

## **FRE/ECON 374 Land Economics Problem Set 1**

**Due: September 19, 2014 at 5pm via Connect only!**

### **Instructions:**

1. Please attach only 1 PDF file (including all graphs/figures, if applicable). If you attach more than one, only the first file will be graded.
2. Please answer all 4 questions. Each question is worth 25 points so you can receive a maximum of 100 points for this problem set.
3. Any problem sets delivered after the due date will receive a ZERO grade.
4. Please, make sure that all graphs and figures are clearly labeled (if applicable).

### **QUESTIONS**

#### **QUESTION 1 (25 points)**

A majority of UBC students who need to take bus 99B line are frustrated with it being constantly overcrowded. Therefore, UBC and Translink BC came to the agreement regarding the construction of new Skytrain line that will connect Commercial Drive Skytrain Station with UBC so students would have a choice to either take 99B line or Skytrain. The preliminary report shows that the population of Vancouver metropolitan area (including Burnaby, Surrey, Richmond and Coquitlam) who will jointly need to finance this new Skytrain line has the following willingness to pay for this project:

- 45% of total population has an inverse demand:  $p=100-Q$ , where  $Q$ =number of trips they would take in the new Skytrain line and  $p$  is measured in dollars
- 25% of total population has an inverse demand:  $p=80-2Q$ , where  $Q$ =number of trips they would take in the new Skytrain line and  $p$  is measured in dollars
- The remaining 30% of total population doesn't care about Skytrain (doesn't assign any value), nor environment because they disregard public transportation and use personal cars only

Additional useful information:

- Assume that total population of Vancouver metropolitan area is 2.1 million people
- The fixed cost of Skytrain construction is \$100 million
- Government faces no marginal cost for this project
- Assume that individuals pay no price for each trip.
- Assume there is no overcrowding on the skytrain. Skytrain provision is in effect a non-rival good.

a. Without taking consideration of present value, should this new Skytrain line be constructed?

b. Assuming that the construction of this new Skytrain line will take 3 years, the discount rate is 4% and the cost \$ 100 million is in Present Value. Should the new Skytrain line be constructed? (Note: Consumer Surplus is realized when Skytrain is operational)

### SOLUTION

a. AG1:  $45\% * 2.1 \text{ million} = 945,000$ , AG2:  $25\% * 2.1 \text{ million} = 525,000$ ,  
The rest:  $30\% * 2.1 \text{ million} = 630,000$ , Cost of Skytrain construction: \$100 million  
Because  $MC=0$ , we compare aggregate consumer surplus to the fixed cost.

Aggregate Surplus= AG1+AG2

AG1:  $\frac{1}{2} * 100 * 100 = 5,000$   
(because  $p=100-Q$ , so  $p=100$  when  $Q=0$  and  $Q=100$  when  $p=0$  )

AG2:  $\frac{1}{2} * 80 * 40 = 1,600$   
(because  $p=80-2Q$  so  $p=80$  when  $Q=0$  and  $Q=40$  when  $p=0$  )

$5,000 * 945,000 = \$4,725,000,000.00$

$1,600 * 525,000 = \$840,000,000.00$

Aggregate Surplus: AG1+AG2= \$5,565,000,000.00

$\$5,565,000,000.00 > 100,000,000$  So new Skytrain line should be constructed.

b.  $\$5,565,000,000.00 / (1+0.04)^3 = \$4,947,264,736.00 > \$100,000,000.00$ . So new Skytrain line should be constructed.

## QUESTION 2 (25 points)

Assume the Marginal Social Benefits curve is given by  $MSB=12-3q$  and the Marginal Social Costs curve is  $MSC=4+q$ .

- What output level maximizes net social benefits? Show this numerically and using a graph.
- At what output level is total benefits maximized? Point to this output level in the graph. Calculate the maximum total benefits.
- Now assume that these two curves represent the marginal current benefits ( $MSB=MCB$ ) and costs ( $MSC=MCC$ ) respectively. Also assume that the user costs equal  $UC=q$  (note that the user costs are positive). Calculate the new output level that maximizes inter-temporal net social benefits.
- If current output equals 4 calculate the inter-temporal marginal net benefit from an increase in current output at this point.

