



B.E. International Program

Faculty of Economics, Thammasat University



EE 465/463 Project Evaluation

Semester 2/2015

Practice Problem Set 1 – Suggested Answer

1. Three mutually exclusive projects are being considered for building a dam: Project A, a dam used for irrigation purposes only, has estimated benefits of \$12 million and costs of \$8 million; Project B, an irrigation dam with some recreational facilities, has estimated benefits of \$14 million and costs of \$10 million; Project C, an irrigation dam with a hydroelectric power station, has estimated benefits of \$20 million and costs of \$18 million. In addition, a road could be built for a cost of \$2 million that would increase the benefits of project A, project B, and Project C by \$3 million, \$7 million, and \$5 million, respectively. Even in the absence of any of the other projects, the road has estimated benefits of \$3 million.
 - a. Calculate the *benefit-cost ratio* and *net benefits* for each possible alternative to the status quo. Note that there are seven possible alternatives to the status quo: A, B, and C, both with and without the road, and the road alone.
 - b. If only one of the seven alternatives can be selected, which should be selected according to the CBA decision rule?

Answer:

- a. The seven possible alternatives to the status quo have the following costs (millions), benefits (millions), benefit/cost ratios, and net benefits (millions):

Alternative	B	C	B/C	NB
Project A without road	12	8	1.50	4.0

Project A with road	15	10	1.50	5.0
Project B without road	14	10	1.40	4.0
Project B with road	21	12	1.75	9.0
Project C without road	20	18	1.11	2.0
Project C with road	25	20	1.25	5.0
Road alone	3	2	1.50	1.0

b. Project B with road should be selected.

2. Suppose that the inverse demand and supply functions of liquor consumption (say, vodka) in a market are given by:

$$P = 100 - 2Q_d \quad \text{and} \quad P = 0.5Q_s - 10$$

where Q_d is the quantity demanded of vodka, Q_s is the quantity supplied of vodka and P is the price per bottle of vodka.

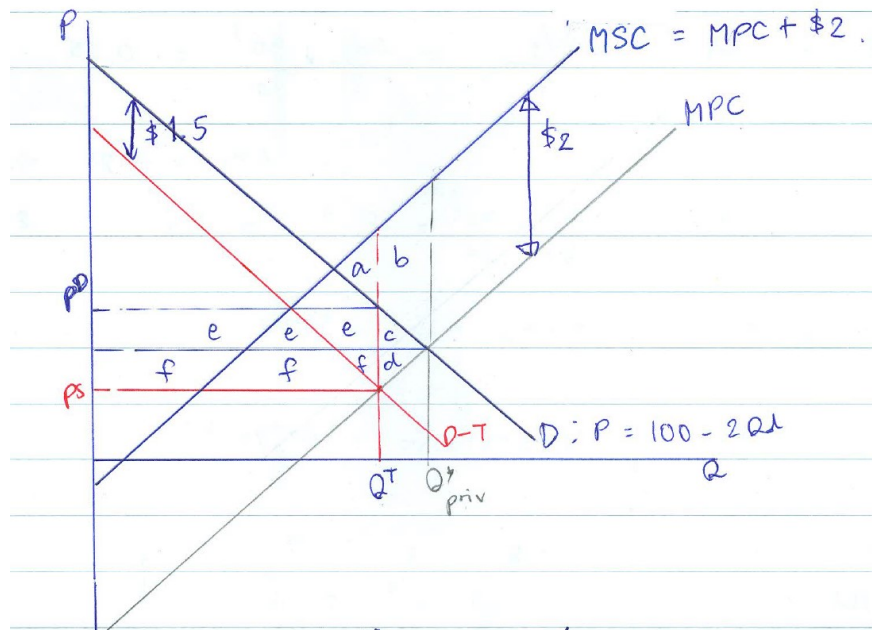
- Find the equilibrium price and quantity of vodka in this market.
- Research has shown that drinking vodka can decrease people's driving ability, and this imposes an extra cost to the society. Suppose the external cost (or negative externality) of vodka consumption is \$2 per unit. Draw a diagram to illustrate the deadweight loss to society if the market is left to its own device.
- Suppose a per-unit tax of \$1.5 is charged from vodka buyers. As a result, the inverse demand shifts downward. Illustrate the changes in net social benefits. Discuss the impact of this tax policy.

[Note: For parts (b) and (c), you need to label the diagrams clearly. No need to calculate.]

Answer:

a. $Q^* = 44, P^* = \$12$

b. & c. (see diagram below)



	Cost	Benefit
Alcohol consumers		$e + c$
Alcohol producers		$f + d$
Third parties	$b + c + d$	
Government	$e + f$	
Net benefit	b	

DWL is reduced to a.

