Market Size, Strategic Location Decision, and Social Welfare *

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Abstract

We examine whether firm's location choice is efficient for viewpoint of social welfare when there exist a fixed number of firms, each of which enters either large size market or small size one. We establish: location in large markets is excessive from viewpoint of both the social surplus and producer surplus, while it is insufficient from consumer surplus.

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1 Introduction

It is often observed that many commodities have several segmented markets, whose market sizes are different. The number of firms located in a large size market is larger than that of firms located in a small size market. Is firm's location decision efficient for viewpoint of social welfare? The purpose of this paper is to address the question.

We construct a simple model: There are two segmented markets, whose market size is different, called *large market* and *small market*. Each firm, whose total number is fixed, determines where it locates. Given firms' location decision, each firm competes in Cournot fashion. We establish: Whereas the number of firms located in large market is insufficient from consumer surplus viewpoint, it is excessive from producer and total surpluses viewpoint. [1]

Our analysis is closely related to the literatures about welfare effect of entry. Mankiw and Whinston (1986) and Suzumura and Kiyono (1987) obtained *excess entry theorem*: Under an oligopolistic market with entry, marginal decreases in long-run equilibrium number of firms improve social welfare. This is called excess entry theorem. Our paper differs from those articles in two points. The total number of firms is fixed in our analysis, while the number is endogenously determined in the "excess entry" papers. Our paper analyzes where markets each firm locates, whist the "excess entry" papers focus on whether each firm enters a *single* market. That is, our paper analyzes the *location* of each firm, while those literatures examines the *entry* of each firm.

The problem of firm location has been studied mainly in the *economic geography* for the last two decades. The literatures (*e.g.*, Krugman (1991), Fujita, Krugman and Venables (1999), Baldwin, *et. al.* (2003)) have dealt with firm's location choice. Our analysis differs from theirs in the following sense: those article explain firm's location choice by the movement of labor and these mainly examine how agglomeration or dispersion emerges in the equilibrium.

[1] Kurata, Ohkawa and Okamura (2006), in which they consider the validity of the optimality for the location choice in the model where firm locates in either of two identical segmented markets. They established: Whereas location equilibrium is from both consumer's welfare and the whole economy welfare viewpoints, it is excessive from producer's welfare viewpoint.

The remaining of our paper is organized as follows: Section 2 presents our model and derives preliminary results. Section 3 shows main results. Section 4 concludes.

2 The Model and The Preliminary Result

There are two segmented markets with different size, called large market L and small market S. An inverse demand function of market $i(= L, S)$ satisfies the following properties: $p_L = p_L(X_L) = kp(X_L), p_S = p_S(X_S) = p(X_S), p'(X_i) < 0, i = L, S.$ where X_i represents total output in market i, p_i is the market i's price, and k is a parameter represented market size differences. [2] The inverse demand function also holds that $kp(X) > p(X)$ for $\forall X > 0$.

Each identical firm produces a homogenous good. The firms engage in the following two stage game: In the first stage, each firm determines which market it enters simultaneously. [3] In the second stage, given firms' location choices, it competes in Cournot fashion. The total number of firms N is fixed due to resource constraint. Each firm's cost function is $C_{ij} = cx_{ij} + F, i = L, S, j = 1, ..., N$ where x_{ij} is quantity supplied by firm j in market i, c is a marginal cost, $F(\geq 0)$ is an entry cost.

We derive a subgame perfect equilibrium of the game by backward induction. At the second stage, given the number of firms in market i, n_i, the profit-maximizing condition for each firm in market i, is given by

$$p_i'(X_i)x_{ij} + p_i(X_i) - c = 0. \tag{1}$$

We focus on the symmetric equilibrium, i.e., $x_{ij} = x_i$. The equilibrium profit of each firm in market i is

$$\pi_i = [p_i(X_i) - c]x_i - F. \tag{2}$$

From (1) and (2), each firm's equilibrium output, equilibrium total output, and the resulting profit π_i are function of the number of firms in the either market L or S; that is, $x_i = x_i(n_i)$, $X_i = X_i(n_i) = n_i x_i(n_i)$, and $\pi_i = \pi_i(n_i)$

[2] This type of demand function is used by "location choice" literatures (*e.g.*, Haufler and Wooton (1999)).
[3] We do not consider the case where a firm enters both markets.

We impose the assumptions:

Assumption 1 (nonnegative profit condition)

The equilibrium profit in market i is nonnegative for any pattern of firm's location. [4]

Assumption 2 (quasi-competitiveness)

The increases in n_i enhances total output in market i, X_i.

