B.E. International Program

Faculty of Economics, Thammasat University

EE 465/463 Project Evaluation

Semester 2/2014

Practice Problem 1 – Suggested Answers

(*Covers materials from chapters 1-5*)

1. Boardman et al., chapter 1 question 2

The effects of a tariff on imported kumquats can be divided into the following categories: tariff revenues received by the treasury ($8 million); increased use of resources to produce more kumquats domestically ($6 million); the value of reduced consumption by domestic consumers ($4 million); and increased profits received by domestic kumquat growers ($5 million). A CBA from the national perspective would find costs of the tariff equal to $10 million-the sum of the costs of increased domestic production and forgone domestic consumption ($6 million + $4 million = $10 million). The increased profits received by domestic kumquat growers and the tariff revenues received by the treasury simply reflect higher prices paid by domestic consumers on the kumquats that they continue to consume and, hence, count as neither benefits nor costs. Thus, the net benefits of the tariff are negative (-$10 million). Consequently, the CBA would recommend against adoption of the tariff.

a. Assuming the agriculture department views kumquat growers as its primary constituency, how would it calculate net benefits if it behaves as if it is a spender?

Ans.

If the agriculture department behaved as if it were a "spender," then the benefits would probably be:

- $5 million domestic grower profits (“constituents”)

- $8 million tariff revenue (income from foreigners, assuming a national perspective)

Total benefits: $13 million

Costs would be $4 million (reduced consumption)

Net benefits: $9 million.

Note: A spender might treat the additional resources devoted to domestic kumquat production ($6 million) as a cost.

b. Assuming the treasury department behaves as if it is a guardian, how would it calculate net benefits if it believes that domestic growers pay profit taxes at an average rate of 20 percent?

Ans. If the treasury department behaved as if it were a "guardian," then it would count only the costs and benefits accruing to the government. If so, benefits would equal $9 million ($8 million in tariff revenue and $1 million in profits tax) and costs would be zero, so that net benefits would equal $9 million.

2. Boardman et al., chapter 2 question 6

Because of a recent wave of jewelry store robberies, a city increases police surveillance of jewelry stores. The increased surveillance costs the city an extra $500,000 per year, but as a result, the amount of jewelry that is stolen falls. Specifically, without the increase in surveillance, jewelry with a retail value of $1 million would have been stolen. This stolen jewelry would have been fenced by the jewelry thieves for $600,000. What is the net social benefit resulting from the police surveillance program? Assume that the thieves are not given standing in this situation.

Ans. Since the robbers are not given standing, society enjoys a $500,000 net benefit from the surveillance project: $1,000,000 - $500,000 = $500,000.

3. Boardman et al., chapter 2 question 7

Excessive and improper use of antibiotics is contributing to the resistance of many diseases to existing antibiotics. Consider a regulatory program in the United States that would monitor antibiotic prescribing by physicians. Analysts estimate the direct costs of enforcement to be $40 million, the time costs to doctors and health professionals to be $220 million, and the convenience costs to patients to be $180 million (all annually). The annual

benefits of the program are estimated to be $350 million in avoided resistance costs in the United States, $70 million in health benefits in the United States from better compliance with prescriptions, and $280 million in avoided resistance costs in the rest of the world. Does the program have positive net benefits from the national perspective? If not, what fraction of benefits accruing in the rest of the world would have to be counted for the program to have positive net benefits?

[Note: Use the spreadsheet provided.]

Ans. Using the spreadsheet, you should get the following:

		Millions of Dollars
Regulatory program to monitor antibiotic prescribing by U.S. physicians to reduce the spread of resistant strains	Regulatory enforcement	40
	Time cost to doctors	220
	Convenience cost to patients	180
	Total U.S. Costs	**440**
	Avoided U.S. resistance costs	350
	Better drug compliance	70
	Total U.S. Benefits	**420**
	Avoided non-U.S. resistance costs	280
	Fraction counted as U.S. Benefits	0
	U.S. Net Benefits	**-20**

To determine what fraction of benefits to non-U.S. resistance costs would have to be included in the CBA to show zero benefits can be determined by changing the value of cell C13 until U.S. Net Benefits rise to zero. Any larger fraction will then yield positive net benefits. The net benefits are about $20,000 (or $0.2m) when the fraction equals .0715.

