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REGIONAL RESTRICTION, STRATEGIC DELEGATION, AND WELFARE

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Abstract

We investigate the effects of restricting locations of firms into Hotelling duopoly models. In the standard location-price models, the equilibrium distance between firms is too large from the viewpoint of consumer welfare. Thus, restricting locations of firms and reducing the distance between firms improve consumer welfare, through lower prices and smaller transportation costs for consumers. We introduce strategic reward contracts into the location-price models. We find that in contrast to the above existing result, restriction of the locations of firms *reduces* consumer welfare. Restricting locations of the firms reduces transportation costs but *increases* the prices through the change of strategic commitments by the firms, and it yields a counterintuitive result.

JEL classification: R52, R32, L13

Key words: product selection, delegation, Hotelling, locational restriction

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1 Introduction

In this paper, we consider the effects of regional restrictions on consumer welfare. We use two standard location-price models on the Hotelling line—one that restricts the locations of firms within the city (d'Aspremont et al. (1979)) and the that other does not impose any such restriction (Tabuchi and Thisse (1995) and Lambertini (1997)). The latter two papers show that the firms locate outside the city if they are allowed to do so. The outside locations yield higher equilibrium prices and larger transportation costs of consumers. Thus, it is obvious that restricting the locations of firms improves consumer welfare. In our paper, however, we show that this welfare property does not hold under a plausible strategic environment.

We introduce strategic reward contracts that are quite popular in the literature on management science and industrial organization. We find that the symmetric equilibrium price in which the firms are not allowed to locate outside the city is *higher* than that in which the firms are allowed to locate outside if the firms can make strategic commitments through reward contracts. On the other hand, the restriction on the firms' locations reduces the transportation costs of consumers. The higher price and the lower transportation costs represent a trade-off. In this setting, the negative effect dominates the positive one—that is, restricting the locations of firms *reduces* consumer welfare when firms can make strategic commitments through reward contracts. Moreover, we show that the symmetric equilibrium price without strategic reward contracts is higher (smaller) than that with them when the firms are (not) allowed to locate outside the city.

The matter discussed here is related to the following fact. In many countries, large stores often locate in suburban areas where the population densities are quite small. Regulations governing stores' locations in suburban areas have been repeatedly discussed to realize a "compact city" that will yield reduction in the environmental damage arising from commute to and from stores, and will also help consumers who do not drive and/or own cars. For example, in Japan, the so called "Three Laws of Community Building" have been in force since 2000 and were further strengthened in 2006; even then, there are discussions on further regulations with regard to the centralization of the store locations.[1] Given such discussions, it is important to discuss whether or not regional restrictions on suburban areas are beneficial.

There are two closely related articles that discuss optimal zoning. Using a standard Hotelling model a la d'Aspremont et al. (1979), Lai and Tsai (2004) show that restricting the locations of firms reduces both transport costs and prices, resulting in an improvement in consumer surplus as well as total social surplus. Chen and Lai (2008) discuss optimal zoning in a spatial Cournot model. There are at least two differences between these two papers and our paper. First, we consider the relation between the strategic commitments of firms and equilibrium outcomes whereas these two papers do not. Second, we mainly consider whether or not the firms should be allowed to locate outside the linear city whereas the above two papers discuss zoning policies within the city. Our setting is closely related to the problem of urban sprawl whereas the two papers are related to the problem of zoning within a city.

We now briefly mention the importance of studying the case where ownership and management are separated. Traditional economic theories assume that the single aim of the firms is profit maximization. In large companies, however, ownership and management are separated, and managerial decision processes are rather complex. In his classical paper, Baumol (1958) mentioned that managers may be guided by objectives other than pure profit-maximization, and he suggested a sales-maximization model as a more realistic alternative. Later, economists noticed that the owners of firms have strategic incentives to link sales to managers' rewards. Fershtman (1985), Vickers (1985), Fershtman and Judd (1987), and Sklivas (1987) made path-breaking contributions in this regard. They considered the separation of owners and managers, and examined the following two-stage game: in the first stage, the owner makes the manager's contract and announces it publicly; in the second stage, after observing the contract, the manager maximizes the payoff given the reward contract. In these papers, the managers' rewards are proportional to a linear combination of profits and outputs or sales. Since the model formulation of the abovementioned works is quite realistic and

[1] Before 2000, there existed a Law on the Locations of Large Stores, which restricted, rather than promoted, the placement of large stores in the city's central district. For the emergence of "Big Box" retail stores in the U.S., see Denning and Lary (2005), Haltiwanger et al. (in press), and the references therein.

explains many of the actual behaviors of the firms, their model has become one of the most popular models in the fields of industrial organization and management science (Jansen et al., 2007).

