

Interconnection Quality and Free Entry of Network Service Providers: Does Excess Entry Theorem Hold in the Network Industry ? *

Ichiroh DAITOH**
Tohoku University

Toru KIKUCHI
Kobe Univesrity

June, 2005

Abstract

We investigate how a new entry of Network Service Providers (NSPs) may affect interconnection quality in a private agreement and when entry promotions are socially desirable in a network industry. The business-stealing effect will degrade interconnection quality while the cost-sharing effect will improve it. If a new entry *degrades* interconnection quality sufficiently *greatly*, an entry bias will be *excessive*. This is more likely to happen when the demand for network service is larger and/or the marginal cost for producing service is lower. If an entry degrades the quality only weakly or *improves* it, the free-entry equilibrium number of NSPs is *smaller* than the socially-optimal number of NSPs. Then entry promotions would be socially desirable, although ISPs exhibit economies of scale and produce homogeneous services. The “excess entry theorem” by Mankiw and Whinston (1986) may not provide sufficient policy prescriptions for network industries.

Keywords: Cournot competition; free entry; network service provider; interconnection quality; network externality

JEL Classification Number: L13; L50; L86

* We appreciate Professor Makoto Yano (Keio University) for useful discussions.

** Correspondence: Ichiroh Daitoh, Department of International Economic Relations, Graduate School of International Cultural Studies, Tohoku University; 41 Kawauchi, Aoba-ku, Sendai-city, Miyagi, 980-8576, Japan. TEL&FAX: +81-22-795-7595, E-mail:idaito@intcul.tohoku.ac.jp

1. Introduction

In the last decade the role of new types of network industries such as the Internet, mobile and IP telephones and satellite communications systems has been widely discussed. It is increasingly recognized that growing interconnectivity of individuals and organizations is achieved through improved networks and that the interconnection quality has thus been an important strategic instrument for firms competing in these industries.

A remarkable feature of the network industries is the scale of entry. According to Cave and Mason (2001), the number of Internet Service Providers (ISPs) in UK doubled from around 350 in 1999 to 700 in 2000.¹ Governments often seem to promote new entries into these industries. For example, since 1996, Federal Communications Commission (FCC) in the United States had maintained the interconnection rules among local telephone companies which were more beneficial to new entrants. They found that these rules tended to induce incumbent firms to avoid making an interconnection agreement with potential entrants, repressing new entries. Thus they changed the rules in 2004 into those in which incumbent firms and entrants are more equally treated. In 2005, the Japanese government (Ministry of Internal Affairs and Communications) has decided to allow a new entry of mobile phone companies after no permission of new entries for the last twelve years.

However, the network service providers (NSPs) exhibit economies of scale due to fixed costs, as often pointed out (e.g. Harris (1995) and Kikuchi (2002)). According to the “excess entry theorem” by Mankiw and Whinston (1986), an entry bias will be excessive in the presence of fixed set-up costs. In this perspective, what is socially desirable in the network industries seems to be entry restrictions, not promotions. Thus we need to ask whether entry promotions are really socially desirable in the network industries and, if so, under what conditions they are.

This paper investigates how a new entry of firms may affect interconnection

¹ They also report that while there is a large number of ISPs, the market is highly concentrated. The top six providers accounted for over 73 per cent of the US market by subscribers, in which there were around 7,700 ISPs operating in 2000.

quality in a private agreement and economic welfare, and show that when endogenizing interconnection quality, an entry bias may be either excessive or insufficient. We formulate a two-stage game of n symmetric NSPs. In the first stage, n symmetric NSPs make an agreement on interconnection quality (degree of compatibility) for their networks. They equally share a fixed investment cost for attaining the quality. In the second stage, they compete *à la* Cournot in the final good (network service) market with network externalities. We will examine how an exogenous increase in the number of NSPs may affect the interconnection quality they agree upon and under what conditions the free-entry equilibrium number of firms will exceed or be short of the socially-optimal number of firms.²