4. Boardman et al., chapter 3 question 1

A person's demand for gizmos is given by the following equation:

$$q = 6 - 0.5p + 0.0002I$$

where, q is the quantity demanded at price p when the person's income is I. Assume initially that the person's income is $40,000.

a. At what price will demand fall to zero? (This is sometimes called the choke price because it is the price that chokes off demand.)
Ans.
$q = 6 - 0.5p + 0.0002I$
$q = 6 - 0.5p + 0.0002(40{,}000) = 14 - 0.5p$

At the choke price, q = 0:
0 = 14 -0.5p
p = $28

b. If the market price for gizmos is $10, how many will be demanded?
Ans.
q = 14 -.5(10) = 9
If the market price is $10, then the consumer will demand 9 gizmos.

c. At a price of $10, what is the price elasticity of demand for gizmos?
Ans.
The price elasticity of demand equals (-0.5)(10/5) = -1. That is, when price equals $10, a one percent rise in price results in a one percent reduction in quantity demanded. Note that for a linear demand schedule, the price elasticity of demand is not constant -- its absolute value increases as price increases.

d. At a price of $10, what is the consumer surplus?
Ans.
The height of the triangle is the choke price minus the market price (28-10=18) and the base is the amount demanded (9). Then, the consumer surplus which is the area of the triangle under the demand curve and above the price is (18)(9)/2 = $81.

e. If price rises to $12, how much consumer surplus is lost?
Ans.
A price rise to $12 reduces demand to 8 gizmos. The new consumer surplus is (28-12)(8)/2 = $64. The reduction in consumer surplus, therefore, is $81-$64 = $17.

f. If income were $60,000, what would be the consumer surplus loss from a price rise from $10 to $12?
Ans.
When income equals $60,000, the demand for gizmos is given by q = 6 - 0.5p + (0.0002)(60,000) = 18 - 0.5p.
For p=$10, q=13; and for p=$12, q=12. The change in consumer surplus is thus (12-10)(12) + (2)(1)/(2) = $25. The larger change in consumer surplus for the higher income situation illustrates the dependence of willingness to pay on income.

5. Boardman et al., chapter 3 question 2

At the current market equilibrium, the price of a good equals $40 and the quantity equals 10 units. At this equilibrium, the price elasticity of supply is 2.0. Assume that the supply schedule is linear.

a. Use the price elasticity and market equilibrium to find the supply schedule. (Hint: the supply schedule has the following form: $q = a + (\Delta q/\Delta p)$p. First, find the value of $\Delta q/\Delta p$, and then, find the value of a.)
Ans.

Elasticity = $(\Delta q/\Delta p)(p/q)$

$2.0 = (\Delta q/\Delta p)(40/10)$

$(\Delta q/\Delta p) = .5$, which is the slope of the supply schedule.

⇨ $q = a+.5p$

At the market equilibrium: $10 = a + (.5)(40)$

$a = -10$

Therefore, the supply schedule is $q = -10 + .5p$.

b. Calculate the producer surplus in the market.

Ans.

First, find the "inverse" supply schedule, which is $p = 20 + 2q$.

Next, find the producer surplus as the area between the price line (p=$40) and the inverse supply schedule from quantity zero to quantity 10. Note that this area forms a triangle with height equal to the price minus the price at zero quantity (40-20=20) and base equal to the quantity (10). The area of the triangle is thus (.5)(20)(10) = $100. Therefore, the producer surplus in this market is $100.

c. Imagine that a policy results in price falling from $40 to $30. By how much does producer surplus fall?

Ans.

Using the supply schedule, we see that at a price of $30, the quantity supplied falls to $q = -10+.5(30) = 5$ units.

