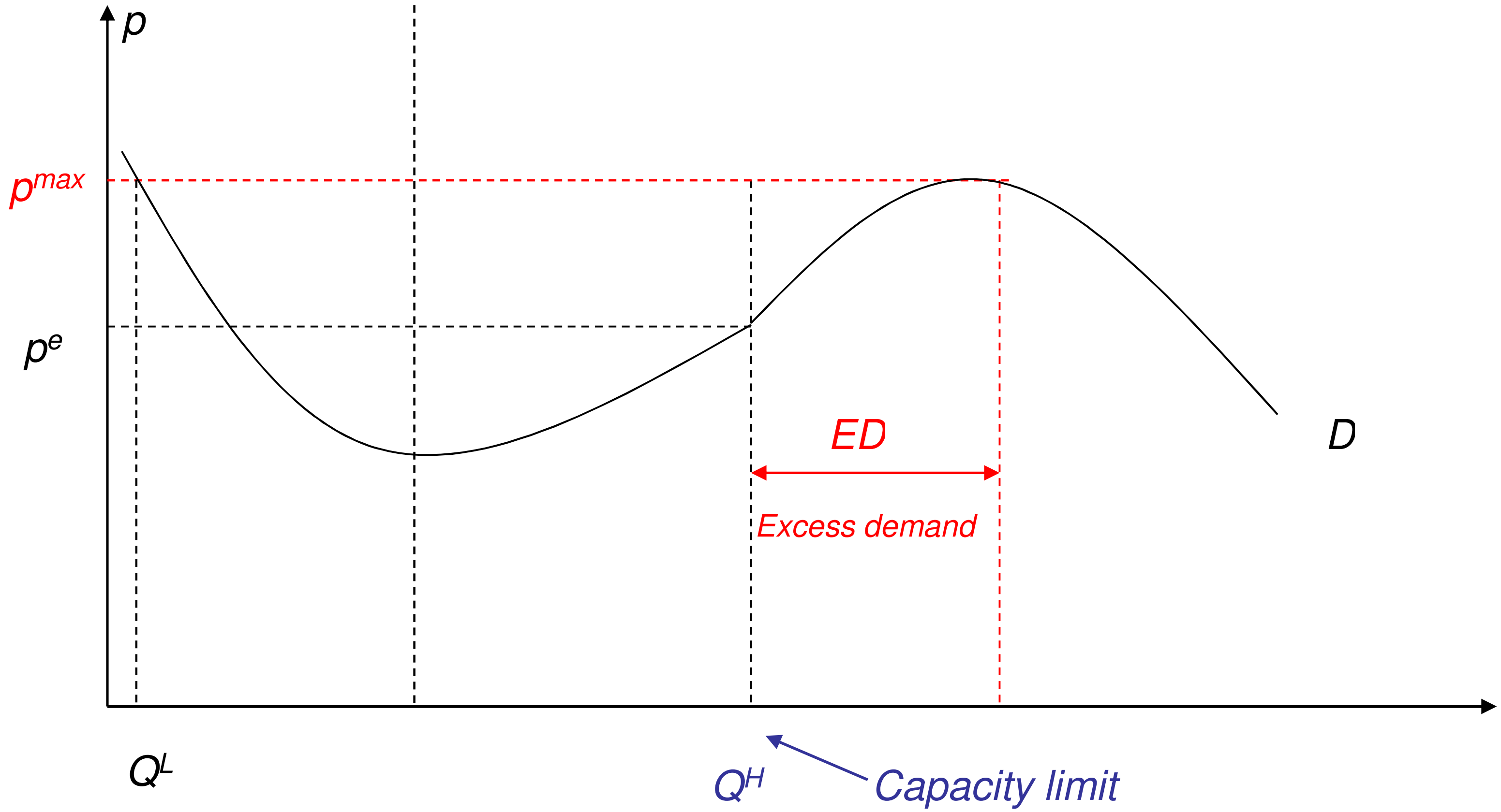
Chapter 9 Selected Industries

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

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

Equilibrium Restaurant Price



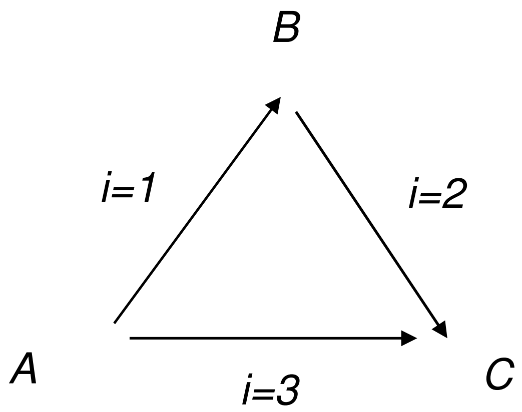
The restaurant sets $p^m=p^{max}$, and faces excess demand ED

Discussion of Restaurant Model

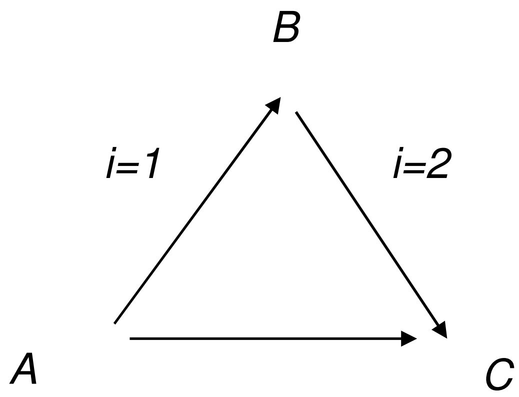
- What kind of (heterogeneous) customer preferences would generate the specific demand curve ?
  – Karni and Levin (1994) provide an example of a group of customers who have different preferences toward their ideal restaurant size

The Airline Industry

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



FC (fully connected) network



FC (hub-and-spoke) network

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

$$TC(n_1,n_2,n_3) \le TC(n_1,0,0)+TC(0,n_2,0)+TC(0,0,n_3)$$

- Let TC be a separate cost function defined by

$$TC(n_1,n_2,n_3) \le c(n_1)+c(n_2)+c(n_3), where\ c(n_1)=F+n^2$$

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

$$U_i \equiv \begin{cases} d_i\delta + \sqrt{f_i} - p_i & \text{if } p_i \le d_i\delta + \sqrt{f_i} \text{ and } f_i \ge 0 \\ 0 & \text{otherwise} \end{cases}$$

The passengers' demand approach (cont')

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

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

- Solving FOC

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

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

The passengers' demand approach (cont')

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

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

- Solving FOC

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

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

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

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 that 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 δ*, $\delta^*=n/4c$, 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)

The Fishing Industry (Cont')

- Consider an economy with n fishermen, n>=2
- Let h_i denote the hours of fishing devoting by fishermen i, i=1,…,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 fishermen I, Formally

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

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

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

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, $w>0$

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

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

First order condition

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

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

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

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

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

Implication: the fishing industry is overproducing

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^e=H^*
  - 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 hi 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

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

Fishing licenses and taxation (cont')

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

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

- Hence,

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

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 $t_C = \alpha + \beta n_C, 0 < \alpha < 1 \text{ and } \beta > 0$