The main findings are as follows. First, an increase in the number of firms may either improve or deteriorate the interconnection quality they agree upon. This is because the quality tends to deteriorate by the *business-stealing* effect while it tends to improve by the *cost-sharing* effect. Second, when a new entry of firms improves interconnection quality, it will increase consumers' surplus. Even if the interconnection quality declines, consumers' surplus may still increase for its weak decline. When the interconnection quality declines to a sufficiently large extent, consumers' surplus will decrease. Third, if a new entry of firms leads to a sufficiently large *decline* in interconnection quality so that consumers' surplus decreases, the free-entry equilibrium number of firms will *exceed* the socially-optimal number of firms. This is more likely to happen when the demand for network service is larger and/or the marginal cost is lower. Taking into account the fact that oligopolistic NSPs exhibit economies of scale due to a fixed investment cost in our model, this can be interpreted as implying that the "excess entry theorem" will hold. Finally, however, if a new entry of firms leads to an *improvement* in interconnection quality, the free-entry equilibrium number of firms is *smaller* than the socially-optimal number of firms. This is because a new entry increases consumers' surplus, which the NSPs does not recognize correctly. In this case, entry restrictions would not be socially desirable, although NSPs

² Cremer, Rey and Tirole (2000) demonstrated in a model of oligopolistic market with network externalities that a larger ISP chooses a lower interconnection quality to maintain its competitive advantage over a smaller ISP. As their model was based on the N-providers setting without entry, the impact of a new entry of ISPs was downplayed in the analysis.

exhibit economies of scale due to a fixed investment cost and produce homogeneous services.

The difference between the “excess entry theorem” by Mankiw and Whinston (1986) and our analysis will be made clearer by focusing on the last finding above. They showed in a basic model of *homogeneous* product market that the existence of imperfect competition and a business-stealing effect always create a bias toward excess entry in the presence of fixed set-up costs. Furthermore, they pointed out that product differentiation can reverse this tendency toward excess entry, because the marginal entrant creates surplus by increasing product variety that he does not capture as profits. In our NSP model of a *homogeneous* product market, the business-stealing effect works in the same fashion. However, the cost-sharing effect will tend to improve the interconnection quality NSPs agree upon and thus create consumers’ surplus due to network externalities. Since the marginal entrant does not capture this welfare-improving effect as profits, the free-entry equilibrium number of firms will be short of the socially-optimal number of firms. Therefore, even if network services can be regarded as *homogeneous*, the direction of entry bias is generally unclear. In this respect, the “excess entry theorem” by Mankiw and Whinston (1986) may not provide sufficient policy prescriptions for network industries.

The structure of the paper is as follows. We build the basic model in Section 2. Section 3 considers the role of interconnection quality. We investigate the welfare effect of a new entry of NSPs in Section 4 and then an entry bias in Section 5. Section 6 concludes.

2. The Model

We will build a Cournot competition model of n symmetric NSPs in the final good market with network externality. The final good is a network service such as access to the Internet. The network service is assumed to be homogeneous from the customers’ point of view. Each NSP operates its own local network. We formulate a two-stage game. In the first stage, the symmetric NSPs make an interconnection agreement, choosing interconnection quality (degree of

compatibility) k , where $\underline{k} \leq k \leq \bar{k}$ (see below). In the second stage, they attain a Cournot-Nash equilibrium.

2.1. Network Structure

The network structure is similar to that in Foros and Hansen (2001). For communications between own customers (on-net traffic), each NSP is offering a quality guarantee of \bar{k} . If there are no private interconnection agreements between the NSPs, the interconnection service is provided by an Network Backbone Provider (NBP) which is operated by a non-profit organization. While the quality \underline{k} of off-net communication is offered by the NBP through a public interconnection point, private NSPs can invest, based on the interconnection agreement, in a direct interconnection point (without a NBP) and thereby provide their customers with the quality k of interconnection, where $\underline{k} \leq k \leq \bar{k}$. For simplicity, the highest possible quality \bar{k} is assumed to be 1.