Subsequent works on this separation of ownership and management showed that the reward contract is crucially dependent on model formulation such as price or quantity competition (strategic complement or substitute). In the context of price competition, the managers' rewards are usually decreasing in the firms' sales; further, this also holds in the location-price model where the firms' locations are restricted within the city. Our result suggests, however, that this does not hold in the location-price model where the firms are allowed to locate outside the city. As mentioned earlier, the managers' rewards are increasing in the sales of the firms and this yields aggressive price competition and improves consumer welfare.

The remainder of this paper is organized as follows. Section 2 formulates the model. Section 3 presents the equilibrium outcomes in the two models. We compare the outcomes and the results derived by the standard location models. Section 4 shows the main result. Section 5 concludes the paper.

2 Model

Consider a linear city along the unit interval $[0, 1]$, where consumers are uniformly distributed along the interval. Firm i $(i = 1, 2)$ is allowed to locate at $x_i \in [\alpha, \beta]$ where $\alpha \leq 0$ and $\beta \geq 1$. If $\alpha = 0$ and $\beta = 1$, the model corresponds to that in d'Aspremont et al. (1979), i.e., the firms are allowed to locate within the city. If α is sufficiently small and β is sufficiently large, the model corresponds to that in Tabuchi and Thisse (1995) and Lambertini (1997). Without loss of generality, we assume that $x_1 \leq x_2$.

Each consumer buys exactly one unit of the good, which can be produced by either firm 1 or 2. Let p_i denote the price of firm i $(i = 1, 2)$. The utility of the consumer located at x is given by

$$u_x = \begin{cases} v - t(x_1 - x)^2 - p_1 & \text{if bought from firm 1,} \\ v - t(x_2 - x)^2 - p_2 & \text{if bought from firm 2,} \end{cases} \tag{1}$$

where v is a positive constant and sufficiently large, and t represents the exogenous parameter of the transport cost incurred by the consumer. For a consumer living at $x(p_1, p_2, x_1, x_2)$, where

$$-t(x_1 - x(p_1, p_2, x_1, x_2))^2 - p_1 = -t(x_2 - x(p_1, p_2, x_1, x_2))^2 - p_2, \tag{2}$$

the utility is the same regardless of the firm chosen. We can rewrite (2) as follows:

$$x(p_1, p_2, x_1, x_2) = \frac{x_1 + x_2}{2} + \frac{p_2 - p_1}{2t(x_2 - x_1)}.$$

Thus, the demand facing firm 1, D_1, and that facing firm 2, D_2, are given by

$$\begin{aligned} D_1(p_1, p_2, x_1, x_2) &= \min\{\max(x(p_1, p_2, x_1, x_2), 0), 1\}, \\ D_2(p_1, p_2, x_1, x_2) &= 1 - D_1(p_1, p_2, x_1, x_2). \end{aligned} \tag{3}$$

We assume that the owners of both the firms hire a manager to delegate the price and the location decisions. The manager is offered a contract that is publicly observable. In this contract, the manager receives a fixed salary and a bonus related to the firm's profits and market share. In particular, if profits π_i are positive, the manager of firm i receives a bonus that is proportional to the linear combination

$$U_i = \pi_i + \lambda_i D_i,$$

where the weight λ_i is a real number chosen by owner i in order to maximize his profits, and profits π_i (the owner i's profits) are represented by

$$\pi_1 = (p_1 - c)D_1(p_1, p_2, x_1, x_2), \quad \pi_2 = (p_2 - c)D_2(p_1, p_2, x_1, x_2),$$

where c is the marginal cost of both the firms. Note that, in this model, D_i is not only the quantity supplied by firm i but also the market share of firm i because the total demand is normalized to 1. Thus, we can say that the model setting in this paper follows that in Jansen et al. (2007).

