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Network Effects and Incentive to Attract Competition

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In this paper, we study the incumbent's incentives to share its essential facility when there exist network effects. We show that without network effects, the incumbent will charge the access fee high enough to deter the entrant. With network effects, however, the incumbent always has an incentive to attract competition. We also show that if the potential entrant has to pay the entry costs, then the incumbent has an incentive to subsidize the entrant with a low access charge. When the network effects become large, the incumbent is willing to lower the access fee to the marginal cost.

Keywords: Network effects, Foreclosure, Essential facility, Access charge.
JEL Classifications: D4, L1, L5

I. Introduction

The purpose of this paper is to study the incentive of a network service provider to share its essential facilities with potential entrants when there are network effects. Examples of such essential facilities or bottlenecks are the local loop for telecommunications, the transmission grid for electricity, pipelines for gas, and computer operating systems for software programs. In in-

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troducing competition into the long distance telephone market, the policy-makers worried that without compulsory interconnection, the incumbent with the essential facility would not provide it to the rival firms. The incumbent has an incentive to foreclose its competitors in order to be a monopolist in downstream markets as well. For this purpose, it is often advised to regulate access fee so as to promote the entry.

In this paper, we show that without network effects, the incumbent indeed has an incentive to deter the entry by charging a high access fee. With network effects, however, it is shown that the incumbent always has an incentive to invite the entry. The reason is that competition effects are overshadowed by network effects. When downstream markets become more competitive, there occur effects on the incumbent's profits in two opposite directions. The standard competition effect reduces the incumbent's profits and it is the only effect without network effects. But with network effects, the willingness to pay by consumers increases as sales increase. Thus, more outputs can be sold at a higher price and access revenues increase. It is shown that the latter overshadows the former. When the entrant should pay the entry costs, the incumbent has an incentive to encourage the entry by charging a low access fee. In particular, as the network effects become larger, the incumbent is willing to lower the access fee to the marginal cost.

The reason why the incumbent alone does not increase outputs and thus enjoy all the benefits of network effects without competition effects is that the incumbent alone cannot make a credible commitment to provide larger outputs. Consumers would not believe the monopolist's promise because they understand that the monopolist has an incentive to reduce its outputs for any given level of expectations. As an effective commitment method, the incumbent invites its competitors to share its essential facilities and thus to increase total outputs.

Our results are closely related with other literature. Farrel and Gallini(1986) showed that the monopolist can increase its profits by surrendering its status as a monopolist.[1] Farrel and Gallini in fact showed that it is in the interests of the incument to invite entry with delay. But in our case, it is in their interests

1) Cf. Gallini(1984).

to invite competitiors as early as possible. Chen and Ross(2000) also discussed the monopoly incentive to share its facilities with its competitors. There are at least two differences. First, the incumbent in Chen and Ross(2000) does not have any option to deter the entry. And more importantly, the monopoly in Chen and Ross(2000) allows the entrant to use its facilities in order to reduce the total outputs less than Cournot duopoly outputs. In our case, the monopoly invites the entrant to increase outputs even with the option to deter the entry. In other words, the motivation behind the facility sharing is opposite. Economides(1996) shows that the monopolist has an incentive to attract competition due to network effects. The main difference between Economides and this paper is the market structure. We consider the vertical relation, but Economides considers the horizontal one. Thus essential facility does not play any role in Economides(1996). On the othe other hand, in our case, access revenues from sharing the essential facilities are one important factor weakening the competition effects. One distinguished feature of this paper is that the incumbent shares its facilities charging the price higher than the marginal cost. This sharply contrasts with most literature with monopoly incentives of inviting competition. In many cases, the monopoly allows the free use of technology (Farell and Gallini(1984), Economides(1996)), or facility (Chen and Ross(2000)).

Ⅱ. Network effects and incentives to invite entry

Although our analysis can be applied to network industries in general with slight adjustments, for concreteness, we consider the telecommunication industry. Suppose that an monopolist incumbent operates both in the local telephony market and the long distance service market. Marginal costs of providing local and long distance service are given by c_0 and c respectively. Now suppose that there is a potential entrant which wants to provide the long distance service only and that services produced by two companies are homogenous. Our analysis focuses on the competition in the long distance service only. In order to provide the service, the entrant should access to the

local loop. Upon the entrant's request of access to the local loop, the incumbent will charge the usage fee of a called the access fee. Let a be the access fee to be paid for connection by the entrant to the incumbent. With a sufficiently high access fee, the incumbent can successfully block the entry.

