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Service Costs and Economic Welfare

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Abstract

This note clarifies the effects of a change in service costs from a welfare perspective. We focus on a “service with location” industry and consider the situation where firms determine their locations in the regions with region-specific marginal costs. We demonstrate that an increase in service cost is not favorable for producers, may be favorable for consumers, and is not favorable for the overall economy. The result implies that a reduction in service cost may make the consumer worse off. The result also explains the incentive for the government to implement policies to reduce service costs.

Keywords: Service costs; Location choice; Cournot competition

JEL classifications: F12; F13; F53

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1 Introduction

Service industry has played an important role in the world economy. According to the government of Japan (2006), the share of the service industry in real GDP has been around 70% in developed countries in the last decade. In particular, in the service industry, it is known that *service with location*, in which firms can provide only in the place of location¹ (e.g., hotels and department stores), have a large share in the overall service industry.² Although we have witnessed such tendencies, existing studies (e.g., Markusen, 1989; Wong *et al.*, 2006; Ishikawa *et al.*, 2010) do not directly shed light on the service with location.³

In the service-with-location industry, service-providing cost is an important factor in determining firm location. Costs differ between cities, regions, and countries and often change depending on wages, government policies and regulations, and R&D investment by firms. How are such changes in service cost favorable for economies? It is worthwhile to clarify the effect of changes in service cost considering the recent importance of the service industry.

The purpose of this note is to clarify the effect of service cost on economic welfare. We build a simple model to examine this effect. We consider two regions with different marginal costs for providing service. Firms simultaneously determine in which region to locate. Firms can provide services only where they are located. After their location choice, firms compete in Cournot fashion in each region. Under this setting, we investigate how an increase in service cost changes the surplus for producers, consumers, and the overall economy. If it increases the surplus, we interpret the change as favorable.

We demonstrate that an increase in service cost is not favorable for producers; it may be favorable for consumers, especially if service cost changes in the region with higher marginal cost and the total number of firms is sufficiently small; it is not favorable for the overall economy. The result implies the possibility that a reduction in service cost makes consumers worse off, although it may make the overall economy better off. The result also explains the incentive for the government to implement policies to reduce service costs.

¹This property is called “simultaneity of consumption and production” (Wong *et al.*, 2006).

²Magdeleine and Maurer (2008) report that the share of service with location, which is categorized as *commercial presence* in the General Agreement on Trade in Services (GATS), is about 55-60% in the total service trade in 2005.

³Markusen (1989) considers service as an intermediate good. Wong *et al.* (2006) investigate the effects of trade liberalization in service. Ishikawa *et al.* (2010) focus on foreign direct investment in aftermarket service.

2 The Model

We focus on a service industry in an economy with two regions: regions L and H . In this industry, there are N symmetric service-providing firms. Because of some managerial resource constraints, we assume that the total number of firms, N , is exogenously given. When firms locate, they incur a fixed entry cost, f , which is assumed to be common between these two regions.⁴ f is sufficiently large for each firm to locate in only one of these regions. By providing service, each firm faces a region-specific marginal cost, c_L or c_H . We assume that $c_L < c_H < 1$. Let n_i be the number of firms locating in region i ($i = L, H$). n_i is endogenously determined as a result of location choice depending on the difference in region-specific marginal costs and rival firms' locations.

Markets are segmented because each firm can provide services only in the place where it locates. The inverse demand function in the market in region i is given by

$$p_i = p_i(X_i) = 1 - X_i, \quad (1)$$

where p_i is the price and X_i is the total demand for service in market i .

We consider the following two-stage game. In the first stage, each firm determines its own location to maximize its profit, given the difference in costs and its rival firms' location. In the second stage, firms compete in each market in the Cournot fashion.

3 Equilibrium

We solve the game by using backward induction and obtain the subgame perfect equilibrium.

First, we consider the second stage. We denote the j th firm locating in region i as firm ij ($i = L, H$; $j = 1, \dots, n_i$). Firm ij 's gross profit, π_{ij} , is given by

$$\pi_{ij} = (p_i(X_i) - c_i) x_{ij}, \quad (2)$$

where x_{ij} is firm ij 's output. Then, firm ij 's net profit including the entry cost is then $\pi_{ij} - f$.

From (2), the first order condition for profit maximization is given by

$$p'_i(X_i)x_{ij} + p_i(X_i) - c_i = 0. \quad (3)$$

⁴This assumption illustrates the situation where the setup cost necessary for providing service is legally determined in the economy.