2.2. Consumers

The NSPs are going to supply network service to consumers after making interconnection agreements. Consumers can purchase the network service by connecting to one NSP. We assume that each consumer purchases at most one unit of network service for one period (each consumer will not connect to both NSPs at the same time). The fixed advantage v of being connected to the network varies across consumers and is uniformly distributed over $[0, a]$. The consumer of type $v \in [0, a]$ obtains, from subscribing to NSP_i ($i \in N = \{1, 2, \dots, n\}$) who offers the price p_i (connection fee), the net utility equal to

$$U_i = v + e_i - p_i$$

where e_i represents the positive externality that the consumer enjoys from connecting to NSP_i 's network. We assume that the network externality is linear in the expected network size

$$e_i = \beta \left\{ x_i + \sum_{j \neq i}^n k_j x_j \right\} \quad (0 < \beta < 1/2, \underline{k} \leq k_j \leq 1) \quad (1)$$

where x_i is the number of consumers connecting to NSP_i , x_j the number of consumers connecting to a rival NSP_j . When the interconnection quality $k_j \in [k, 1]$ is higher, the expected network size $(x_i + \sum_{j \neq i}^n k_j x_j)$ will be larger for the same levels of x_i and x_j s. In other words, k_j measures the degree of compatibility between the networks. On the other hand, β reflects the strength of network externality. Given the network size, a higher value of β leads to a larger value of e_i . Consumers are assumed to be homogeneous in their valuations of the network externality (β). We assume $0 < \beta < 1/2$ for the existence of a unique and stable Nash equilibrium.³

The consumer of type v connects to NSP_i to maximize his or her net utility. If the net utility is negative ($U_i = v + e_i - p_i < 0$), then consumers of type v do not purchase any network service from NSP_i . Both ISPs will have a positive sale only if

$$p_i - e_i = p_j - e_j = p \quad i \in N \quad i \neq j \quad (2)$$

where $p_i - e_i$ is the adjusted price from which the effect of network externality is excluded, that is, the price that the NSP_i offers only for the fixed advantage v . If these adjusted prices were different, all consumers would intend to connect to the NSP who offers a lower price. Because the network service is homogeneous aside from the network externality, the demand for NSP_i with a higher price would be zero. If both NSPs are to have positive sales, the adjusted prices must be equal between them.

If each NSP offers the price satisfying (2), only consumers of type v with $v \geq p_i - e_i$ subscribe to NSP_i . Given the uniform distribution of v , the total demand is $a - p$. This is equal to the total supply:

³ The linear network externality function of an individual subscriber is used in, e.g., Crémer, Rey and Tirole (2000) and Daitoh and Yanagawa (1994). This is consistent with the Metcalfe's law, which states that the aggregate network value is proportional to the square of network size. See Swann (2002) for detailed discussion of the functional form of network effects.

$$x_i + \sum_{j \neq i}^n x_j = a - p \quad (3)$$

From (1), (2) and (3), the prices p_i are determined by

$$p_i = a - (1 - \beta)x_i - \left\{ \sum_{j \neq i}^n x_j - \beta \sum_{j \neq i}^n k_j x_j \right\} \quad (4)$$

This can be interpreted as the inverse demand curve that NSP_i faces.

2.3. ISPs' Behavior and Market Equilibrium

We assume that NSP_i incurs a constant marginal cost c for supplying network service to customers. In addition, they incur the investment cost $I(k)$ for attaining the interconnection quality k .⁴ Given k in the first stage, ISP_i chooses x_i so as to maximize its gross profit (excluding $I(k)$)

$$\pi_i = (p_i - c)x_i = \left[(a - c) - (1 - \beta)x_i - \left\{ \sum_{j \neq i}^n x_j - \beta \sum_{j \neq i}^n k_j x_j \right\} \right] x_i \quad i \in N \quad i \neq j$$

where he regards x_j as given. The first-order condition (FOC) for profit maximization yields its reaction curve

$$x_i = \frac{1}{2(1 - \beta)} \left[(a - c) - \left\{ \sum_{j \neq i}^n x_j - \beta \sum_{j \neq i}^n k_j x_j \right\} \right] \quad i \in N \quad i \neq j \quad (5)$$