One long distance call requires one unit of local and long distance service. Then, the marginal cost of a long distance call to the incumbent is $c_I = c_0 + c$ and that of an entrant is $c_E = a + c$. We will focus on network industries with network effects. The willingness to pay for the service increases with the total amount of services provided by the industry. When Q^e is the expected sales of the service, f(Q^e) denotes the network effects which measure the increase in the willingness to pay. The total willingness to pay for the total service Q takes the following form; $P(Q\,;\,Q^e) \equiv P(Q\,;0) + f(Q^e)$.

The game proceeds in three stages. In the first stage, the incumbent chooses the access fee. In the second stage, the entrant makes the entry decision. Finally, if entry occurs, two firms compete in the Cournot fashion. Otherwise, the incumbent remains as the monopolist.

For a concrete analysis, we begin with a linear demand case. For this purpose we assume that $P(Q\,;\,Q^e) = A - Q + f(Q^e) \equiv B - Q$, where $B = A + f(Q^e)$. As usual, $A > c_I$ is assumed. And we make the following standard assumption on $f(\cdot)$.[2)]

Assumption 1: $f(0) = 0$, and f is differentiable with

$$f' > 0, f'' \leq 0, \lim_{Q^e \to \infty} f'(Q^e) < 1.$$

For given Q^e, Profits of the incumbent and the entrant are given by:

$$\pi_I = (B - q_I - q_E - c_I) q_I, \quad \pi_E = (B - q_I - q_E - c_E) q_E .$$

When entry occurs, in the third stage, given the expected sales Q^e, equilibrium quantities of the incumbent and the entrant are $q_I^* = (B - 2c_I + c_E)/3$, $q_E^* = (B - 2c_E + c_I)/3$, respectively. Actual market production level and the

2) These assumptions are also found in Economides(1996).

market price are $Q^* = q_I^* + q_E^* = (2B - c_I - c_E)/3, p^* = (B + c_I + c_E)/3$. As expected, the equilibrium production level, and price increase as the expected level of production increases.

At equilibrium, the expectations must be fulfilled. This defines the rational expectation equilibrium level of expected production level by $Q^* = Q^e$, which implies that $Q^* = \dfrac{2(A + f(Q^*)) - c_I - c_E}{3}$. Since f is continuous, strictly monotone and its slope becomes less than 1 eventually, there exists a unique rational equilibrium.

Lemma 1 *There exists a unique rational expectation equilibrium in the third stage.*

For a concreteness, it is assumed that network effects are a linear function of the expected sales.

Assumption 1′ : $f(Q^e) = vQ^e$, where $0 < v < 1$.

Under Assumption 1′, Lemma 2 follows.

Lemma 2 *The unique rational equilibrium in the third stage is as follows;*

$$Q^* = \frac{2A - (c_I + c_E)}{3 - 2v} \quad p^* = \frac{A + (1 - v)(c_I + c_E)}{3 - 2v} \text{ and,}$$

$$q_I^* = \frac{A - (2 - v)c_I + (1 - v)c_E}{3 - 2v} \quad q_E^* = \frac{A - (2 - v)c_E + (1 - v)c_I}{3 - 2v}.$$

In the second stage, given a, entry occurs if and only if $q_E^* > 0$. We now consider the first stage. The incumbent profits are defined by $\prod_I(a; v) = (a - c_0)q_E^* + \pi_I^* = (a - c_0)q_E^* + (p^* - c_I)q_I^*$. Since $c_E = a + c$, we can redefine $\prod_I(c_E ; v)$ by $\prod_I(c_E ; v) = \dfrac{(c_E - c_I)[A - (2 - v)c_E + (1 - v)c_I]^2}{3 - 2v} + \dfrac{[A - (2 - v)c_I + (1 - v)c_E]^2}{(3 - 2v)^2}$. The incumbent's problem is to solve c_E

maximizing $\prod_I(c_E, v)$.

