

Chapter 9 Selected Industries

- Restaurant Economics
- The airline Industry
- The Fishing Industry
- Public Roads and Congestion

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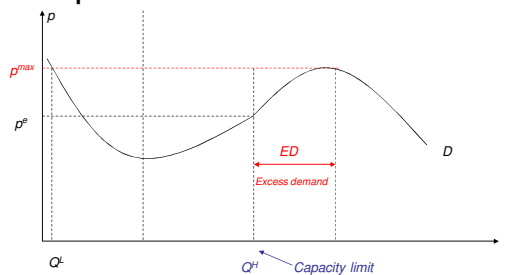
Restaurant Economics

- Observation
 - Popular restaurants, theaters, bars, and dancing places often have people standing in line to get in
 - These entertainment places do not raise prices in the presence of queues (excess demand) as predicted by simple conventional, supply-and-demand theory

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Equilibrium Restaurant Price



➡ The restaurant sets $p^m = p^{\max}$, and faces excess demand ED

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Discussion of Restaurant Model

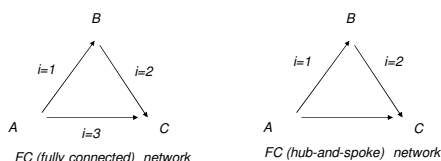
- What kind of (heterogeneous) customer preferences would generate the specific demand curve ?
 - Karni and Levin (1994) provide an example of a group of customers who have different preferences toward their ideal restaurant size

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The Airline Industry

- Analyze the effects of route or network structuring on the profit of airline firms as well as on consumer welfare



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The cost approach

- Let the total cost of an airline be a function of number of passengers transported on each route, and denote by $TC(n_1, n_2, n_3)$
- Definition: An airline technology is said to exhibit economies of scope if

$$TC(n_1, n_2, n_3) \leq TC(n_1, 0, 0) + TC(0, n_2, 0) + TC(0, 0, n_3)$$
- Let TC be a separate cost function defined by

$$TC(n_1, n_2, n_3) \leq c(n_1) + c(n_2) + c(n_3), \text{ where } c(n_i) = F + n_i^2$$

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The cost approach (cont')

- Under *FC* network

$$TC^{FC} \equiv 3F + (n_1)^2 + (n_2)^2 + (n_3)^2$$

- Under *HS* network

$$TC^{HS} \equiv 2F + (n_1 + n_3)^2 + (n_2 + n_3)^2$$

- Assuming equal number of passenger on each route, we have

$$TC^{HS} \leq TC^{FC} \text{ if and only if } F > 5n^2 \text{ or } n < \sqrt{F/5}$$

The passengers' demand approach

- The airfare per trip on route *i* is denote by p_i
- Let d_i denote whether a flight is a direct one $d_i=1$, or not $d_i=0$
- On each route *i*, each of the n_i passengers is assumed to travel only once.
- The utility of a passenger on route *i* is affected by the fare (p_i), by whether the flight is direct or indirect. δ is the extra dollars a consumer is willing to pay for a direct flight. Formally, the utility function of a passenger on route *i*, u_i is given by

$$U_i = \begin{cases} d_i \delta + \sqrt{f_i} - p_i & \text{if } p_i \leq d_i \delta + \sqrt{f_i} \text{ and } f_i \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

The passengers' demand approach (cont')

- Direct flights:** The fully connected network (FC)
- The single airline chooses f^d that solves

$$\max_f \pi^d = 3n(\delta + \sqrt{f}) - 3cf$$

- Solving FOC

$$\Rightarrow f_i^d = \left(\frac{n}{2c}\right)^2; p_i^d = \delta + \frac{n}{2c} \text{ and } \pi^d = 3n\left(\delta + \frac{n}{2c}\right) - 3c\left(\frac{n}{2c}\right)^2$$

$$\partial f_i^d / \partial n > 0 \quad \partial \pi^d / \partial n > 0$$

The passengers' demand approach (cont')

- The hub-spoke network (HS)**
- The single airline chooses f that solves

$$\max_f \pi^h = n(p_1 + p_2 + p_3) - 2cf = 2n\delta + 3n\sqrt{f}, i = 1, 2$$

- Solving FOC

$$\Rightarrow f^h = \left(\frac{3n}{4c}\right)^2; p_i^h = \delta d + \frac{3n}{4c}, \text{ for } d_1 = d_2 = 1, d_3 = 0$$

$$\text{and } \pi^h = 2n\delta + \frac{9n^2}{4c} - 2\left(\frac{3n}{4c}\right)^2$$

$$p_3^h < p_1^h = p_2^h$$

The passengers' demand approach (cont')