- Consider a low-wage labor market. Workers in this market are not presently covered by the minimum wage, but the government is considering implementing such legislation. If implemented, this law would require employers in the market to pay workers a 300 baht daily wage. Suppose all workers in the market are equally productive, the current market clearing wage rate is 200 per day, and that at this market clearing wage there are 1,000 employed workers. Further suppose that under the minimum wage legislation, only 800 workers would be employed and 400 workers would be unemployed. Finally, assume that the market demand and supply schedules are linear and that the market reservation wage, the lowest wage at which any worker in the market would be willing to work, is 50

baht per day. Compute the monetary value of the impact of the minimum-wage policy on employers, workers, and society as a whole.

Answer:

- The impact on employers (demanders) is the loss in consumer surplus (the trapezoid area under the demand curve and between the two wages):

$$\Rightarrow \text{Employers' total loss} = \frac{1}{2} * [(1000+800)/2] * \text{฿}100 = \text{฿}90,000$$

- The impact on workers (suppliers) can be decomposed into two groups:

- The 800 workers who remain employed and gain \$100 higher wage:

$$\Rightarrow \text{Total gain to 800 workers} = 800 * \text{฿}100 = \text{฿}80,000$$

- The 200 workers who become unemployed. Assume these workers are assumed to be equally distributed along the market supply curve between the market reservation wage of ฿50 and the market equilibrium wage of ฿200.

$$\Rightarrow \text{Total loss to 200 workers} = 200 * [\frac{1}{2} * (\text{฿}200 + \text{฿}50)] = \text{฿}25,000.$$

Finally, 400 workers are induced by the higher wage to enter the market.

However, since jobs are not available for these persons, they do not work either before or after the minimum wage is introduced. Hence, they neither gain nor lose surplus.

➔ Therefore, the total impact of the minimum wage on society as a whole equals: ฿80,000

$$- \text{฿}90,000 - \text{฿}25,000 = -\text{฿}35,000.$$

4. Suppose the government is considering an increase in the toll on a certain stretch of expressway from 40 baht to 50 baht. At present, 25,000 cars per day use that expressway stretch; after the toll increase is imposed, it is projected that only 20,000 cars per day will use the expressway stretch.
 - a. Assuming that the marginal cost of expressway use is constant (i.e., the supply schedule is horizontal) and equal to 40 baht per car, calculate the change in consumer surplus and the net cost to society attributable to the increase in the toll.

(Hint: The toll increase will cause the supply schedule, not the demand schedule, to shift.)

Answer:

- Change (loss) in consumer surplus = $(1/2) * (50-40) * [1/2 * (20,000+25,000)] = 225,000$
- The increased toll paid by the remaining drivers is $(50-40)(20,000) = 200,000$. This collected toll can be viewed as a transfer from the drivers to the government.

Hence, the net social cost of the project is the deadweight loss = $(1/2)(50-40)(25,000-20,000) = 25,000$ baht.

- b. Because of the reduced use of the expressway, demand in the secondary market for gasoline increases by 20,000 liters per day (since drivers avoid the expressway by using local roads which have longer distance). As we realize, there is a stiff tax on gasoline, one that existed prior to the new toll. Assuming that the marginal cost of producing gasoline is 30 baht per liter, that these marginal costs are constant (i.e., the supply schedule is horizontal), that no externalities result from the consumption of gasoline, and that the gasoline tax adds 5 baht to the supply price, are there any additional costs or benefits due to this shift? If so, how large are they?

Answer: Yes, there are additional costs due to the increase in the toll – that is, the increase in the government's tax revenue from increased gasoline sales: $5 * 20,000 = 100,000$ baht.

5. A highway department is considering building a temporary bridge to cut travel time during the three years it will take to build a permanent bridge. The temporary bridge can be put up in a few weeks at a cost of \$750,000. At the end of three years, it would be removed and the steel would be sold for scrap. The real net cost of this would be \$81,000. Based on estimated time savings and wage rates, fuel savings, and reductions in risks of accidents, department analysts predict that the benefits in real dollars would be \$275,000

during the first year, \$295,000 during the second year, and \$315,000 during the third year. Departmental regulations require use of a real discount rate of 4 percent.

- a. Calculate the present value of net benefits assuming that the benefits are realized at the end of each of the three years.
- b. Calculate the present value of net benefits assuming that the benefits are realized at the beginning of each of the three years.
- c. Calculate the present value of net benefits assuming that the benefits are realized in the middle of each of the three years.
- d. Calculate the present value of net benefits assuming that half of each year's benefits are realized at the beginning of the year and the other half at the end of the year.
- e. Does the temporary bridge pass the net benefits test?