Since $\prod_I(c_E, v)$ is concave in c_E, from the first order condition, we have $c_E^*(v) = \frac{(5-4v)A + (2v^2-6v+5)c_I}{2(v^2-5v+5)}$. Let $a^*(v) = c_E^*(v) - c_0$. Note that

$$\frac{dc_E^*}{dv} = \frac{(A-c_I)(5-10v+4v^2)}{2(5-5v+v^2)^2}, \quad \frac{d^2c_E^*}{dv^2} = \frac{-(A-c_I)(15-15v+4v^2)}{(5-5v+v^2)^3}$$

For $v \in [0,1]$, $\frac{d^2c_E^*}{dv^2} < 0$. Hence $c_E^*(v)$ is concave in v. Setting $\frac{dc_E^*}{dv} = 0$, we get $v = \frac{5-\sqrt{5}}{4}$. Therefore, $c_E^*(v)$ is maximized at $v = \frac{5-\sqrt{5}}{4}$. An interesting fact is that $c_E^*(v)$, therefore, $a^*(v)$ is not monotone in v.

Until v reaches $\frac{5-\sqrt{5}}{4}$, the incumbent raises the access fee and thereafter, lowers it. This is summarized in Lemma 3. For lower value of v, when v increases, the incumbent worries that the entrant steals the market from it too much. Hence it raises the access fee. When v is larger than the critical value, as v increases, the network effects matter more. The incumbent wants the entrant to supply more output. Therefore, it lowers the access fee.

Lemma 3 *$a^*(v)$ satisfies the following properties;*

- 3-1. $a^*(v)$ is concave in v with $\frac{da^*}{dv} \mid_{v=1} = \frac{A-c_I}{2} > 0$ and $\frac{da^*}{dv} \mid_{v=1} = \frac{-A+c_I}{2} < 0$;
- 3-2. $a^*(0) = a^*(1) = A$;
- 3-3. $a^*(v)$ achieves its maximum at $v = \frac{5-\sqrt{5}}{4}$.

By substitution, we have $\prod_I^*(v) = \prod_I^*(c_E^*(v); v) = \frac{5(A-c_I)^2}{4(v^2-5v+5)}$. In

Proposition 1, we show that without network effects, the incumbent always forecloses its competitor by charging a high access fee.

Proposition 1 *When there is no network effect, foreclosure occurs always.*

Proof: When $v=0$, it is optimal for the incumbent to set $c_E^*(0)=\frac{A+c_I}{2}$. With this, $q_E^*=0$. This completes the proof. Q.E.D.

Proposition 1 can be shown differently. Let $\prod_{IM}(v)$ denote the monopoly profit when there is no entry. Then, it can be easily shown that $\prod_{IM}(v)=\frac{(A-c_I)^2}{(2-v)^2}$. Since $\prod_I^*(v)=\frac{5(A-c_I)^2}{4(v^2-5v+5)}$, $\prod_I^*(v)=\prod_{IM}(v)$ when $v=0$. Entry occurs only when c_E is lower than $c_E^*(0)=\frac{A+c_I}{2}$. But, this lowers the incumbent's profit below $\prod_{IM}(v)$. Hence without network effects, the incumbent never invites the entry. Proposition 1 shows that no effort to introduce competition in the network market where the essential facilities are monopolized will be effective without a relevant regulation. Thus the regulation of mandatory access with the access fee set close to the marginal cost is justifiable in the sense of promoting competition in the network industry.

With network effects, then it is not entirely clear whether the incumbent should deter the entrant or accommodate it since the more competitive downstream market gives effects on the incumbent's profits in two opposite directions. First, the more competition reduces the incumbent's profits. This is a standard competition effect. But with network effects, the willingness to pay increases as the sales increase. If the market gets more competitive, then more outputs can be sold at the higher price and access revenues increase. Thus if the latter overshadows the former, then the incumbent invites the entry. With $v>0$, $\prod_I^*(v)$ is always greater than $\prod_{IM}(v)$. This proves Proposition 2.

Proposition 2 *When there are network effects, then the incumbent always invites the entrant. That is, with* $v > 0$, $\prod_I^*(v) > \prod_{IM}(v)$.

Proposition 2 shows that when there are network effects, the incumbent always invites the entrant. Economides(1996) shows similar results for the homogenous product case. He shows that the incumbent invites the entrant if network effects are strong enough. For the case of linear market demand and linear network effect, $v > \frac{1}{2}$ must be satisfied.[3] In our paper, however, $\prod_I^*(v) > \prod_{IM}(v) \forall v > 0$. It is the access revenue that makes the incumbent invite the entry even with weak network effects. The entrant brings about two effects on the incumbent's profits. The entry increases its profits by increasing the market sales and thus the willingness to pay by consumers. It also increases the incumbent's profits by paying for the access. These two positive effects together outweigh the negative competition effect.