Under the assumption of $0 < \beta < 1/2$, there uniquely exists a stable symmetric Nash equilibrium. Using (5), the equilibrium outputs in the symmetric Nash equilibrium are

$$x^* = \frac{a - c}{2(1 - \beta) + (n - 1)(1 - \beta k)} = x(n, k) \quad (6)$$

Substituting (6) into (4) and rearranging the terms, the equilibrium price is

$$p_i^* - c = \frac{(1 - \beta)(a - c)}{2(1 - \beta) + (n - 1)(1 - \beta k)} \quad i \in N \quad (7)$$

From (6) and (7), the gross profit function is

⁴ The marginal cost c is almost zero while the fixed cost $I(k)$ is large. This characteristic of the cost structure has been emphasized in, e.g. Harris (1995) and Kikuchi(2002).

$$\pi_i^* = \frac{(1-\beta)(a-c)^2}{[2(1-\beta) + (n-1)(1-\beta k)]^2} = \pi(n, k) \quad i \in N \quad (8)$$

The total output of the industry is

$$X^* = nx^* = \frac{n(a-c)}{2(1-\beta) + (n-1)(1-\beta k)}$$

When a and β rise or c declines, x_i increases and p_i declines. Intuitively, the demand for network service (a) and the strength (β) of network externality increases, the demand from the consumers increases under the same output levels. Thus all NSPs increase the equilibrium output levels, and therefore, the total output increases. Since the total supply increases, the equilibrium price declines. On the other hand, a decline in the marginal cost (c) leads to a rise in the gross profit of each NSP under the same price and output levels. Thus x increases and thus the equilibrium price declines.

3. Interconnection Agreement

3.1 Determination of Interconnection Quality

Now consider the first stage where the NSPs make a private interconnection agreement. Differentiating the profit function (8) with respect to k yields

$$\frac{\partial \pi(n, k)}{\partial k} = \pi_k = \frac{2\beta(n-1)(1-\beta)(a-c)^2}{[2(1-\beta) + (n-1)(1-\beta k)]^3} \quad i \in N \quad (9)$$

Because a rise in k leads to the same amount of increase in the gross profit, all the firms have the incentive to agree upon the same level of k .

In order to raise interconnection quality k above \underline{k} , the NSPs need to incur investment cost $I = I(k)$.⁵ It is reasonable to expect the investment cost function to be convex. For example, if the interconnection quality is already high, an additional improvement in quality will be more difficult for technological reasons. Furthermore, the contracts among firms will probably become more complicated as

⁵ Assume that it is costless to improve the quality of interconnection. Then, since the profit functions are equally increasing in k , both ISPs will agree on the same quality level $k = 1$.

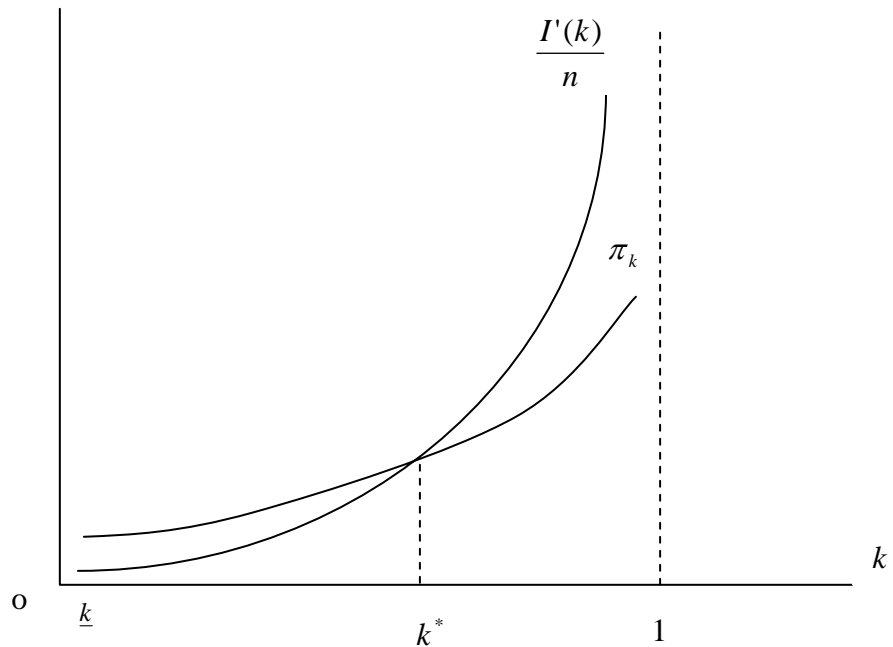
interconnection quality increases. We thus assume that $I'(k) > 0$ and $I''(k) > 0$ hold. For simplicity, it is also assumed that $\lim_{k \rightarrow 1} I'(k) = \infty$ and $\lim_{k \rightarrow \underline{k}} I'(k) = 0$.