From the symmetry of firms, firms' individual outputs and profits are at the same level in the equilibrium. Furthermore, the equilibrium total output is the sum of firms' individual outputs. Using superscript e to express the equilibrium value and denoting $x_{ij}^e = x_i^e$ and $\pi_{ij}^e = \pi_i^e$, we have

$$x_i^e = \frac{\alpha(c_i)}{n_i + 1}, \quad \pi_i^e = (x_i^e)^2 = \left(\frac{\alpha(c_i)}{n_i + 1} \right)^2, \quad \text{and} \quad X_i^e = n_i x_i^e = \frac{\alpha(c_i) n_i}{n_i + 1}, \quad (4)$$

where $\alpha(c_i) \equiv 1 - c_i$.

We now consider the first stage. Each firm determines its location to maximize its profit. The equilibrium location is defined as follows.

Definition (Equilibrium Location)

The equilibrium location (n_L^e, n_H^e) is a pair of firms locating in each region such that

- (i) $n_L^e + n_H^e = N$;
- (ii) $\pi_L(n_L^e) - f \geq \pi_H(n_H^e + 1) - f$ and $\pi_L(n_L^e + 1) - f \leq \pi_H(n_H^e) - f$;
- (iii) Each firm maximizes its profit; i.e. equation (3) holds for each firm.

Condition (i) implies that each firm locates in either region L or region H . Condition (ii) illustrates that no firms have incentives to change their locations because the change in location cannot increase their profits. Note that at this moment, any firms take into consideration the effect of changing location on prices and on the rivals' output responses.

Here, for analytical simplicity, we approximate the number of firms as a continuous variable.⁵ Then, condition (ii) for the equilibrium location is replaced by

$$\pi_L(n_L^e) - f = \pi_H(n_H^e) - f. \quad (5)$$

In other words, the net profit of each firm is equalized across the markets.⁶ Let us define $\sigma(c_L, c_H) \equiv \alpha(c_L) + \alpha(c_H) = 2 - c_L - c_H$ and $\delta(c_L, c_H) \equiv \alpha(c_L) - \alpha(c_H) = c_H - c_L$. Both parameters are positive because $c_L < c_H < 1$. Then, we obtain the following equilibrium location:

$$(n_L^e, n_H^e) = \left(\frac{\alpha(c_L)N + \delta(c_L, c_H)}{\sigma(c_L, c_H)}, \frac{\alpha(c_H)N - \delta(c_L, c_H)}{\sigma(c_L, c_H)} \right). \quad (6)$$

⁵This implies that we ignore the "integer problem." This approach was often adopted in the research on "excess entry" (e.g., Suzumura and Kiyono, 1987).

⁶This is a sufficient condition for condition (ii), because $\pi_L(n_L^e) = \pi_H(n_H^e) = \pi_H(N - n_L^e) > \pi_H(N - n_L^e + 1)$ and $\pi_L(n_L^e + 1) < \pi_L(n_L^e) = \pi_H(n_H^e) = \pi_H(N - n_L^e + 1)$.

From (6), $n_L^e > n_H^e$ because $c_L < c_H$. Substituting (6) into equations (4), we then obtain the equilibrium outputs, profits, and total profits as follows:

$$\begin{aligned} x_L^e = x_H^e &= \frac{\sigma(c_L, c_H)}{N+2}, \quad \pi_L^e = \pi_H^e = \left(\frac{\sigma(c_L, c_H)}{N+2} \right)^2, \\ X_L^e &= \frac{\alpha(c_L)N + \delta(c_L, c_H)}{N+2}, \text{ and } X_H^e = \frac{\alpha(c_H)N - \delta(c_L, c_H)}{N+2}. \end{aligned} \quad (7)$$

4 Effects of Service Cost

We now examine the welfare effects of service cost. We focus on changes in producer surplus, consumer surplus, and social surplus induced by a change in service cost in each country. If it increases the surplus, we interpret the change as favorable.

Before starting, we state two properties. The first relates to the equilibrium number of firms. Partially differentiating (6) with respect to c_i ,

$$\frac{\partial n_i^e}{\partial c_i} = -\frac{\alpha(c_i)(N+2)}{\sigma(c_L, c_H)^2} < 0 \quad \text{and} \quad \frac{\partial n_j^e}{\partial c_i} = \frac{\alpha(c_j)(N+2)}{\sigma(c_L, c_H)^2} > 0. \quad (8)$$

An increase in c_i makes region i less attractive for firms, and thus decreases n_i^e and increases n_j^e .

