising demand exist in user markets, positive direct network effects offset the negative ones. In addition, it was indicated that the positive indirect network effect on user demand exists in advertising markets. We have shown that the profits of a portal can be increased by exploiting these network effects as a method for attracting users by increasing banner prices and providing free content and services. This corresponds to a differentiated price structure on both sides, like the “divide and conquer” methods mentioned in prior studies on two-sided markets. In particular, the results indicate that even concentration in a user market can provide a larger surplus to users since they are able to enjoy more utility with networking services and content generation independently. Further, the methods and results in this study can be utilized as a source for related research when analyzing various markets with complex network effects.

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