Consumer surplus and social welfare are given by

$$\begin{aligned} CS &= \int_0^{D_1} (v - p_1 - t(x - x_1)^2)dx + \int_{D_1}^1 (v - p_2 - t(x_2 - x)^2)dx, \\ SW &= \int_0^{D_1} (v - c - t(x - x_1)^2)dx + \int_{D_1}^1 (v - c - t(x_2 - x)^2)dx. \end{aligned}$$

The game runs as follows. In the first stage, each owner seeks to maximize his profits by properly choosing the weight in the manager's contract λ_i. In the second stage, manager i chooses its location

x_i, and in the third stage, manager i chooses its price $p_i \in [c - c_i, \infty)$. Note that, we consider two cases concerning the location choices of the firms in the second stage: (i) the firms are not permitted to locate outside the line and (ii) the firms are permitted to locate outside the line.

3 Equilibrium

In this section, we derive the equilibrium locations, the managers' contracts, profits, consumer surplus, and total social surplus in the two models. One is the model wherein $\alpha = 0$ and $\beta = 1$. The other is the model wherein α is sufficiently small and β is sufficiently large that the restriction $\alpha \leq x_i \leq \beta$ is not binding.

First, we investigate the price competition stage. Given the locations of the firms, x_1 and x_2, the managers face Bertrand competition. The manner of competition is common between the two models. Let the superscript "B" denote the equilibrium outcome at the price-competition stage given x_1 and x_2. The equilibrium prices are

$$\begin{aligned} p_1^B &= \frac{3c - 2\lambda_1 - \lambda_2 + t(2 + x_1 + x_2)(x_2 - x_1)}{3}, \\ p_2^B &= \frac{3c - 2\lambda_2 - \lambda_1 + t(4 - x_1 - x_2)(x_2 - x_1)}{3}. \end{aligned}$$

Then, the managers' rewards are given by

$$\begin{aligned} U_1^B &= \frac{(\lambda_1 - \lambda_2 + t(2 + x_1 + x_2)(x_2 - x_1))^2}{18t(x_2 - x_1)}, \\ U_2^B &= \frac{(\lambda_2 - \lambda_1 + t(4 - x_1 - x_2)(x_2 - x_1))^2}{18t(x_2 - x_1)}. \end{aligned}$$

3.1 Locations are restricted

As a benchmark, we consider the case in which the locations of the firms are restricted within the linear city, that is, $\alpha = 0$ and $\beta = 1$.

We consider the location choices by the managers. If the difference determined in the first stage ($|\lambda_1 - \lambda_2|$) is not so large,[2] the maximum differentiation appears in equilibrium, that is,

$$x_1 = 1 - x_2 = 0.$$

[2] This difference is related to the discussion on the large cost difference in Matsumura and Matsushima (2009).

Then the profits of the firms, the managers' rewards, the consumer surplus, and social welfare are given by

$$\pi_i^R = \frac{(3t-2\lambda_i-\lambda_j)(3t+\lambda_i-\lambda_j)}{18t},\ U_i^R = \frac{(3t+\lambda_i-\lambda_j)^2}{18t},\ p_i^R = \frac{3(c+t)-2\lambda_i-\lambda_j}{3},$$
$$CS^R = -\frac{36tc-18t(\lambda_i+\lambda_j)-(\lambda_i-\lambda_j)^2+39t^2}{36t},\quad (i=1,2,\ i\neq j),$$

where the superscript "R" denotes the equilibrium outcome in the case where the locations are restricted.

We now obtain the equilibrium value of λ_i $(i=1,2)$. In the first stage, each owner i independently chooses λ_i so as to maximize its profit $\pi_i = \pi_i^R$. The first-order condition is

$$-\frac{3t+4\lambda_i-\lambda_j}{18t} = 0,\quad i=1,2,\ i\neq j. \tag{4}$$

From (4), we have the following lemma:

Lemma 1 *When the firms' locations are restricted, each owner i chooses λ_i at*

$$\lambda_1^{ER} = \lambda_2^{ER} = -t. \tag{5}$$

The profits and the consumer surplus are as follows:

$$x_1^{ER}=0,\ x_2^{ER}=1,\ p_i^{ER}=c+2t,\ \pi_i^{ER}=t,\ CS^{ER}=v-\frac{12c+25t}{12},\ (i=1,2). \tag{6}$$

If each owner is unable to set a negative value of λ_i, the result is

$$x_1^{ER}=0,\ x_2^{ER}=1,\ \lambda_i^{ER}=0,\ p_i^{ER}=c+t, pi_i^{ER}=\frac{t}{2},\ CS^{ER}=v-\frac{12c+13t}{12},\ (i=1,2). \tag{7}$$