The producer surplus is the area of the new triangle formed by the price line p = $30 and the inverse supply schedule from quantity zero to 5 units. The area of this triangle is (.5)(30-20)(5) = $25. Thus, the decline in price from $40 to $30 results in a loss of producer surplus of $100-$25 = $75.

d. What fraction of the lost producer surplus is due to the reduction in the quantity supplied and what fraction is due to the fall in price received per unit sold?

Ans.

One-third of the producer surplus loss is due to the reduction in the quantity sold and the remaining two-thirds of the loss is due to producers receiving less for each unit that they continue to sell.

6. Boardman et al., chapter 3 question 3

Imagine a person's utility function over two goods, X and Y, where Y represents dollars. Specifically, assume a Cobb-Douglas utility function:

$$U(X,Y) = X^a Y^{(1-a)}$$

where $0<a<1$.

Let the person's budget be B. The feasible amounts of consumption must satisfy the following equation:

$$B=pX+Y$$

where p is the unit price of X and the price of Y is set to 1.

Solving the budget constraint for Y and substituting into the utility function yields

$$U = X^{a} (B-pX)^{(1-a)}$$

Using calculus, it can be shown that utility is maximized by choosing

$$X=aB/p$$

Also, it can be shown that the area under the Marshallian demand curve for a price increase from p to q yielding a change in consumption of X from x_p to x_q is given by

$$\Delta CS = [aBln(x_q)-p\ x_q]- [aBln(x_p)-p\ x_p]-(q-p)x_q$$

When B=100, a=0.5, and p=.2, X=250 maximizes utility, which equals 111.80. If price is raised to p=.3, X falls to 204.12.

a. Increase B until the utility raises to its initial level. The increase in B needed to return utility to its level before the price increase is the compensating variation for the price increase. (It can be found by guessing values until utility reaches its original level.)

b. Compare ΔCS, as measured with the Marshallian demand curve, to the compensating variation.

[Note: Use the spreadsheet provided. Use iteration to solve for a price change from $.20 to $.30 instead of $0.4.]

Ans.

The provided spreadsheet shows the compensating variation, change in consumer surplus, and equivalent variation for a change in price from $0.20 to $.40. The numbers shown are as follows:

Compensating variation:	-$41.42
Change in consumer surplus:	-$38.04
Equivalent variation:	-$29.29

Note that the compensating variation and equivalent variation bracket the change in consumer surplus. Also note that the discrepancy between these money metrics and the change in consumer surplus is quite large. This results because the good makes up such a large fraction of the consumer's expenditure so that the income effect that puts a wedge between the money metrics is very large.

Solving iterative for a price change from $.20 to $.30 yields the following:

Compensating variation:	-$22.47
Change in consumer surplus:	-$21.37
Equivalent variation:	-$18.35

7. Boardman et al., chapter 4 question 3

A country imports 3 billion barrels of crude oil per year and domestically produces another 3 billion barrels of crude oil per year. The world price of crude oil is $90 per barrel. Assuming linear schedules, economists estimate the price elasticity of domestic supply to be 0.25 and the price elasticity of domestic demand to be 0.1 at the current equilibrium.

a. Consider the changes in social surplus that would result from imposition of a $30 per barrel import fee on crude oil that would involve annual administrative costs of $250 million. Assume that the world price will not change as a result of the country imposing the import fee, but that the domestic price will increase by $30 per barrel. Also assume that only producers, consumers, and taxpayers within the country have standing. Determine the quantity consumed, the quantity produced domestically, and the quantity imported after the imposition of the import fee. Then estimate the annual social net benefits of the import fee.