Under these assumptions, we can prove the following lemma:

Lemma 1

The equilibrium profit in either market decreases with the number of firms, i.e., $\pi_i'(n_i) < 0$.

Proof. Differentiating $\pi_i(n_i)$, we have

$$\pi_i'(n_i) = (p_i - c)x_i'(n_i) + p_i'(X_i)x_i X_i'(n_i).$$

Considering (1), we transform the above equation into

$$\pi_i'(n_i) = p_i'(X_i)x_i[X_i'(n_i) - x'(n_i)].$$

When $x_i'(n_i)$ is nonpositive, the sign of $\pi_i'(n_i)$ is negative because of Assumption 2. When $x_i'(n_i)$ is positive, the sign of $\pi_i'(n_i)$ is also negative because $X_i'(n_i) - x_i'(n_i) = x_i + (n_i - 1)x_i'(n_i)$.

□

Let consider the first stage. If the resulting profit differs in either market, for a pattern of the firms location, any firms located in the less profit market have an incentive to move another market. At location equilibrium, the resulting profit must be equalized in both market. [5] Then, we define

Definition

The location equilibrium (n_L^e, n_S^e), $n_L + n_S = N$

[4] This assumption ensure that agglomeration does not occur, and that all firm can always enter either market L or S.

[5] We ignore the "integer" problem of the game.

(i) $\pi_L(n_L^e) = \pi_S(n_S^e)$,

(ii)For given n_i, equation (1) holds.

We also impose

Assumption 3

$\pi_L(n) > \pi_S(n)$ *for any* n.

This assumption means that a firm can earn more profits located in the large market than in the small one.

We obtain

Proposition 1

At the location equilibrium, the equilibrium number of firms in large market is greater than that of firms in small one.

Proof. Suppose that $n_L^e \leq n_S^e$. From Assumption 3 and Lemma 1, we have

$$\pi_L(n_L^e) \geq \pi_L\left(\frac{N}{2}\right) > \pi_S\left(\frac{N}{2}\right) \geq \pi_S(n_S^e),$$

which contradicts the location equilibrium condition. □

3 The Main Results

3.1 Location Inefficiencies for Consumer's Viewpoint

The consumers welfare of the economy W_C is the sum of consumer's surplus in each market. The consumer's surplus in each market is defined as

$$CS_i = \int_0^{X_i} p_i(s)ds - p_i(X_i)X_i. \tag{3}$$

Differentiating (3) with respect to n_i and considering $X_i = n_i x_i$ yield

$$\frac{\partial CS_i}{\partial n_i} = -p_i'(X_i)X_i\frac{dX_i}{dn_i} = -p_i'(X_i)X_i x_i - p_i'(X_i)X_i n_i\frac{dx_i}{dn_i}. \tag{4}$$

The first term of (4) represents a *direct price effect* on consumer's expenditures caused by relocation, and the second term shows the *indirect price effect* on consumer's expenditures through all incumbents' strategic response against relocation.

Using (1), (4) can be rewritten as

$$\frac{\partial CS_i}{\partial n_i} = n_i[p_i(X_i) - c]x_i - n_i[p_i(X_i) - c]x_i\theta_i, \tag{5}$$

where $\theta_i = -\frac{n_i}{x_i}\frac{\partial x_i}{\partial n_i}$, which means a firm's output elasticity of number of firms. We impose the following for the elasticity:

Assumption 4

The elasticity θ_i is independent of the market size, and increasing in n_i. [6]

We examine the relocation effect from the small market S to the large one L evaluated at the location equilibrium. To do so, we introduce the new parameter z such that $\frac{dn_L}{dz} = 1$ and $\frac{dn_S}{dz} = -1$. From (6), we derive

$$\frac{\partial W_D}{\partial z} = \frac{\partial}{\partial z}(CS_L + CS_S) = \Pi(n_L - n_S) + \Pi(\theta_S n_S - \theta_L n_L) \tag{6}$$

where Π is gross profit at the location equilibrium, i.e., $\Pi = [p(X_L) - c]x_L = [p(X_S) - c]x_S$. The first term on the RHS of (6) is the differences of the direct price effect between two markets, whose sign is positive. The second one represents the differences of the indirect price effect between two markets, whose sign is negative. Thus, we establish

[6] This assumption holds under any demand function in following class:

$$p_L = k[1 - X_L]^{\alpha+1}, p_S = [1 - X_S]^{\alpha+1},$$

where $\alpha > -1$ and $k > 1$. This includes linear demand function as well as constantly elastic demand function. From (1), we compute equilibrium firm's output in above class of demand function:

$$x_i = \frac{1}{n_i}\left[\frac{n_i(1 - c_i)}{n_i + \alpha + 1}\right]^{\frac{1}{1+\alpha}},$$

where $c_L = \frac{c}{k}$ and $c_S = c$. Therefore, we obtain

$$\theta_i = \frac{n_i + \alpha}{n_i + \alpha + 1},$$

which means that θ_i is independent of k and increasing function of n_i.