When the entrant should pay the entry cost, the incumbent has an incentive to subsidize the entrant with a low access fee. Suppose that the entrant should pay the entry cost, F. Let $\prod_E^*(v)$ be the profit to the entrant before paying F when the incumbent charges $a^*(v)$. If $\prod_E^*(v) \geq F$, the incumbent charges $a^*(v)$, and the entry occurs. Suppose that $\prod_E^*(v) < F$. With the access charge, $a^*(v)$, the entry does not enter. Then, the incumbent cannot enjoy the positive network effects, thus the incumbent profits will be down to $\prod_{IM}(v)$. If so, the incumbent has an incentive to invite the entrant with a lower access charge. It has an incentive to lower the access charge until $\prod_I(c_E ; v) = \prod_{IM}(v)$.

Proposition 3 Given v, there exists $F^*(v) > 0$ such that the incumbent invites the entry when $F < F^*(v)$. Furthermore, when the network effects are sufficiently large, the incumbent charges the access fee close to the marginal cost.

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3) cf. Proposition 5 in Economides(1996).

Proof: The incumbent has an incentive to lower the access fee below the optimal level of $a^*(v)$ until $\prod_I(c_E;v)=\prod_{IM}(v)$. Since $\prod_I(c_E;v)$ is quadratic in c_E and $\prod_I(c_E^*(v);v)>\prod_{IM}(v)$, we have two roots solving $\prod_I(c_E;v)-\prod_{IM}(v)=0$. One is lower, and the other higher than $c_E^*(v)$. Since the entrant's profit is decreasing in the access charge, we are interested in the lower value, which is denoted by $c_E^L(v)=\dfrac{A(1-v)(3v-5)+c_I(v^3-4v^2+7v-5)}{v^3-7v^2+15v-10}$. Let $\prod_E(v)$ be the payoff to the entrant when the incumbent charges $c_E^L(v)$. Since $c_E^L(v)$ is the lowest possible level of access fee that the incumbent can charge, as long as $F<F^*(v)=\prod_E(v)$, the firm will invite the entry. As v becomes 1, $c_E^L(v)$ is getting close to $c_I=c_0+c$. Hence, a converges to c_0 when the network effects are sufficiently large. Thus the incumbent has an incentive to set access fee close the marginal cost when v is sufficiently large. Q.E.D.

Proposition 3 resembles some literature that encourage the monopoly to attract competition by subsidizing the entrant. Some use free licensing (Farrel and Gallini(1986) or Gallini(1984)), and some use free sharing of its facility (Chen and Ross(2000)). In our paper, the incumbent uses the access fee.

Ⅲ. Concluding Remarks

In this paper, we showed that the incumbent's incentive to share its essential facility depends on the network effects. Without network effects, the incumbent has no incentive to provide access to potential entrants. Thus any policy toward competitive markets in the network industry will fail without a well-designed regulation regarding access. On the other hand, if there exist network effects, then it is in incumbent's interests to invite entrants. Thus the market will

be competitive without any regulation. Regulation on the access charge might promote welfare. But it is possible for such a regulation to harm consumers if there exist sufficiently large entry costs.

In this paper, we assumed that the local telephony market is separated from the long distance market in the sense that the incumbent's decision in the local telephone market is independent. The relaxation of this assumption needs to be investigated further.

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[Abstract]

망외부성과 경쟁 도입 유인에 관한 연구

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본 논문은 망외부성이 존재할 경우, 기존 기업이 자신이 가지고 있는 필수 설비를 잠재적 경쟁기업에게 제공할 유인을 분석하고 있다. 망외부성이 없으면 기존 기업은 접속료를 매우 높이 책정하여 진입을 봉쇄할 유인을 가진다. 반면에 망외부성이 존재하면, 기존 기업은 진입을 촉진할 유인을 가진다. 또한 진입 비용이 존재할 경우, 기존 기업은 접속료를 낮게 책정하여 진입 기업에게 암묵적으로 보조금을 지불하고자 하는 유인을 가진다. 마지막으로 망외부성이 증가하면, 접속료의 크기는 한계비용으로 수렴한다.

핵심용어 : 망외부성, 진입 봉쇄, 필수 설비, 접속료