The second property relates to the equilibrium outputs and profits. Partially differentiating (7) with respect to c_i , we have

$$\frac{\partial x_i^e}{\partial c_i} = \frac{\partial x_j^e}{\partial c_i} = -\frac{1}{N+2} < 0, \quad \frac{\partial \pi_i^e}{\partial c_i} = \frac{\partial \pi_j^e}{\partial c_i} = -2x_i \frac{\partial x_i}{\partial c_i} < 0, \quad (9)$$

$$\frac{\partial X_i^e}{\partial c_i} = -\frac{N+1}{N+2} < 0, \quad \text{and} \quad \frac{\partial X_j^e}{\partial c_i} = \frac{1}{N+2} > 0. \quad (10)$$

In particular, (9) illustrates a specific property: a change in service cost has the same effect on each producer regardless of where it locates. We can understand the background of this property by partially differentiating (4) with respect to c_i :

$$\frac{\partial x_i^e}{\partial c_i} = -\frac{1}{n_i^e + 1} - \frac{\alpha(c_i)}{(n_i^e + 1)^2} \frac{\partial n_i^e}{\partial c_i} < 0, \quad (11)$$

$$\frac{\partial x_j^e}{\partial c_i} = -\frac{\alpha(c_j)}{(n_j^e + 1)^2} \frac{\partial n_j^e}{\partial c_i} < 0. \quad (12)$$

For an increase in c_i , some firms move from region i to region j . In (11), the first term shows a change in output directly induced by changing cost, and the second term stands for a change in output indirectly induced by changing regional

competition: i.e. decreasing the number of locating firms. The former effect is negative, while the latter effect is positive because the number of firms decreases and firms' individual output increases. Since the effect of direct change in service cost dominates that of indirect change in competition, the sign of (11) is negative. In (12), there is a sole term, which shows a change in output induced by changing regional competition (i.e., increasing the number of locating firms, whose sign is negative). Since $\pi_i^e = (x_i^e)^2$, changes in the equilibrium profits are in the same direction as those in the equilibrium outputs.

We now focus on the effect of a change in service cost on producer surplus. Let PS_i and PS be the producer surplus in country i and the overall producer surplus, respectively. In our setup, producer surplus in country i is given by

$$PS_i \equiv n_i(\pi_i - f), \quad (13)$$

and the overall producer surplus is then organized as $PS = \sum_{i=L,H} PS_i$. Partially differentiating (13) with respect to c_i yields

$$\frac{\partial PS_i}{\partial c_i} = \frac{\partial n_i}{\partial c_i}(\pi_i - f) + n_i \frac{\partial \pi_i}{\partial c_i}, \quad (14)$$

$$\frac{\partial PS_j}{\partial c_i} = \frac{\partial n_j}{\partial c_i}(\pi_j - f) + n_j \frac{\partial \pi_j}{\partial c_i}. \quad (15)$$

Effects of an increase in c_i consist of two parts. The first is the effect induced by the change in the number of firms. The second is the effect from changes in profits. For an increase in c_i , the first effect is negative for producers in region i and positive in region j . Partially differentiating PS is the sum of equations (14) and (15).

From (5), the equilibrium net profits are equalized. Thus, the first terms of equations (14) and (15) are offset in the equilibrium. Letting π^e be the equilibrium gross profit, the change in total output by c_i is

$$\frac{\partial PS^e}{\partial c_i} = (n_i^e + n_j^e) \frac{\partial \pi^e}{\partial c_i} < 0. \quad (16)$$

Proposition 1

An increase in c_i is not favorable for producers for all $i = L, H$.

Proposition 1 implies that a reduction in service cost is favorable for firms, regardless of where it occurs.

We next consider the effects of a change in service cost on consumer surplus. Let CS_i and CS be consumer surplus in region i and the overall consumer surplus, respectively. The consumer surplus in region i is given by

$$CS_i \equiv \int_0^{X_i} p_i(z) dz - p_i(X_i)X_i, \quad (17)$$

and the overall consumer surplus is organized as $CS = \sum_{i=L,H} CS_i$. Partially differentiating (17) with respect to c_i , we have

$$\frac{\partial CS_i}{\partial c_i} = -p'_i(X_i)X_i \frac{\partial X_i}{\partial c_i} < 0 \quad \text{and} \quad \frac{\partial CS_j}{\partial c_i} = -p'_j(X_j)X_j \frac{\partial X_j}{\partial c_i} > 0. \quad (18)$$

(18) shows that the effects of a change in service cost for consumers are those brought about changes in prices. If an increase in c_i occurs, it raises the price in region i and lowers that in region j . An increase in c_i thus decreases consumer surplus in region i and increases consumer surplus in region j .