In the standard location-price model in d'Aspremont et al. (1979), the equilibrium outcome is as follows:

Result 1 (d'Aspremont et al., 1979): Suppose that each owner directly manages its own firm. When the firms are not allowed to locate outside the linear city, the equilibrium outcome is

$$x_1=0,\ x_2=1,\ \ p_1=p_2=c+t, pi_1=\pi_2=\frac{t}{2},\ CS=v-\frac{12c+13t}{12}. \tag{8}$$

Henceforth, we refer to this case as "the non-delegation case." From (6), (7), and (8), we have the following proposition:

Proposition 1 *Suppose that the firms are not allowed to locate outside the linear city. If each owner can set a negative value of λ_i, the following three properties hold. The equilibrium prices in the delegation case are larger than those in the non-delegation case. The consumer surplus in the delegation case is smaller than that in the non-delegation case. The equilibrium profits in the delegation case are larger than those in the non-delegation case. If each owner is unable to set a negative value of λ_i, the equilibrium outcomes in the delegation case and in the non-delegation case are the same.*

We now mention the intuition behind the result. In the two cases, the firms fully maximize the degree of product differentiation within the Hotelling line. The incentive contracts λ_i $(i = 1, 2)$ only affect the price strategies. A higher value of λ_i leads to a lower price p_i because the manager i tends to put more stress on the sales volume. Because of the strategic complementarity, the competition between the firms is intensified. Anticipating this, each owner sets a lower λ_i so as to mitigate the subsequent price competition.

3.2 Locations are not restricted

We now consider the case in which the locations of the firms are not restricted. In other words, α is sufficiently small and β is sufficiently large that the constraint $\alpha \leq x_i \leq \beta$ is not binding.

The result in the third stage (price competition) has already been derived. We consider the location choices by the managers. The first-order conditions lead to

$$x_1 = \frac{4(\lambda_1 - \lambda_2) - 3t}{12t}, \quad x_2 = \frac{15t - 4(\lambda_2 - \lambda_1)}{12t}.$$

The resulting profits of the firms, the managers' rewards, the consumer surplus, and social welfare are given by

$$\pi_i^U = \frac{(9t + 4(\lambda_i - \lambda_j))(9t - 2(\lambda_i + 2\lambda_j))}{108t}, \; U_i^U = \frac{(9t + 4(\lambda_i - \lambda_j))^2}{108t}, \; p_i^U = \frac{6c + 9t - 2(\lambda_i + 2\lambda_j)}{6},$$
$$CS^U = -\frac{432tc + 765t^2 - 216(\lambda_i + \lambda_j)t + 16(\lambda_i - \lambda_j)^2}{432t}, \quad (i = 1, 2, \quad i \neq j),$$

where the superscript "U" denotes the equilibrium outcome in the case where the locations are unrestricted.

We now obtain the equilibrium value of λ_i $(i = 1, 2)$. In the first stage, each owner i independently chooses λ_i so as to maximize its profit $\pi_i = \pi_i^U$. The first-order condition is

$$\frac{9t - 8\lambda_i - 4\lambda_j}{54t} = 0, \quad i = 1, 2, \ i \neq j. \tag{9}$$

From (9), we have the following lemma:

Lemma 2 *When the firms' locations are not restricted, each owner i chooses λ_i at*

$$\lambda_1^{EU} = \lambda_2^{EU} = \frac{3t}{4}. \tag{10}$$

The profits and the consumer surplus are as follows:

$$x_1^{EU} = -\frac{1}{4}, \ x_2^{EU} = \frac{5}{4}, \ p_i^{EU} = c + \frac{3t}{4}, \ \pi_i^{EU} = \frac{3t}{8}, \ CS^{EU} = v - \frac{48c + 49t}{48}, \ (i = 1, 2). \tag{11}$$

In the standard location-price model in Tabuchi and Thisse (1995), the equilibrium outcome is as follows:

Result 2 (Tabuchi and Thisse, 1995): Suppose that each owner directly manages its own firm. When the firms are allowed to locate outside the linear city, the equilibrium outcome is

$$x_1 = -\frac{1}{4}, \ x_2 = \frac{5}{4}, \ \ p_1 = p_2 = c + \frac{3t}{2}, pi_1 = \pi_2 = \frac{3t}{4}, \ CS = v - \frac{38c + 85t}{38}. \tag{12}$$