Ans.
The imposition of the import fee would have the following effect on the domestic market:
Change in quantity consumed: $-.1 = (\Delta q/\Delta p)(p/q)$

$\Delta q = (-.1)\Delta p(q/p)$
$\Delta q = (-.1)(\$30)(6 \text{ billion})/(\$90)$
$\Delta q = -.2 \text{ billion}$

Change in domestic supply: $.25 = (\Delta q/\Delta p)(p/q)$

$\Delta q = (.25)\Delta p(q/p)$
$\Delta q = (.25)(\$30)(3 \text{ billion})/(\$90)$
$\Delta q = .25 \text{ billion}$

Thus, after imposition of the fee, domestic consumption will fall to 5.8 billion barrels per year, domestic production will rise to 3.25 billion barrels per year, and imports will fall to 2.55 billion barrels per year (5.8 billion - 3.25 billion).

The changes in surplus to producers, consumers, and tax-payers are:

Change in domestic producer surplus:

A. Surplus from additional .25 billion barrels produced
Revenue = (.25 billion)($120) = $30 billion/year

Production costs (area under supply schedule) =
(.5)($120-$90)(.25 billion) + ($90)(.25 billion) = $26.25 billion/year
Net change in surplus from new production = $3.75 billion/year

B. Surplus from higher prices on original production =
($120-$90)(3 billion) = $90 billion/year

⇨ Total change in producer surplus = $93.75 billion/year

Change in consumer surplus:

C. "Deadweight loss" from reduced consumption =
(.5)($120-$90)(.2 billion) = $3 billion/year

D. Additional payments on quantity still consumed =
($120-$90)(5.8 billion) = $174 billion/year

⇨ Total change in consumer surplus = -$177 billion/year

Change in tax revenues:

E. Import fee applied to new import level:
($30)(2.55 billion) = $76.5 billion/year

F. Administrative costs = -$.25 billion/year

⇨ Total change in tax revenues = $76.5 billion - $.25 billion = $76.25 billion/year

CBA from country's perspective:

Costs:	
Change in consumer surplus	-$177.00 billion/yr
Benefits:	
Change in domestic producer surplus	$93.75 billion/yr
Net gain to tax-payers	$76.25 billion/yr
Net benefits:	-$7.00 billion/yr

The import fee would have negative net benefits of $7 billion/year and therefore does not pass the CBA test.

b. Economists have estimated that the marginal excess burden of taxation in the country is 0.25 (see Chapter 3). Re-estimate the social net benefits assuming that 20 percent of the increase in producer surplus is realized as tax revenue under the existing tax system. In answering this question, assume that increases in tax revenues less the cost of administrating the import fee are used to reduce domestic taxes.

Ans. Assuming 20 percent of producer surplus is collected as taxes, the costs and benefits are:

Change in consumer surplus:	-$177.00 billion
After tax change in producer surplus:	$75.00 billion
Net gain to taxpayers	$95.00 billion
Net gain to taxpayers times METB	$23.75 billion
Net benefits	$16.75 billion

Not only do tax-payers enjoy reductions in tax payments, but the reduction in tax payments results in a reduction in deadweight loss. To calculate this latter benefit, we multiply the fiscal change by the METB. Taking account of the METB in this case makes an important difference: the tax would not pass the net benefits test if METB is zero (implicitly assumed in part a), but would pass the net benefits test if the METB is .25.

c. The reduction in the country's demand for imports may affect the world price of crude oil. Assuming that the import fee reduces the world price from $90 to $80 per barrel, and thus, the after-tax domestic price is $80 + $30 = $110 per barrel, a net increase in domestic price of $20 per barrel, repeat the analysis done in parts a and b.

Ans. Change in quantity consumed: $-.1 = (\Delta q/\Delta p)(p/q)$

$\Delta q = (-.1)\Delta p(q/p)$

$\Delta q = (-.1)(\$20)(6 \text{ billion})/(\$90)$

$\Delta q = -.133$ billion

Change in domestic supply: $.25 = (\Delta q/\Delta p)(p/q)$

$\Delta q = (.25)\Delta p(q/p)$

$\Delta q = (.25)(\$20)(3 \text{ billion})/(\$90)$

$\Delta q = .167$ billion

Thus, after the tax, 5.867 billion barrels are consumed, 3.167 billion barrels are domestically produced, and 2.7 billion barrels are imported.

