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Stubbornness is unprofitable :On the role of consumer expectations in a monopoly network goods market

Tsuyoshi Toshimitsu
(School of Economics, Kwansei Gakuin University)

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SCHOOL OF ECONOMICS

KWANSEI GAKUIN UNIVERSITY

1-155 Uegahara Ichiban-cho
Nishinomiya 662-8501, Japan

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"Stubbornness is the greatest ill." – Yiddish proverbs

"Man's worst ill is stubbornness of heart." – Sophocles

Tsuyoshi TOSHIMITSU☆

School of Economics, Kwansei Gakuin University

Abstract

We consider the formation (or timing) of consumer expectations regarding network size. Using a simple monopoly model with network externalities, we examine how the formation of consumer expectations, i.e., either stubborn or flexible expectations, affects the fulfilled expected monopoly equilibrium. We demonstrate that an increase in stubbornness reduces both output and consumer surplus. Furthermore, it is unprofitable for the monopolist that consumers have stubborn expectations.

Keywords: stubbornness; consumer expectations; network externality; monopoly

JEL Classification: D42; L12; L15

☆ School of Economics, Kwansei Gakuin University, 1-155, Nishinomiya, 662-8501, Japan

Tel: +81 798 54 6440, Fax: +81 798 51 0944, e-mail: ttsutomu@kwansei.ac.jp

1. Introduction

Since the early 21st. century, the world has witnessed remarkable growth in many information and communications technology industries, including telecommunications, computer hardware, and software. One particular feature is the presence of network externalities for goods and services in digital markets. In this regard, many studies have analyzed the role of network externalities in giving rise to demand-side economies of scale, such that network externalities are commonly defined as general properties whereby the utility of individual consumers increases alongside the increase in the total number of consumers purchasing either the same brand or compatible brand products. In these studies, there is usually an attempt to distinguish between direct (telecommunication) network externalities and indirect (system) network externalities. In the present analysis, we consider both of these cases.

In network goods markets, the formation of consumer expectations regarding network size (or market share) is a critical determinant of market outcomes. For example, to avoid coordination failure in multiple equilibria, Shy (2002, Definition 2.4 and Assumption 2.2, p. 20) assumes consumers have perfect foresight. In this paper, by focusing on the formation (or timing) of consumer expectations, we reconsider a fulfilled expectations equilibrium (e.g., Katz and Shapiro, 1985, 1994; Economides, 1996a, 1996b).

Suleymanova and Wey (2012) examine the role of consumer expectations in a duopoly model á la Hotelling with network externalities and consider the following types of expectations: (i) strong (stubborn) expectations, (ii) weak (price-sensitive) expectations, and (iii) partially stubborn (a mix of strong and weak expectations). In Suleymanova and Wey's (2012) model, strong (stubborn) expectations imply that consumers commit to initial expectations before their

price decisions and do not subsequently revise them. In particular, and as related to our analysis, they show that an increase in stubbornness reduces competitiveness in a duopolistic market. In our model, and as shown below, we find that an increase in stubbornness also has a negative effect on consumer surplus and profit.

Hurkens and López (2014) point out the importance of consumer expectations in any market with network externalities. That is, they consider how "passive" (strong) and "responsive" (weak) expectations affect retail competition in a mobile telephony market.

In this paper, using a spatial monopoly model á la Hotelling with network externalities, we consider how the degree of stubbornness of consumer expectations—in other words, the timing of the formation of consumer expectations—affects the fulfilled monopoly equilibrium. We demonstrate that an increase in stubbornness reduces output in the fulfilled equilibrium. Thus, our main finding is that stubbornness is unprofitable for both consumers and the monopolist.

2. The model

2.1 Consumer expectations and direct network externalities

We address the case of direct network externalities as already observed in telecommunication industries. We consider a monopoly market where there is a continuum of consumers, indexed $\theta \in [0,1]$, and output (i.e., actual network size), $x \in [0,1]$, of the good and service. To simplify, consumers are uniformly distributed with a density of one in the market, and the utility function (or the willingness-to-pay) of consumer θ is given by $u(\theta) = N(S^e)\theta$, where $N(S^e)$ represents the network externality function of the expected network size, i.e., S^e. In this case,

we assume that all consumers' expectations regrading network size are the same, $S_\theta{}^e = S^e$.

To simplify the analysis, we also assume: (i) a linear network externality function given by $N(S^e) = nS^e$, where $n(>0)$ represents the parameter of network externalities, and (ii) production costs are zero. For example, this assumption implies that the marginal cost of production is either negligible or zero in network goods industries such as telecommunications.

A consumer purchases, at most, either one unit of the product or none, given the price. Hence, we express the net surplus of consumer θ as $v = \max\{u - p, 0\}$. Thus, the index of the marginal consumer who has the same net surplus from purchasing either one unit of the product or none is given by:

$$\hat{\theta} = \frac{p}{N(S^e)}. \tag{1}$$

The quantity demanded of the product in the market (i.e., the actual network size) is given by $x = 1 - \hat{\theta}$. Thus, the monopolist's profit function and consumer surplus are represented as $\pi = p(1-\hat{\theta}) = px$ and $CS = \int_{\hat{\theta}}^{1} \{N(S^e)\theta - p\} d\theta$, respectively.