In the interconnection agreement among symmetric NSPs, the investment cost will be shared equally. Thus the cost per firm is $I(k)/n$. Each NSP will choose the interconnection quality k so that the net profit is maximized. The FOC implies

$$\frac{\partial \pi(n, k)}{\partial k} = \frac{I'(k)}{n} \tag{10}$$

Figure 1 shows how the interconnection quality is determined, given the number of firms. Notice that the second-order condition ($\pi_{kk} < I''(k)/n$) for profit maximization is satisfied.

Figure 1. Determination of Interconnection Quality



Under the assumptions above, as k approaches to \underline{k} , $I'(k)/n$ goes to zero. As k

approaches to 1, $I'(k)/n$ goes to infinity. On the other hand, the gross profit function is increasing and convex in k . When k equals \underline{k} , $\pi_k(\underline{k})$ is larger than zero. When k equals unity, $\pi_k(1)$ takes a positive finite value. Therefore, $\pi_k(\underline{k}) > I'(\underline{k})/n$ and $\pi_k(1) < I'(1)/n$ hold. There exists a unique value of $k \in (\underline{k}, 1)$ satisfying (14).

3.2 New Entry and Interconnection Quality

Let us show that a new entry of NSPs may either improve or degrade interconnection quality. This is because an increase in the number of firms will make both $I'(k)/n$ and $\pi_k(n, k)$ curves shift downward. The next lemma indicates the shift of $\pi_k(n, k)$ curve.

Lemma 1. When the number of firms increases, $\pi_k(n, k)$ curve shifts downward.

(PROOF) Differentiating (9) with respect to n , we get

$$\frac{\partial \pi_k(n, k)}{\partial n} = \frac{4\beta(1-\beta)(a-c)^2[(1-\beta) - (n-1)(1-\beta k)]}{[2(1-\beta) + (n-1)(1-\beta k)]^4} \quad (11)$$

Suppose that $1-\beta > (n-1)(1-\beta k)$ holds. Dividing both sides yields $\frac{1-\beta}{1-\beta k} > n-1$.

Because $1-\beta \leq 1-\beta k$ holds, we have $\frac{1-\beta}{1-\beta k} \leq 1$. Thus, $1 \geq \frac{1-\beta}{1-\beta k} > n-1$ holds.

This means $2 > n$, which is a contradiction. Therefore $1-\beta \leq (n-1)(1-\beta k)$ must hold. The sign of (11) is negative. (Q.E.D.)

The downward shift of $I'(k)/n$ curve indicates the *cost-sharing* effect. An increase in the number of firms, ceteris paribus, reduces the marginal investment cost per firm. This tends to improve interconnection quality. On the other hand, the downward shift of $\pi_k(n, k)$ curve indicates the *business-stealing* effect. When the number of firms increases the perceived demand curve faced by each firm will shift downward and thus the marginal gross profit per firm due to an increase in k will decrease. This tends to degrade interconnection quality. If the cost-sharing effect dominates the business-stealing effect, the interconnection

quality will improve, and vice versa. The business-stealing effect is stronger (the absolute value of (11) is larger) when the demand for network service (a) is larger and/or the marginal cost (c) of producing network service is smaller.⁶ This establishes the next proposition.

Proposition 1. (*Entry of Firms and Interconnection Quality*) *Suppose that n symmetric NSPs compete à la Cournot in the network service market and that the investment cost function for interconnection quality is increasing and convex. Then an increase in the number of NSPs improves (degrades) interconnection quality when the cost-sharing effect dominates (is dominated by) the business-stealing effect.*

This result is new and different from that reported by previous studies, in which an NSP with a larger installed base intends to lower interconnection quality in order to keep competitive advantage over an NSP with a smaller installed base. Notice that this strategic behavior cannot appear under the setting of symmetric NSPs.