- Consumer surplus loss = (.5)(.134 billion)($110-$90) + (5.867 billion)($110-$90) = $118.68 billion/year
- Producer surplus gain = (.25 billion)($120) - [(.5)(.25 billion)($120-$90) + (.25 billion)($90)] + (3 billion)(120-$90) = $61.67 billion/year
- Net taxpayer gain = ($30)(2.7 billion) - $.25 billion = $80.75 billion/yr.

If the METB is assumed to be zero, then net benefits are $23.74 billion per year.

Assuming that 20 percent of producer surplus is transferred to the government through the existing tax system and the METB is 0.25, the net social benefits are:

(49.34) + (80.75+12.33) + (0.25)(80.75+12.33) – 118.68 = $47.01 billion/year.

8. Boardman et al., chapter 5 question 2

Recall exercise 3 from Chapter 4 in which a country imposes an import fee on the crude oil it imports. Assume that prior to the imposition of the import fee, the country annually consumed 900 million short tons of coal, all domestically mined, at a price of $66 per short ton. How would the CBA of the import fee change if, after imposition of the import fee, the following circumstances are assumed to result from energy consumers switching from crude oil to coal?

a. Annual consumption of coal rises by 40 million short tons, but the price of coal remains unchanged.

Ans. As long as the secondary market for coal is undistorted and its price does not change, the increased consumption of coal is irrelevant to estimation of changes in social surplus in the primary (crude oil) market.

b. Annual consumption of coal rises by 40 million short tons and the price of coal rises to $69 per short ton. In answering this question, assume that the prices of other goods, including coal, were not held constant in estimating the demand schedule for crude oil.

Ans. Since it was assumed that the price of other goods, including coal, were not held constant in estimating the primary market (crude oil) demand schedule, the crude oil demand curve can be viewed as an equilibrium demand curve. Consequently, there is no need to consider changes in the secondary market for coal.

c. Annual consumption of coal rises by 40 million short tons and the price of coal rises to $69 per short ton. In answering this question, assume that the prices of other goods, including coal, were held constant in estimating the demand schedule for crude oil. Also assume that the demand schedule for coal is completely inelastic.

Ans.

If price rises in the secondary (coal) market and the prices of other goods were held constant in estimating the demand schedule in the primary (crude oil) market, then this demand schedule does not capture all the changes in social surplus. Hence, in principle, it is necessary to subtract the change in social surplus in the coal market from the estimated social surplus in the crude oil market.

The price rise in the domestic crude oil market can be thought of as causing an outward shift in the demand for coal. The change in social surplus in the coal market would be measured relative to the shifted demand schedule.

We can calculate the gain in producer surplus in the coal market as (.5)(40 million)($69-$66)+(900 million)(($69-$66) = $2,760 million/year, because we have two points on the supply schedule ($66, 900 million) and ($69, 940 million), which allow us to calculate the area of the relevant trapezoid as a triangle above the added production and a rectangle above the previous production.

By assuming perfectly inelastic demand for coal, we can calculate the loss in consumer surplus as: (940 million)($69-$66) = $2,820 million/year. [Note that this amount would be slightly larger if we had assumed somewhat more realistically that the demand curve had a negative slope.]

Thus, the net benefits of the import fee as measured in the crude oil market should be reduced by: $2,820 million - $2,760 million = $60 million/year.

d. The market price of coal underestimates its marginal social cost by $15 per short ton because the coal mined in the country has a high sulphur content that produces smog when burned. In answering this question, assume that, as in question 2.a, the annual consumption of coal rises by 40 million short tons, but the price of coal remains unchanged.

Ans.
If the market for coal is distorted with an externality, then a relevant social surplus change occurs even if price does not change. In this case, the social surplus loss in this secondary market would be (40 million short tons)($15 externality per short ton) = $0.60 billion/per year.
[Note that all of the analyses in the answers to question 3 in Chapter 4 and to this question assume that there are no externalities in the primary (crude oil) market.]