- The hub-spoke network (HS)**
- Suppose the monopoly airline does not provide a direct flight on route $i=3$, but instead transports all passengers via a hub at city *B*

- Solving FOC



The passengers' demand approach (cont')

- A monopoly airline will operate with greater frequency under the *HC* network than under the *FC* network. Formally $f^h > f^d$
- The airfare set by monopoly for passenger who start or end their trip at the hub city *B* is higher under the *HS* than under the *FC*. Formally $p_i^h > p_i^d$
- If passengers' valuation of direct flights (δ) is higher than a critical value, the airfare for passengers traveling from city *A* to a nonhub destination at city *C* is lower under the *HS* than under *FC* network. Formally, there exists $\delta^*, \delta^* = n/4c$, such that for every $\delta > \delta^*, p_3^h < p_3^d$
- The monopoly airline will operate an *HS* network, Otherwise, $\delta^* = 3n/8c$, it would operate an *FC* network

The Fishing Industry

- The use of common properties as factors of production stems from the fact that common-property factors of production are not sold in competitive markets
- The economic factor prices that should reflect their relative scarcity do not play a role in firms' profit-maximization since firms behave as if the cost of obtaining public factors is zero
- The target of the commons arises from overuse of these factors**
- Literatures: Coase (1960), Cornes and Sandler (1983), Haverman (1973), and Weitman (1974)

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The Fishing Industry (Cont')

- Consider an economy with n fishermen, $n \geq 2$
- Let h_i denote the hours of fishing devoted by fishermen i , $i=1, \dots, n$, and H the aggregate fishing time devoted by all the n fishermen. Formally,

$$H \equiv \sum_{i=1}^n h_i$$

- Denote H_{-i} the aggregate number of hours devoted to fishing by all fishermen except fisherman i . Formally

$$H_{-i} \equiv \sum_{j \neq i} h_j = H - h_i$$

- The aggregate weight of fish collected by all fisherman together is denoted by Y

$$Y \equiv \sqrt{H} = \sqrt{\sum_{i=1}^n h_i}$$

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The Fishing Industry (Cont')

- Denote by y_i the catch of fisherman i and assume that the share of fisherman i in the aggregate catch depends on the share of time devoted by fisherman i relative to the aggregate fishing time. Formally, the catch of fisherman i is given by

$$y_i \equiv \frac{h_i}{H} Y = \frac{h_i}{H} \sqrt{H} = \frac{h_i}{\sqrt{H}} = \frac{h_i}{\sqrt{h_i + H_{-i}}}$$

- We normalize the price of one tone of fish to equal 1 and denote the other costs associated with fishing by w , $w > 0$

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Oligopoly equilibrium in the fishing industry

- Each fisherman i takes the amount of time allocated by other fishermen H_{-i} as given and choose h_i that solves

$$\max_{h_i} \pi_i \equiv y_i - w h_i = \frac{h_i}{\sqrt{h_i + H_{-i}}} - w h_i$$

First order condition

$$\frac{\partial \pi_i}{\partial h_i} = \frac{(h_i + H_{-i})^{-1/2} - (h_i / 2)(h_i + H_{-i})^{-3/2}}{h_i + H_{-i}} - w = 0$$

$$\Rightarrow \begin{cases} h^* = \frac{(2n-1)^2}{n^3} \frac{1}{4w^2}, H^* = \frac{(2n-1)^2}{n^2} \frac{1}{4w^2} \\ y_i^* = \frac{Y^*}{n} = \frac{2n-1}{n^2} \frac{1}{2w}, y_i^* = \frac{2n-1}{n} \frac{1}{2w} \end{cases}$$

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The social planner's optimal fishing

- Denote by h^* the common allocation of fishing hours to each fisherman. Let $H^* = nh^*$ denote the aggregate amount of fishing hour allocated to the entire industry
- The social planner chooses H^* that solve

$$\max_H Y - wH = \sqrt{H} - wH$$

$$\text{FOC} \Rightarrow H^* = \frac{1}{4w^2} = \left(\frac{n}{2n-1} \right)^2 H^c < H^c, \forall n \geq 2$$

Implication: the fishing industry is overproducing

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Fishing licenses and taxation