4. New Entry and Economic Welfare

The gross economic welfare, excluding the investment cost, is $W(n) = n\pi(n) + CS(n)$. Differentiating it with respect to n , we obtain

$$W'(n) = \pi(n) + n\pi'(n) + CS'(n) \quad (12)$$

The change in welfare can be decomposed into three effects: an entrant's profit, changes in incumbents' profits and a change in consumers' surplus. First, an entrant's profit is

$$\pi(n) = \frac{(1-\beta)(a-c)^2}{[\phi(n)]^2} > 0 \quad (13)$$

⁶ The role of the strength (β) of network externality is more complicated. If $n-1 < 1/k$ holds, a larger β corresponds to a weaker business-stealing effect.

where $\phi(n) = 2(1-\beta) + (n-1)(1-\beta k(n))$ and $\phi'(n) = (1-\beta k(n)) - (n-1)\beta k'(n)$. It always improves welfare. Second, a change in the incumbents' profits is

$$\pi'(n) = -\frac{2(1-\beta)(a-c)^2 \phi'(n)}{[\phi(n)]^3} \quad (14)$$

It may be either positive or negative. (a) When $k'(n) > 0$ is so large that $\phi'(n) < 0$ holds, it is possible that $\pi'(n) > 0$ holds. Even under $k'(n) > 0$, the gross profit will decrease if an improvement in interconnection quality is not large enough. (b) When $k'(n) < 0$ holds, $\phi'(n) > 0$ and thus $\pi'(n) < 0$ hold. If an increase in the number of firms degrades interconnection quality, the gross profit will decrease.

Third, consumers' surplus in the symmetric Nash equilibrium ($nx = a - p$) is

$$CS(n) = \frac{1}{2}(nx^*)^2 = \frac{n^2}{2}(x^*)^2 = \frac{n^2}{2} \frac{(a-c)^2}{[2(1-\beta) + (n-1)(1-\beta k^*)]^2} \quad (15)$$

Differentiating it with respect to n , we obtain

$$CS'(n) = \frac{(a-c)^2}{2} \frac{d}{dn} \frac{n^2}{[2(1-\beta) + (n-1)(1-\beta k^*)]^2} = \frac{(a-c)^2}{\phi(n)^3} n [\phi(n) - n\phi'(n)] \quad (16)$$

where $\phi(n) - n\phi'(n) = \{1 + \beta(k(n) - 2)\} + n(n-1)\beta k'(n)$. Under the assumption of $0 < \beta < 1/2$, $1 + \beta(k(n) - 2) \geq 0$ holds (Notice that $1 - 2\beta \geq 0$ holds at $k=0$).

$CS'(n)$ may be either positive or negative. (a) When $k'(n) > 0$ holds, $\phi(n) - n\phi'(n) > 0$ and thus $CS'(n) > 0$ always holds. An increase in the number of firms will increase the consumers' surplus if it improves interconnection quality. Even if $k'(n) < 0$ holds, $CS'(n) > 0$ will still hold for a weak decline in k . (b) When $k'(n) < 0$ is strong enough, $\phi(n) - n\phi'(n) < 0$ and thus $CS'(n) < 0$ will hold.

Lemma 2 (Entry of Firms and Consumers' Surplus)

(a) If a new entry of firms improves interconnection quality ($k'(n) > 0$), the consumers' surplus increases. (b) If it degrades interconnection quality ($k'(n) < 0$) to a sufficiently large extent, the consumers' surplus will decrease.

5. Free-Entry Equilibrium and Social Optimality

5.1 Excessive or Insufficient Entry

Here let us compare the number of firms in the free-entry equilibrium (FEE) and the socially-optimal number of firms.