Proposition 2

If the direct price effect dominates indirect one, then firms locate in large market insufficiently from consumer's welfare viewpoint.

Corollary 1

Suppose that demand function satisfies the class shown in footnote 6. Then, firms locate in large market insufficiently from consumer's welfare viewpoint.

Proof. We transform (6) into

$$\frac{\partial W_D}{\partial z} = \Pi[(1-\theta_L)n_L - (1-\theta_S)n_S].$$

Under the above demand function, we have $\theta_i = \frac{n_i+\alpha}{n_i+\alpha+1}$ shown in footnote 6. Substituting it into the above equation yields

$$\frac{\partial W_D}{\partial z} = \Pi\left[\frac{n_L}{n_L+\alpha+1} - \frac{n_S}{n_S+\alpha+1}\right].$$

Since $\frac{n_i}{n_i+\alpha+1}$ is an increasing function of n_i, the sign on the RHS of the above equation is positive. □

3.2 Location Inefficiencies for Producer's Viewpoint

We consider whether firms enter the large market efficiently from producer's welfare viewpoint. The producer's welfare of the economy W_P is the sum of producer's surplus in each market, $PS_i = n_i\pi_i$. The effect of n_i on the producer's surplus in each market is given by

$$\frac{\partial PS_i}{\partial n_i} = [(p_i - c)x_i - F] + n_i p_i' x_i X_i'(n_i) + n_i(p_i - c)\frac{\partial x_i}{\partial n_i}. \tag{7}$$

The first term of (7) represents an entering or exiting firm's profit. The second one shows a price effect on the incumbents' revenue associated with relocation. The third one is a change in incumbents' profits through strategic interaction against relocation.

By the same parameter z, we examine the relocation effect from the small market S to the large one L evaluated at the location equilibrium. From (1) and (7), we derive

$$\frac{\partial W_P}{\partial n} = \Pi(n_S - n_L) + \Pi(\theta_L n_L - \theta_S n_S) + \Pi(\theta_S - \theta_L). \tag{8}$$

The first term of (8) represents differences of the direct price effect on the firms' revenues. The second one means differences of the indirect price effect on the firms' revenue. The third one is differences of strategic effect of relocation. The sign of the first and that of the third one are negative, whilst the sign of the second one is positive. Note that the scale of the first (the second) term of (9) is equal to that of the first (the second) term of (5), because consumers' total expenditures equals producers' total revenue. Therefore, we can transform (8) into

$$\frac{\partial W_P}{\partial z} = -\frac{\partial W_C}{\partial z} + \Pi(\theta_S - \theta_L). \tag{9}$$

Thus, we establish

Proposition 3

If the differences of the direct effect dominates that of indirect one, then firms locate in large market excessively from producer's welfare viewpoint.

Corollary 2

Suppose that demand function satisfies the class shown in footnote 6. Then, firms locate in large market excessively from producer's welfare viewpoint.

3.3 Location Inefficiencies for Whole Economy Viewpoint

A whole economy welfare, W is defined as a sum of consumer's surplus and producer's surplus. The whole economy welfare effect of relocation from the small market S to the large one L evaluated at the location equilibrium is derived from (9):

$$\frac{\partial W}{\partial n} = \frac{\partial W_D}{\partial n} + \frac{\partial W_P}{\partial n} = \Pi(\theta_S - \theta_L) \tag{10}$$

Thus, we establish

Proposition 4

Firms locate in large market excessively from whole economy welfare viewpoint.

4 Concluding Remarks

We examine whether firm's location decision is efficient for viewpoint of social welfare when firm enter the either large size market or small size one. We establish: Whereas location in large market is insufficient from consumer's welfare viewpoint, it is excessive from both producer's welfare and the whole economy welfare viewpoints.

Our research is, for instance, applicable to a service FDI, in which all foreign firms undertake to enter either a large or a small domestic markets. Our results suggests that location equilibrium in the service FDI is inefficient in the sense that whereas location in large market is insufficient from domestic country's welfare viewpoint, it is excessive from both foreign country's welfare and the whole economy welfare viewpoints.

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