Partially differentiating CS with respect to c_L yields

$$\frac{\partial CS^e}{\partial c_L} = -p'(X_L)X_L \frac{\partial X_L^e}{\partial c_L} - p'(X_H)X_H \frac{\partial X_H^e}{\partial c_L} = \frac{-(N+1)X_L^e + X_H^e}{N+2}. \quad (19)$$

Since $X_L^e > X_H^e$ from (7), the sign of (19) is negative. Partially differentiating this with respect to c_H yields

$$\frac{\partial CS^e}{\partial c_H} = -p'(X_L)X_L \frac{\partial X_L^e}{\partial c_H} - p'(X_H)X_H \frac{\partial X_H^e}{\partial c_H} = \frac{X_L^e - (N+1)X_H^e}{N+2}. \quad (20)$$

The sign of (20) is ambiguous and depends on the sign of the numerator. From (7), we find that if $\alpha(c_H)N^2 - 2\delta(c_L, c_H)N - 2\delta(c_L, c_H) < 0$, the numerator is positive.

Proposition 2

An increase in c_L is not favorable for consumers. An increase in c_H is favorable for consumers if $N < \bar{N}$, where

$$\bar{N} \equiv \frac{\delta(c_L, c_H) + \sqrt{\alpha_L(c_L)\delta(c_L, c_H)}}{\alpha_H(c_H)}. \quad (21)$$

Proposition 2 implies that cost reduction may be globally unfavorable for consumers depending on the region in which the cost reduction occurs and the total number of firms in the service industry.

The intuitive reason for Proposition 2 is as follows. As shown before, an increase in c_i decreases the equilibrium number of firms in region i and increases that in region j . Then, the total output decreases and the price increases in region i . The opposite relation applies in region j . An increase in c_i is thus negative for the consumers in region i and positive in region j . The effect on the overall consumer surplus is obtained by adding the effects between the two regions. For an increase in c_L , the negative effect in region L dominates the positive effect in region H , because the total output in region L is larger. In contrast, for an increase in c_H , the negative effect in region L can be dominated by the positive

effect in region H because the total output in region H is smaller. When N is small, the share of each firm is large. Thus, for N less than $\bar{N}$, the location change from region H to L strikingly decreases consumer surplus in region L and therefore increases the overall consumer surplus.

Finally, we focus on the effect of a change in service cost on the overall economy. Social surplus is given by

$$W \equiv PS + CS. \quad (22)$$

(22) implies that the effect on the social surplus is the sum of the effects on producer surplus and consumer surplus. With respect to the effect on producer surplus, (14) and (15) are rewritten as

$$\frac{\partial PS_i}{\partial c_i} = \frac{\partial n_i}{\partial c_i}(\pi_i - f) + p'_i X_i \frac{\partial X_i}{\partial c_i} + n_i(p_i - c_i) \frac{\partial x_i}{\partial c_i} - n_i x_i, \quad (15')$$

$$\frac{\partial PS_j}{\partial c_i} = \frac{\partial n_j}{\partial c_i}(\pi_j - f) + p'_j X_j \frac{\partial X_j}{\partial c_i} + n_j(p_j - c_j) \frac{\partial x_j}{\partial c_i}. \quad (16')$$

The first terms stand for effects by changing the number of firms. These correspond to the third terms in equations (15) and (16). The sign is negative in equation (15') and positive in equation (16'). The second terms are effects on prices for producers. The sign is positive in equation (15') and negative in equation (16'). Note that these signs are opposite of the effects on prices for consumers in (18). The third terms are effects caused by changes in firms' individual output. Recall that both terms are negative. The fourth term in equation (15') is an effect caused by a direct change in service cost, whose sign is negative. With respect to the effect on consumer surplus, we have (18), the sole effect on prices.

Summing the effects on producers and consumers, the second terms in equations (15') and (16') are offset by the effect on prices for consumers. Further, in the equilibrium, the first terms in equations (15') and (16') are offset because the equilibrium net profits are equalized. Therefore, in the equilibrium, the effect of a change in service costs on the social surplus is

$$\frac{\partial W^e}{\partial c_i} = n_i^e(p_i - c_i) \frac{\partial x_i^e}{\partial c_i} + n_j^e(p_j - c_j) \frac{\partial x_j^e}{\partial c_i} - n_i^e x_i^e < 0.$$

Proposition 3

An increase in c_i is not favorable for the overall economy for all $i = L, H$.

Proposition 3 implies that a reduction in service cost is favorable regardless of where it occurs and the number of firms. This result explains the incentive of governments to implement policies to reduce in service cost. It also implies that if a cost reduction is realized by a local policy, the central government must consider where to implement it. Moreover, if a cost-reducing policy is conducted in a region with a higher cost, the total number of firms in the industry must be considered.

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