## SOLUTION

a.  $MSB=MSC$

$$12-3q=4+q$$

$4q=8$ ,  $q=2$ -this output maximizes net social benefit

b. Total benefits are:  $\frac{1}{2} \cdot 4 \cdot 12=24$

c.  $MCB=MCC+UC$ , so  $12-3q=4+2q$ ,  $5q=8$   
 $q=1.6$

d. At  $q=4$ ,  $MSB=12-3 \cdot 4=0$  so there is no marginal benefit.  $MSC=4+4=8$ . So marginal net benefit at  $q=4$  is  $-8$ .

### QUESTION 3 (25 points)

Bolivian quinoa in a competitive market has an aggregate inverse demand of  $p = 144 - 2Q$ , where  $p$  represents the price in dollars and  $Q$  represents the quantity in units. The supply of Bolivian quinoa is estimated at  $p = 24 + 4Q$

- Find the equilibrium price and quantity. Show it graphically and compute the total net benefit (also called social welfare or social surplus).
- Now, suppose that production of Bolivian quinoa generates pollution, a negative externality. The government taxes at a rate of \$5 for every unit of produced quinoa. Find the new equilibrium price and quantity. Show it graphically and compute the total net benefit (while computing this net benefit ignore the damages from the negative externality, but include revenue collected from taxes).
- Suppose the industry adopts a new technology that eliminates pollution while maintaining the same cost of production. Government cancels the tax. Comparing the equilibrium with tax to the equilibrium with the new technology, which one creates greater net benefits? Explain why.

### SOLUTION

- Equilibrium is reached when  $D=S$ . In order to calculate both equations for  $S$  and  $D$  need to be equated:

$$S=D$$

$$24+4Q=120-2Q$$

$$6Q=144-24$$

$$6Q=120$$

$$Q=20, \text{ substitute } Q=20 \text{ to either } D \text{ or } S \text{ function to calculate } p: p=144-2*20, p=144-40,$$

$$p=104$$

Welfare distribution:

$$CS: \frac{1}{2} * 20 * (144 - 104) = 400$$

$$PS: \frac{1}{2} * 20 * (104 - 24) = 800$$

$$TS: CS + PS = 400 + 800 = 1,200$$

- Construct new supply function that accounts for \$5 tax:

$$p=24+5+4Q, \text{ then find new equilibrium: } S=D$$

$$29+4Q=144-2Q$$

$$6Q=144-29$$

$$6Q=115$$

**Q=19.17 (rounded), p=29+4\*19.17, p=105.68**

Welfare distribution:

CS:  $\frac{1}{2} * 19.17 * (144 - 105.68) = 367.30$  (rounded)

PS:  $\frac{1}{2} * 19.17 * (105.68 - 29) = 734.98$

Tax revenue:  $19.17 * 5 = 95.85$

TS:  $CS + PS + Tax = 367.30 + 734.98 + 95.85 = 1,198.13$

c.

$1,200 > 1,198.13$ , no tax option creates higher net benefits.

#### QUESTION 4 (25 points)

The owners of the Mission Hill Winery from the Okanagan Valley, a well known winery that in 2013 won Decanter's prize for the best pinot noir in the world think that they should buy a drone. If interested, for more information about drones, please refer to the link below (<http://www.technologyreview.com/featuredstory/526491/agricultural-drones/>)

The winery can buy one drone at the cost of \$3,000. This is a custom made drone specifically adapted for the purpose of grapes cultivation. Because drone's infrared aerial photos are able to gather data on fertilizer and water content in the soil where wine grapes are cultivated, the winery hopes to use this technology to improve its inputs use.

It has been assessed that the introduction of one drone in the Mission Hill winery can allow following cost savings for each of the next 5 years (per year savings):

- Savings of \$800 in fertilizer use
- Savings of \$1,000 in water use

Assuming that the rate of discount is at the level of 3.5% should Mission Hill winery buy a drone? Explain clearly why or why not.

#### SOLUTION

Cost of technology: \$3000, Total savings:  $\$800 + \$1,000 = \$1,800$

Calculate the present value over 5 years @ 3.5%:

$$(1,800/1+0.035+1,800/(1+0.035)^2+1,800/(1+0.035)^3+1,800/91+035)^4+1,800/(1+035)^5) \\ =8,127.09$$

Net profits = PV Revenues - PV Costs =  $8,127.09 - 3,000 = 5,127.09$  which is  $> 0$  so yes, they should buy a drone.