- Licenses**
 - Granting a single license will make the equilibrium fishing level equal to the socially optimal level. Formally, when $n=1$, $H^* = H^c$
 - Granting a single license cannot be an optimal solution if consumer welfare is taken into account
- Taxation**
 - Let t denote the fee each fishermen has to pay for each hour of fishing
 - The total cost of h_i hours of fishing is now given by $TC_i(h_i) = (w+t)h_i$
 - The industry's total fishing time when a tax of t is imposed on each hour of fishing is given by

$$H^c(t) = \left(\frac{2n-1}{n} \right)^2 \frac{1}{4(w+t)^2}$$

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Fishing licenses and taxation (cont')

- Denote by t^* the tax rate that would induce the industry to fish at the socially optimal level, t^* is determined by solving

$$H'(t) = \left(\frac{2n-1}{n} \right)^2 \frac{1}{4(w+t)^2} = H'$$

- Hence,

$$t^* = \frac{2n-1}{n} \frac{1}{2\sqrt{H^*}} - w = \frac{n-1}{n} w$$

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Public Roads and Congestion

- Let consider N passengers, work in a downtown of a major city and wish to be transported from the suburbs to downtown every morning
- There are two possible methods for getting downtown. Each passenger can **ride a train** or can **drive a car**
- Let t_T denote the travel time of the train, and t_C the travel time in a car
- The driving time to downtown depends on the traffic (congestion) and therefore depends on the number of all passengers who decide to drive a car. Formally, let the driving time be given by $t_C = \alpha + \beta n_C$, $0 < \alpha < 1$ and $\beta > 0$

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Public Roads and Congestion (cont')

- We denote by v the value of time, by n_T the number of passengers who ride the train, and by n_C the number of passengers who drive their cars, where $n_C + n_T = N$
- Suppose that the train operator is competitive, so the train ticket equals the unit cost, which is denoted by ϕ
- The monetary value of the loss to a passenger who rides the train is given by $L_T = 1v + \phi$
- The monetary value of the loss to a passenger who derive a car is given by $L_C = v(\alpha + \beta n_C)$

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Equilibrium highway congestion (cont')

- We assume that there is a large number of passengers wishing to go downtown, so each passenger ignores his or her marginal effect on congestion. Hence each passenger takes n_C as given and minimizes $\min_{T,C} L = \min \{L_T, L_C\}$
- If in equilibrium passengers use both transportation methods. Then n_C must satisfy $v + \phi = v(\alpha + \beta n_C^e)$
- Equilibrium allocation of passengers is given by $n_C^e = \frac{(1-\alpha)v + \phi}{\beta v}$

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The socially optimal congestion level (cont')

- Assume that the objective of the regulator is to minimize the aggregate time loss to passengers $L^s = n_T(v + \phi) + n_C v(\alpha + \beta n_C)$

- The regulator solves

$$\min_{n_C} \text{ s.t. } 0 \leq n_C \leq N$$

- Substitute $(N - n_C)$ for n_T , and solve FOC

$$\frac{\partial L^s}{\partial n_C} = -v - \phi + v\alpha + 2\beta v n_C = 0$$

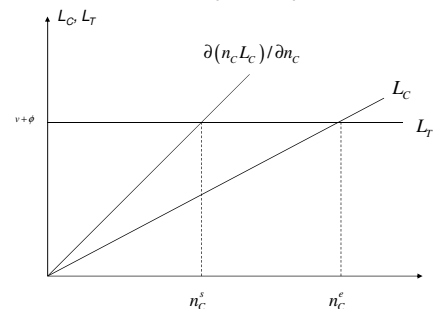
- Assuming an interior solution

$$n_C^s = \frac{(1-\alpha)v + \phi}{2\beta v} = \frac{n_C^e}{2} \Rightarrow \frac{\partial(n_C^e / n_C^s)}{\partial \phi} = 0$$

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The socially optimal congestion level (cont')



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Highway tolls

- The regulator should be able to reduce highway congestion to the optimal level by collecting a highway toll
- Suppose that the regulator collects a toll of τ dollars from each passenger who uses the highway
- The equilibrium number of passengers when there is a toll is given by solving

$$v + \phi = v(\alpha + \beta n_c) + \tau \quad \Rightarrow \quad n_c(\tau) = \frac{(1-\alpha)v + \phi - \tau}{\beta v}$$

- Solving $n_c(\tau) = n_c^s$, we have
- Optimal toll is given by $\tau^s = \frac{(1-\alpha)v + \phi}{2} \quad \Rightarrow \quad \partial \tau^s / \partial \phi > 0$

Implication : Optimal toll fee increase with the train fare