The FEE number of firms is determined by the zero-(net) profit condition

$$n\pi(n) = I(k(n)) \quad (17)$$

By differentiating it with respect to n , we obtain a necessary condition for FEE

$$\pi(n) + n\pi'(n) = I'(k)k'(n) \quad (18)$$

Denoting $\Gamma(n) = \pi(n) + n\pi'(n)$ and $\Delta(n) = I'(k)k'(n)$, it can be written as

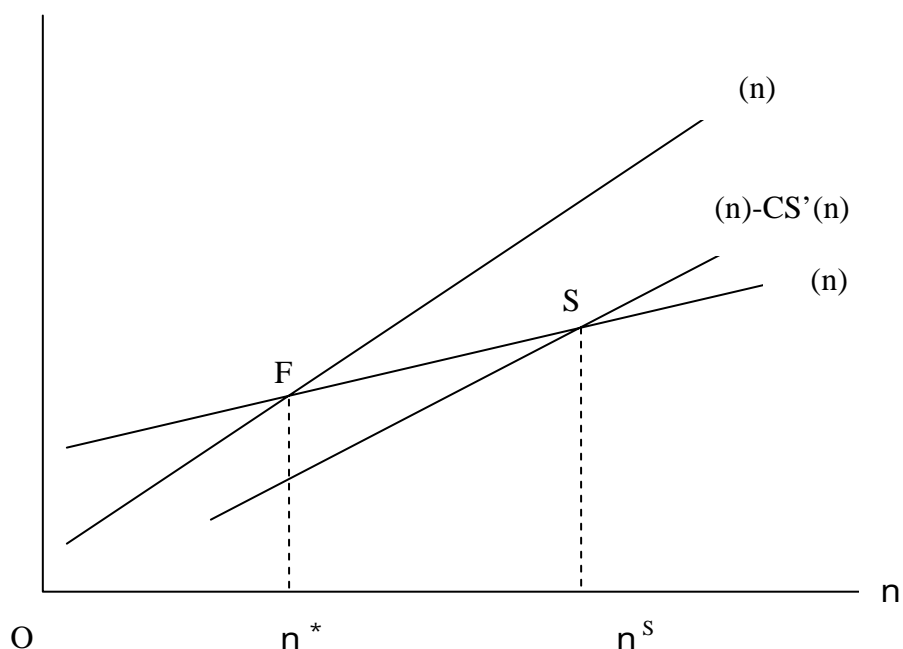
$$\Gamma(n) = \Delta(n) \quad (19)$$

Next, the socially optimal number of firms is determined by $dW(n)/dn = dI(k(n))/dn$. Thus we have $\pi(n) + n\pi'(n) + CS'(n) = I'(k)k'(n)$, which can be written as

$$\Gamma(n) = \Delta(n) - CS'(n) \quad (20)$$

We focus on the benchmark case where $k''(n) = 0$ holds. In this case, the graf of $\Delta(n)$ is increasing ($\Delta'(n) = I''(k)[k'(n)]^2 + I'(k)k''(n) = I''(k)[k'(n)]^2 > 0$). Because the sign of $\Gamma'(n) = 2\pi'(n) + n\pi''(n)$ is ambiguous, the graf of $\Gamma(n)$ may be either increasing or decreasing. Under the stability condition for FEE, the two curves intersect in a manner shown in Figure 2 for the case of $CS'(n) > 0$. Even if $\Gamma(n)$ is decreasing, the qualitative results will be the same.

Figure 2. Free Entry Equilibrium and Social Optimum



Proposition 2. (Free Entry Equilibrium and Social Optimum) *Suppose that n symmetric NSPs compete à la Cournot in the network service market and that the investment cost function for interconnection quality is increasing and convex. If $CS'(n) > 0$ is satisfied, $n^* < n^S$ holds. If $CS'(n) < 0$ is satisfied, $n^S < n^*$ holds.*

Intuitively, when the consumers' surplus decreases by a new entry of firms, they do not take that effect into consideration and thus too many (from the social viewpoint) firms will enter into the industry.

5.2 Policy Implication

Let us elucidate a policy implication of Proposition 2. Mankiw and Whiston (1986) identify the fundamental and intuitive forces that work in imperfectly competitive markets where firms incur fixed set-up costs upon entry. In homogeneous product markets the existence of imperfect competition and a business-stealing effect always creates a bias toward excessive entry. An policy implication would thus be that entry restrictions are often socially desirable in homogeneous product markets

under economies of scale.

