Problem Set #1

Note: Because of the holiday, some questions in the questions in this problem set have not been covered in lecture but they are covered in Nicholson and Snyder – Chapter 16 in the 11'th edition or Chapter 18 in the 10'th edition. Some copies of each addition are on reserve at Roche and we can put a couple of additional copies in reserve if necessary. Let me know if they are needed.

1) One of the readings for this past Tuesday was "A Pure Theory of Local Expenditures" by Charles Tiebout. Tiebout's ideas have led to many economic studies of "Tiebout Sorting" - the process by which families with different tastes and incomes choose to reside in different communities.

In recent years, a number of states have passed large-scale reform packages for K-12 education that contain two major elements: targeted state aid to increase the spending-per-pupil level of poorer towns, and state-wide testing with highly publicized results of student scores to help improve the accountability of each town's schools.

Describe how each of these elements – raising the expenditures in the lowest expenditure towns, and extensive publicity for standardized test scores – can be expected to affect the sorting of families among towns that Tiebout postulates.

Answer: The two pieces of the policy likely work in opposite directions. The targeted expenditure potentially raises the quality of the poorest schools. Because it is financed through state aid, this quality increase is not accompanied by higher local taxes. Other things equal, this should lower the differences among communities and so moderate the sorting process. The highly publicized test scores provide increase the available information about school local school systems and so this should increase the sorting with families who are very concerned about education working hard to buy into the districts with the highest test scores, etc.

2) Jo and Maureen (aka Mo) are the only two people who drive cabs from the Leominster Airport to the Leominster Inn. The two cabs have the following identical total cost functions.

  $TC_{Jo} = \$3.00 \times Q_{Jo}$, $TC_{Mo} = \$3.00 \times Q_{Mo}$ where Q_X = number of trips per day made by driver X.

Demand for trips is given by the demand function:

                    Price per Trip = $6.00 - .05 \times Q$

a) Write down the average and marginal cost functions for this cab "industry".

Answer: You should be able to write down the answers by inspection but we can derive them mathematically.

Define $Q = Q_{Joe} + Q_{Moe}$. Then $TC_{Industry} = \$3.00 \times Q$

$AC_{Industry} = TC_{Industry}/Q = \$3.00$ $MC_{Industry} = \dfrac{d(TC_{Industry})}{dQ} = \$3.00$

i.e. both average and marginal costs are the same horizontal line = $3.00

b) Assume Jo and Mo agree to cooperate to set the price per trip and split any profits they generate. Determine the industry equilibrium price and quantity.

Answer: They will run the industry like a monopoly setting marginal revenue = marginal cost. They will then presumably equally split the profit maximizing number of trips. As we know by now, Marginal Revenue for this demand curve is $6.00 - .1Q so:

$\quad\quad\quad$ $6.00 - .1Q = \$3.00$ or $Q = \$3.00/.1 = 30$ trips (total) or 15 trips per driver.

To get the price, we plug 30 trips back into the demand curve and get $P = \$6.00 - .05 \times 30 = \$4.50$

Profit per cab = (price - average cost) x quantity = $1.50 \times 15 = \$22.50$

c) The Leominster Environmental Protection Agency (LEPA) has determined that each cab trip between the Leominster Airport and the Leominster Inn generate a pollution cost equal to $.50 per trip. What is the implication of this cost for your solution in (b)? Discus in as much detail as you can LEPA's policy options for dealing with this cost.

Answer: Using the terms we developed in class, the $3.00 MC is really the private marginal cost per trip while the $.50 is the social cost of the trip. The economically efficient outcome is that the taxi industry set:

$\quad\quad\quad$ Marginal revenue = $MC_{Private} + MC_{social} = \$3.00 + \$.50 = \$3.50$.

The $.50 per trip is then collected by the government and distributed as compensation to those harmed by the pollution.

There are two ways to reach this socially optimal outcome: by imposing a $.50 tax on each ride or by calculating the socially optimal level of trips and requiring that Jo and Mo's trips do not

exceed this level. In this second case, the government will still have to collect the $.50 per trip from the two drivers to use as compensation.

3) In class, we discussed both financial incentives and legal restrictions to deal with externalities. A third option is negotiation between the parties creating the externalities (either positive or negative). We will discuss this next Thursday in class and it is also discussed in Nicholson-Snyder under the heading of the Coase Theorem.

