ECN 145 Lecture 15

Transportation Economics: Pricing II

Policy Problems:

- With *increasing returns to scale,* then p=MC<AC will not cover costs
- *Private* costs and benefits may differ from *social* costs and benefits due to **externalities**
- Transport might require both public supply (roads) and private supply (drivers); how to reflect the costs of both?
- In practice, transit is “underpriced” in the U.S.

Outline:

- 1) Review Social Optimum
  - **what would the gov't provide?**
- 2) Consider joint public-private problem
  - **e.g. financing for roads**
- 3) Look at "Ramsey" pricing
  - **used when prices need to cover costs**
- 4) Look at "Second-best" pricing
  - **used when some prices not optimal**

1) Social Welfare

- Inverse demand, $P(X)$
- Social welfare (Net social benefits):

$$NSB = \int_0^Q P(X)\,dX - Q \cdot AC(Q)$$

- where,

$$Costs = Q \cdot AC(Q)$$

Social Optimum

- Choose Q to max Net social benefits:

$$\frac{dNSB}{dQ} = P(Q) - [AC(Q) + Q \cdot AC'(Q)] = 0$$

- or,

$$P = AC + Q \cdot AC'(Q)$$

- Price = Marginal Costs

2) Social Welfare (extended)

- Social welfare (Net social benefits):

$$NSB = \int_0^Q P(X)dX - Q \cdot UC(Q/L) - L \cdot CC(L),$$

- Q=traffic on road (final output)
- L=Lanes on the road (capacity)
- UC(Q/L)=users costs (e.g. waiting)
- CC(L)=capital costs (e.g. construction)

Social Optimum

- Choose Q to max NSB:

$$\frac{dNSB}{dQ} = P(Q) - [UC + \frac{Q}{L} \cdot UC'] = 0$$

- or,

$$P = UC + (Q/L) \cdot UC'$$

- Price = User Cost + Toll!

Social Optimum (cont'd):

- Choose L to max NSB:

$$\frac{dNSB}{dL} = \frac{Q^2}{L^2} \cdot UC' - CC - L \cdot CC' = 0$$

- if CC'=0, then,

$$(Q^2/L) \cdot UC' = L \cdot CC(L)$$

- Q Toll = Total capital costs!

Results:

- With constant returns in construction, optimal tolls will just be enough to cover capital costs
- With increasing returns in construction, optimal tolls will not be enough to cover capital costs
- Look at evidence on capital costs:

Highway capital costs (1989 U.S.)

Degree of Urbanization	**Rural**	**Urban**			**Central city**
Width (lanes)	6	4	6	8	6
EXPRESSWAY Study 1:					
Cost/lane-mile ($1000s):					
Construction	916	1740	1436	1283	1955
Land	23	131	108	96	244
Total	939	1871	1543	1380	2199
Returns to Scale:	1.47	2.11	1.74	1.55	1.89
EXPRESSWAY Study 2:					
Cost/lane-mile ($1000s):					
Construction	1194	1570	1551	1537	4730
Land	358	507	501	497	3264
Total	1552	2078	2052	2034	7994
Returns to Scale:	1.03	1.03	1.03	1.03	1.03

Policies used in California.:

- Gasoline taxes
- Vehicle registration fees
- Driver’s license fees
- Vehicle-weight fees (trucking)
- Tolls
- *Not related to transportation*:
- Sales taxes, and bonds

3) Ramsey Pricing

- Suppose that there are *increasing returns to scale,* so P=MC<AC will not cover costs
- Question:
- How should prices be increased, for different consumers, so that costs can be covered?

Same price to all consumers:

- Choose Q to max Net social benefits, but now we must cover some costs K!

$$NSB = \int_0^Q P(X)dX - C(Q)$$

- Subject to, $P(Q)Q \geq K$
- Lagrangian,

$$L = \int_0^Q P(X)dX - C(Q) + \lambda(PQ - K)$$

Same price to all consumers:

- Choose Q to max L:

$$\frac{dL}{dQ} = P(Q) - C'(Q) + \lambda[P + Q \cdot P'(Q)] = 0$$

- or,

$$[P - C'(Q)]/P = \lambda[(1/E) - 1]$$

- (Price-MC)/P = $\lambda \cdot$ Inverse of Elasticity

Consumers with different prices:

- Suppose there are differing consumers i, and each type of consumer can be charged different prices
- Then to max social welfare they should each be charged prices:

$$(P_i - MC_i)/P_i = k/E_i,$$

- (Price-MC)/P = $k \cdot$ Inverse of Elasticity

Results:

- Customers with lowest elasticities should be charged the highest prices
- This will minimize the *reduction in consumption* that comes from charging prices above marginal costs
- Therefore, this policy will minimize the *deadweight loss = drop in social welfare* from charging prices above MC

Example: **Post office**

- MC < AC of delivering service. So MC pricing will not cover costs
- It is constrained to charge the same for letters to any U.S. destination!
- Therefore, it charges *higher prices* to first-class customers, who have *less elastic* demand

Example: **Highway financing in U.S.**

- Some of the financing comes from motor vehicle use fees
- This is probably the *least elastic* of any transportation decision, though it does little to reduce congestion (as tolls do)
- So from Ramsey pricing, it makes sense to have motor vehicle and driver's license fees

4) Second-best Pricing

- Suppose that some prices are *not set* at the socially optimal level.
- How will this affect the choice of price for other commodities?
- E.g. Motorists are charged prices (i.e. tolls, gasoline tax, etc.) that are *too low*
- How does this affect socially optimal transit prices?

Second-best rule:

- Suppose that commodities j are not priced optimally. Then price i should be,

$$P_i - MC_i = \sum_{j \neq i} \left[\frac{E_{ij}}{E_i} \cdot \frac{Q_j}{Q_i} \cdot (P_j - MC_j) \right],$$

- >0 if $P_j > MC_j$ for substitute goods j
- <0 if $P_j < MC_j$ for substitute goods j

Result:

- So if motorist charged below social MC, then we should also charge below social MC for transit!
- Why?
- Otherwise, even more people would be induce to drive, with further pollution, and congestion.

Second-best transit fares for London

- Suppose that cars have congestion costs of 21 p=$1 / mile, and buses have 5 p / mile
- *Marginal costs of transit:*
- **Case 1,**
- operating and external costs considered
- **Case 2,**
- operating, external and capacity costs, which are assigned to peak hours

Second-best transit fares for London

Scenario	*Car*	*Bus* *Peak*	*Bus* *Off-peak*	*Rail* *Peak*	*Rail* *Off-peak*
Cost and fares (in pence per pass. mile)					
Existing					
External costs	21.0	5.0	0.0	0.0	0.0
Fare	—	4.3	4.3	4.3	4.3
Case 1					
Marginal cost	—	11.0	6.0	2.0	1.0
Optimal fare	—	3.4	3.1	0.3	0.5
Case 2					
Marginal cost	—	14.0	6.0	30.0	1.0
Optimal fare	—	5.2	2.1	20.4	0.4
Traffic volumes (in millions pass. hours)					
Existing	1.46	0.70	0.18	1.76	0.22
Case 1	1.25	0.51	0.13	3.53	0.86
Case 2	1.59	0.79	0.17	1.08	1.20

Results:

- Both fares below existing, except during peak hours
- Rail fares should not be so heavily subsidized
- More persons should be using the bus (to reduce traffic congestion), but fewer persons should be using the train during peak hours