From (11) and (12), we have the following proposition:

Proposition 2 *Suppose that the firms are not allowed to locate outside the linear city. The equilibrium prices in the delegation case are smaller than those in the non-delegation case. The consumer surplus in the delegation case is larger than that in the non-delegation case. The equilibrium profits in the delegation case are smaller than those in the non-delegation case.*

Proposition 2 is quite different from Proposition 1. When the firms are allowed to locate outside the linear city, price competition in the delegation case is tougher than that in the non-delegation case. We now mention the intuition behind this result. The incentive contracts λ_i $(i = 1, 2)$ affect not only the price strategies but also the location strategies. A higher value of λ_i leads to a lower price p_i because the manager i tends to put more stress on the sales volume. In the case where the firms are allowed to locate outside, a lower price p_i caused by a higher value of λ_i also affects the location choices of the firms. The rival firm j ($j \neq i$) moves far away from the center to escape the tougher competition resulting from the higher value of λ_i. As a result, the quantity supplied by firm i substantially increases. This demand-enhancing effect dominates the competition-enhancing effect because of the strategic complementarity of the price strategies. Anticipating this, each owner sets a higher λ_i; this accelerate competition.

4 Main result

We compare the equilibrium outcomes in the two models discussed above and mention welfare implications. Comparing (6) and (7) with (11), we have the following proposition.

Proposition 3 *Suppose that α is sufficiently small and β is sufficiently large—that is, the firms are allowed to locate outside the linear city. In this case, the profits of the firms are lower than those in the case where the locations are restricted ($\alpha = 0$, $\beta = 1$). The consumer surplus is higher than in the case where the locations are restricted ($\alpha = 0$, $\beta = 1$).*

In our delegation case, the restriction on the locations of firms that reduces the distance between the firms mitigates competition and then reduces consumer welfare. At first glance, the relation between the location restriction and consumer welfare is counterintuitive. As explained in the previous section, no restriction on the locations accelerates the competition between the firms because of the demand-enhancing effect resulting from the high-powered incentive contracts. Note that, since this result holds with and without the non-negative constraint of λ_i ($i = 1, 2$), Proposition 3 is highly robust.

Proposition 3 is in sharp contrast to the relation between the results obtained in d'Aspremont et al. (1979) and Tabuchi and Thisse (1995). These two papers show that the profits are higher when the locations are unrestricted. Moreover, they show that when the locations are unrestricted, the consumer surplus is lower. Proposition 3 indicates that incorporating the separation of ownership and management and the reward contracts of the managers into the models of d'Aspremont et al. (1979) and Tabuchi and Thisse (1995) drastically changes the results.

5 Concluding Remarks

In this paper, we investigate the effects of the location restriction on consumer welfare. We use two standard location-price models on the Hotelling line—one restricts the firms' locations within the Hotelling line and the other does not impose any such restriction. We incorporate strategic reward contracts into the models. We find that the former model with the location restrictions yields *smaller* consumer welfare than the latter. This means that the restrictions on locations reduce consumer welfare. This result is quite different from the two results derived by the standard models (d'Aspremont et al. (1979) and Tabuchi and Thisse (1995)). We think that our result provides a caveat to the recent debate on urban sprawl in the U.S. and Japan.

Our paper also sheds light on the value of strategic commitment in Hotelling models. In the model without location restrictions, the firms have strong incentives for exhibiting aggressive behavior in the subsequent stages; in contrast, in the model with location restrictions, the firms have strong incentives for exhibiting less aggressive behavior. Thus, our result indicates that the strategic value of commitment crucially depends on the model formulation of the location choices.

Our result depends on the assumption that the managers choose both the locations and the prices. If the owners choose the locations and the managers choose the prices, our results do not hold. Here, less aggressive behavior is exhibited in both cases—with and without the restriction of locations—because the owners have already chosen the locations. However, no restrictions on the locations always reduces consumer surplus.

Our results may be consistent with the retail prices set by the supermarkets located in suburban areas, such as Wal-Mart in the U.S. and ÆON in Japan. These retailers set their prices at lower levels—this is not consistent with previous researches (d'Aspremont et al. (1979) and Tabuchi and Thisse (1995)) but is consistent with our main result. We believe that our result also has implications in the context of retailer strategies.

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