Answer:

Begin by calculating the present value of the costs. This includes the construction cost of the temporary bridge, which occurs at the beginning of year 1, and the net cost of decommissioning the bridge at the end of year 3:

$$PV(\text{cost}) = \$750,000 + \$81,000/(1+.04)^3 = \$750,000 + \$72,009 = \$822,009.$$

a. Benefits accrue at the end of the year:

$$\begin{aligned} PV(\text{ben}) &= \$275,000/(1+.04)^1 + \$295,000/(1+.04)^2 + \$315,000/(1+.04)^3 \\ &= \$264,423 + \$272,744 + \$280,034 \\ &= \$817,201 \end{aligned}$$

$$NPV = \$817,201 - \$822,009 = -\$4,808$$

b. Benefits accrue at the beginning of the year:

$$\begin{aligned} PV(\text{ben}) &= \$275,000 + \$295,000/(1+.04)^1 + \$315,000/(1+.04)^2 \\ &= \$275,000 + \$283,654 + \$291,235 \\ &= \$849,889 \end{aligned}$$

$$\text{NPV} = \$849,889 - \$822,009 = \$27,880$$

c. Benefits accrue at mid-year:

$$\begin{aligned}\text{PV}(\text{ben}) &= \$275,000/(1+.05)^{.5} + \$295,000/(1+.05)^{1.5} + \$315,000/(1+.05)^{2.5} \\ &= \$269,660 + \$278,145 + \$285,580 \\ &= \$833,385\end{aligned}$$

$$\text{NPV} = \$833,385 - \$822,009 = \$11,376$$

d. Benefits split equally between beginning and end of year:

$$\text{PV}(\text{ben}) = (\$817,201 + \$849,889)/2 = \$833,545$$

$$\text{NPV} = \$833,545 - \$822,009 = \$11,536$$

Alternatively, average the answers to parts a and b: $(-\$4,808 + \$27,880)/2 = \$11,536$.

f. The sign of the present value of net benefits depends on when the benefits are assumed to occur. In practice, they are likely to accrue throughout the year, so either method (c) or (d) is most appropriate, and the temporary bridge passes the net benefits test.

6. A town's recreation department is trying to decide how to use a piece of land. One option is to put up basketball courts with an expected life of eight years. Another is to install a swimming pool with an expected life of 24 years. The basketball courts would cost \$180,000 to construct and yield net benefits of \$40,000 at the end of each of the eight years. The swimming pool would cost \$2.25 million to construct and yield net benefits of \$170,000 at the end of each of the 24 years. Each project is assumed to have zero salvage value at the end of its life. Using a real discount rate of 5 percent, which project offers larger net benefits?

Answer:

As only one of these projects can be built on the site, they are mutually exclusive. The comparison is complicated because the swimming pool has an expected life three times longer than the basketball courts.

Consider first the NPV of each project separately:

$$\text{NPV}(\text{one basketball court project}) = -\$180,000 + \sum_{i=1}^8 \frac{40,000}{(1+0.05)^i} = \$78,529$$

$$\text{NPV}(\text{one swimming pool project}) = -\$2,250,000 + \sum_{i=1}^{24} \frac{170,000}{(1+0.05)^i} = \$95,769$$

If we choose on the basis of this comparison, then the swimming pool has a larger present value of net benefits. However, this is not appropriate as the projects are of different lengths. There are two possible correct approaches:

1. One could choose between one swimming pool and three successive basketball court projects so that the site is used in each case for the same length of time.

$$\begin{aligned} \text{NPV}(\text{three successive basketball court projects}) \\ &= \$79,525 + \$79,525/(1+.05)^8 + \$79,529/(1+.05)^{16} \\ &= \$79,525 + \$53,826 + \$36,431 \\ &= \$169,782 \end{aligned}$$

Thus, three successive basketball court projects offer a higher present value of net benefits than the swimming pool project. One should build the basketball court.

2. An alternative approach for comparing these projects of different lengths is to divide each project's NPV by its appropriate annuity factor to find its equivalent annual net benefits, an approach called "amortization." The appropriate annuity factor in each case can be obtained by using the formula for the present value of an annuity found in Appendix 6a.

$$\text{The 8-year annuity factor} = [1-(1+.05)^{-8}]/(.05) = 6.4632$$

$$\text{Annualized NB for the basketball court} = \$79,525/6.4632 = \$12,304$$

$$\text{The 24-year annuity factor} = [1-(1+.04)^{-24}]/(.04) = 13.7986$$

$$\text{Annualized NB for the swimming pool} = \$95,796/13.7986 = \$6,942$$

The basket ball court projects offers net benefits equivalent to an annuity paying \$12,304 each year over its life. The swimming pool offers net benefits equivalent to an annuity paying \$6,942 each year over its life.