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

$$L_C = v(\alpha + \beta n_C)$$

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

$$v + \phi = v\left(\alpha + \beta n_C{}^e\right)$$

- Equilibrium allocation of passengers in given by

$$n_C^e = \frac{(1-\alpha)v + \phi}{\beta v}$$

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

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

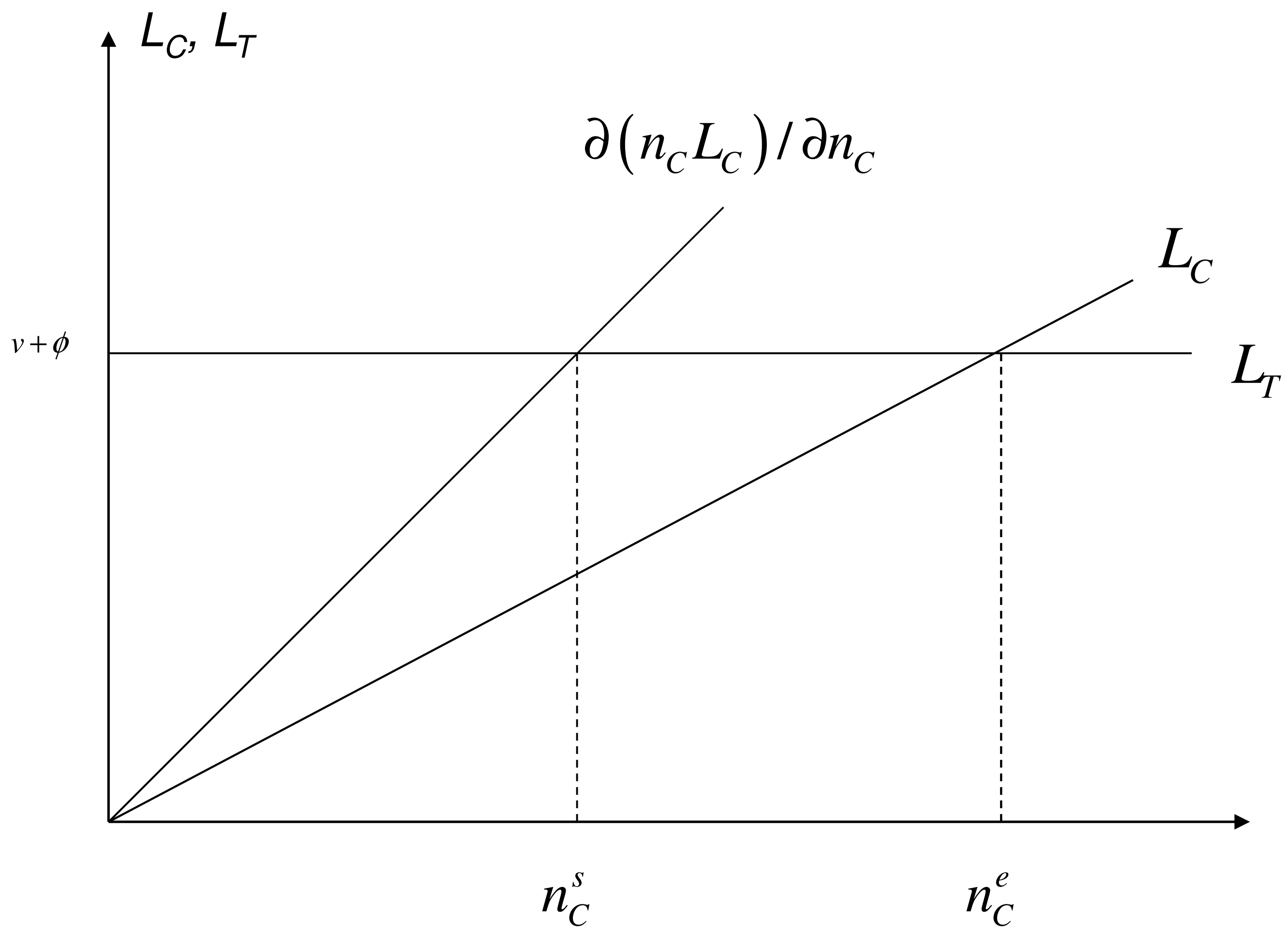
- Substitute (N-n_C) for n_T, and solve FOC

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

- Assuming an interior solution

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

The socially optimal congestion level (cont')



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 τdollars from each passenger who uses the highway
- The equilibrium number of passengers when there is a toll is given by solving

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

- Solving $n_C\left(\tau\right)=n_C^s$, 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