In our NSP model in which interconnection quality is endogenously determined, the business-stealing effect works in the same fashion. However, the cost-sharing effect will tend to improve interconnection quality agreed upon and thus create consumers' surplus due to network externalities. Since the marginal entrant does not capture this welfare-improving effect as profits, the free-entry equilibrium number of firms will tend to be smaller than the socially-optimal number of firms. Therefore, even if network services can be regarded as homogeneous, the direction of entry bias is generally unclear in the network industry. When the demand for the network service (a) is large and/or the marginal cost (c) of producing the service is low, the entry bias is likely to be excessive. Otherwise, entry restrictions would *not* always be socially desirable even if NSPs incur a fixed costs and produce homogeneous service.

6. Conclusion

We have investigated how a new entry of Network Service Providers (NSPs) may affect interconnection quality in a private agreement and when entry promotions are socially desirable in a network industry. The business-stealing effect will degrade interconnection quality while the cost-sharing effect will improve it. If a new entry *degrades* interconnection quality sufficiently greatly, an entry bias will be *excessive*. This is more likely to happen when the demand for network service is larger and/or the marginal cost for producing service is lower. If an entry degrades the quality only weakly or *improves* it, the free-entry equilibrium number of firms is *smaller* than the socially-optimal number of firms. Then entry promotions would be socially desirable, although NSPs exhibit economies of scale and produce homogeneous services. The "excess entry theorem" by Mankiw and Whinston (1986) may not provide sufficient policy prescriptions for network industries.

References

- Cave, Martin and Robin Mason, 2001, *The Economics of the Internet: Infrastructure and Regulation*, *Oxford Review of Economic Policy* Vol.17, No.2, pp.188-201.
- Crémer, J. P. Rey and J. Tirole, 2000, *Connectivity in the Commercial Internet*, *Journal of Industrial Economics* XLVIII, 433-472.
- Daitoh, I. and N. Yanagawa, 1994, *Product Standardization and Economic Growth*, *Economic Review* 45, 230-237 (Japanese).
- Foros, Ø. and B. Hansen, 2001, *Competition and Compatibility among Internet Service Providers*, *Information Economics and Policy* Vol.13, 411-425.
- Foros, Ø. Hans Jarle Kind and Jan Yngve Sand, 2004, *Do internet incumbents choose low interconnection quality?*, forthcoming in *Information Economics and Policy*.
- Harris, R., 1995, *Trade and communication costs*, *Canadian Journal of Economics* XXVIII, Special Issue, November, S46-S75.
- Ji, H. and I. Daitoh, 2003, *Interconnection Agreement between Internet Service Providers and the Optimal Policy Intervention: The Case of Cournot-type Competition under Network Externalities*, Tohoku University, mimeo.
- Katz, M. and C. Shapiro, 1985, *Network Externalities, Competition and Compatibility*, *American Economic Review* 75, 424-440.
- Kende, M., 2000, *The Digital Handshake: Connecting Internet Backbones*, OPP (Office of Plans and Policy) Working Paper No.32, Federal Communications Commission.
- Kikuchi, T. 2002, "Country-Specific Communications Networks and International Trade in a Model of Monopolistic Competition," *Japanese Economic Review* Vol. 53, No.2, pp.167-176.
- Mankiw, N. Gregory and Michael D. Whinston, 1986, *Free Entry and Social Inefficiency*, *Rand Journal of Economics* Vol.17, No.1, Spring, pp.48-58.
- OECD, 2001, *Internet Traffic Exchange and The Development of End-to-End International Telecommunication Competition*, Discussion Paper DSTI/ICCP/TISP (2001) 5/ FINAL, OECD.
- Suzumura, K. and Kiyono, K, *Entry Barriers and Economic Welfare*, *Review of Economic Studies*, Vol.54, No.1, 1987, pp.157-167.

Swann, P.G.M., 2002, The functional forms of network effects, Information Economics and Policy 14, pp.417-429.