A standard example of *positive* externalities involves a beekeeper who keeps hives in a yard that is next door to an apple orchard. Bees pollinate the apple trees so the orchard owner benefits from more hives. Similarly bees use the apple blossom nectar to make honey so the beekeeper benefits from more apple trees.

(Nicholson 18.5). Suppose that a beekeeper is located next to a 20 acre apple orchard. Each hive of bees is capable of pollinating ¼ acre of apple trees, thereby raising the value of apple output by $25.00

a) Suppose the market value of the honey from one hive is $50.00 and the beekeeper's marginal costs are given by:

$$MC = 30 + .5Q$$

Where Q is the number of hives employed. In the absence of any bargaining between the beekeeper and the orchard owner, how many hives will the beekeeper have and what portion of the apple orchard will be pollinated.

Answer: (**This problem would have been clearer if it said explicitly that the beekeeper was operating in perfect competition.**) If the beekeeper makes the decision on her own, she will maximize profit by setting MC = P:

$$30 + .5Q = \$50 \text{ or } .5Q = 20 \text{ or } Q = 40 \text{ hives.}$$

Notice that each hive increases also the value of the apple output by $25.00 so a hive is creating $75.00 worth of product (honey + extra apples) rather than $50 but from the perspective of the beekeeper, the $25.00 in increased apple fees is a positive externality that she does not receive.

b. What is the maximum amount per hive the orchard owner would pay as a subsidy to the beekeeper to prompt her to install extra hives? Will the owner have to pay this much to prompt the beekeeper to use enough hives to pollinate the entire orchard?

Answer: As noted above, each hive increases the value of the apple harvest by $25.00. In theory, the apple farmer would be willing to pay up to $24.99 for each extra hive. On the other hand,

If we view the problem from the beekeeper's perspective, her profit maximizing condition is:

$$.5Q = (P - MC) \text{ or } Q = 2P - 30.$$

For every fifty cents increase in P, Q increases by one hive. As of now, the beekeeper has 40 hives so an increase of fifty cents per hive's output translates into $20.00. Thus an amount of money equal to $20 would be enough to get one more hive, etc.

In addition, there is the issue of the two way externality: More apples mean more nectar which means a bee hive produces more than $50 of honey. This second externality means adds to the argument that the beekeeper may be willing to add more hives for less than $24.99/hive from the farmer.

4) In class, we discussed congestion externalities. In particular, we discussed a theoretical model of the relationship between automobile speed (miles per hour) and automobile density (congestion) on the Throggs Neck Bridge summarized in the following equation:

$$MPH = 113 - .353*(\text{cars per mile})$$

Consider one lane of the Throggs Neck Bridge For simplicity we will say the bridge length is one mile long. Suppose that at 7:15 in the morning, the density of the lane is 275 cars per mile at which point you decide to enter the lane.

a) What was the speed of cars on the bridge before you entered the lane? After you entered the lane?

Answer: Before you enter, speed = 113 - .353*275 = 15.925 MPH

   After you enter, speed = 113 - .353*276 = 15.572 MPH

b) Besides you, there are currently 275 cars in the one mile lane. What is the increase in time it will take each of these 275 cars to cross the bridge now that you have entered the lane?

Answer: Before you enter, it will take another car (1/15.925)*60 = 3.767 minutes.

After you enter, it will take another car (1/15.572)*60 = 3.853 minutes

c) If we value people's time at $25.00 per hour, what total cost have you imposed on the other cars by entering the bridge at this time?

Answer: Because you have entered the bridge and increased the density, each car requires an extra ((3.853 – 3.767) = .085 minutes. We multiply that loss per car by 275 to show that the cars in your one mile cohort are slowed down by a total of 23.587 minutes. If we value people's time at $25.00 per hour – i.e. an average opportunity cost wage – the lost minutes involve an expense of (23.587/60)*$25.00 = $9.79 cents.

Two things to note here:

1) While each car is slowed down by only a small amount, the total effect can still be significant because a lot of cars are being slowed down by this amount.

2) The implication of these calculations is that when traffic density is this heavy, the toll ought to be set at $9.79 so that you actually pay the cost you are imposing on others.

****

MIT OpenCourseWare
http://ocw.mit.edu

11.202 Planning Economics
Fall 2010

For information about citing these materials or our Terms of Use, visit: http://ocw.mit.edu/terms.