2.2 Fulfilled expected monopoly equilibrium and stubbornness

We assume that the formation of consumer expectations for a given network size is expressed as:

$$S^e = \lambda x^* + (1-\lambda)x, \quad \lambda \in [0,1], \tag{2}$$

where λ represents the degree of stubbornness of consumer expectations, x^* is the equilibrium output, and x is the actual output. That is, if $\lambda = 1$, then $S^e = x^*$ holds. This implies that because consumers form an expectation for network size before the monopolist decision, the monopolist cannot affect the expected network size. In this case, consumers are

completely stubborn. This result is identical to that in the case of myopic expectations. Namely, consumers cannot accurately predict the monopolist's output and thus think that the network size depends on the output given in the past.

Conversely, if $\lambda = 0$, then $S^e = x$ holds. This implies that because consumers form an expectation for network size after the monopolist decision, the monopolist can affect the expected network size.

Based on equation (1), because the indirect demand function is given by $p = nS^e(1-x)$, the profit function is expressed as $\pi = nS^e(1-x)x$. Accordingly, taking equation (2), we derive the first-order condition (FOC) for profit maximization and the second-order condition (SOC) as follows:

$$\frac{\partial \pi}{\partial x} = n\lambda x^*(1-2x) + n(1-\lambda)x(2-3x) = 0, \tag{3}$$

$$\frac{\partial^2 \pi}{\partial x^2} = -2n\left\{\lambda x^* + (1-\lambda)(3x-1)\right\} < 0. \tag{4}$$

Thus, under the fulfilled expectation, i.e., $x = x^*$, from equation (3), we have:

$$x^* = \frac{2-\lambda}{3-\lambda} (< 1), \tag{5}$$

where the SOC as per equation (4) is satisfied in the equilibrium.

Given equation (5), it holds that $\frac{dx^*}{d\lambda} < 0$. That is, from the slope of the indirect demand function, we derive $-\frac{\partial p}{\partial x} = n\left\{\lambda x^* + (1-\lambda)(2x-1)\right\} \equiv \eta$. In this case, the effect of an increase in stubbornness on the slope in the equilibrium is given by $\left.\frac{d\eta}{d\lambda}\right|_{x=x^*} = n(1-x^*) > 0$. This implies that an increase in stubbornness steepens the slope of the inverse demand curve, and thus reduces

output in equilibrium. Conversely, a decrease in stubbornness, i.e., more flexible expectations, increases output in equilibrium. We also obtain $\frac{dp^*}{d\lambda} = nx^*(1-2x^*)\frac{dx^*}{d\lambda} \geq 0$, because $\frac{1}{2} \leq x^*$. With respect to consumer surplus, which is given by $CS^* = \frac{n(x^*)^3}{2}$, we derive $\frac{dCS^*}{d\lambda} < 0$. Furthermore, the monopolist profit in the equilibrium is given by $\pi^* = n(x^*)^2(1-x^*)$. Thus, we have $\frac{d\pi^*}{d\lambda} = nx^*(2-3x^*)\frac{dx^*}{d\lambda} \leq 0$, because $\frac{2}{3} \geq x^*$.

Based on the above results, we present the following proposition.

Proposition 1

An increase in the degree of stubbornness of consumer expectations regarding network size reduces output, consumer surplus, and the monopolist's profit.

Therefore, the existence of consumers bearing stubborn expectations is preferable for neither consumers nor the monopolist.

2.3 Indirect network externality case

Here we address the case of indirect network externalities, i.e., system network products (e.g., personal computers and software, smartphones, Internet services). That is, we assume that the utility function of consumer θ is given by $u = \theta + N(S^e)$. In this case, because the indirect demand function is given by $p = 1 - x + nS^e$, the profit function is $\pi = (1 - x + nS^e)x$. Here, we assume $\frac{1}{2} > n$.

Thus, we derive the FOC and SOC for profit maximization as follows:

$$\frac{\partial \pi}{\partial x} = 1 + n\lambda x^{*} - 2\{1 - n(1-\lambda)\}x = 0, \tag{6}$$

$$\frac{\partial^2 \pi}{\partial x^2} = -2\{1 - n(1-\lambda)\} < 0. \tag{7}$$

Under a fulfilled expectation in the case of indirect network externalities, i.e., $x = x_{idn}^{*}$, based on equation (6), we have:

$$x_{idn}^{*} = \frac{1}{2 - n(2-\lambda)} (< 1), \tag{8}$$

where subscript *idn* denotes the case of indirect network externalities. From equation (8), we derive as follows: $\frac{dx_{idn}^{*}}{d\lambda} < 0$, $\frac{dCS_{idn}^{*}}{d\lambda} < 0$, and $\frac{d\pi_{idn}^{*}}{d\lambda} < 0$.

Therefore, stubbornness is not profitable for both the monopolist and consumers in the case of indirect network externalities.

3. Conclusion

Based on a very simple model, we considered how the formation of consumer expectations regarding network size affects the fulfilled monopoly equilibrium by focusing on the degree of stubbornness of expectations. In particular, it is not profitable for both the monopolist and the consumers themselves that consumers have stubborn expectations regarding network size.

From the viewpoint of the monopolist, in the case of flexible (not stubborn) expectations, because consumers believe the announcement of planned output, the monopolist's commitment is

credible. Contrarily, in the case of stubborn expectations, because the announcement is not credible, consumers form their expectations themselves prior to the output decision. In this case, the expectation is self-fulfilling, that is, the equilibrium output (market share, network size) is equal to the initial expectation. However, the formation of stubborn expectations reduces the monopolist's incentive to provide the good and service in the market.

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