Homework #3 (due October 31st, 2012) – EconS 330

Instructor: Ana Espinola, Hulbert 111C, anaespinola@wsu.edu

1. Identify and explain the negatives effects of a price control policy on the provision of a Depletable resource (natural gas). Use a graph to represent this policy [Assume increasing marginal extraction cost with substitute resource in the presence of price controls]. (10 Points)

2. The Federal Reserve, the European Central Bank, the Japanese Central Bank and the Chinese Central Bank have all indicated that they are likely to raise interest rates in the year to come. Suppose that they do this, and that this leads to higher interest rates worldwide. Based on the models covered in the course for optimal extraction of nonrenewable resources, what (if any) effect would you expect a higher interest rate to have on the optimal extraction rate of oil over time? Why? What would the effect of this be on the price of oil? (10 Points)

3. If the current tension over Iran’s nuclear program leads to war, and this causes higher oil prices, what would you expect to happen to the demand curve for SUVs? For mountain bikes? For milk? Illustrate graphically. Explain your reasoning. (10 Points)

4. Suppose that the long-envisioned “paperless office” finally comes to pass, at least to some extent that use of information technology means that a large number of businesses and government agencies can cut down drastically on their paper consumption, and that this happens in fairly short order.
   a) How would this affect the quantity of recycled paper used, and the recycling ratio for paper? You can use the standard assumptions used in the course for modeling the use of recycled vs. virgin materials. Illustrate your answer graphically. (10 Points)
   b) If a sharp reduction in the use of paper leads to a fall in the value of wood, what impact(s) would this have on the decision about the optimal rotation period for forests? Why? Illustrate graphically. Your answer to this question does not need to be linked to your answer in (a). (10 Points)

5. Assume that the U.S. oil demand is represented by the following demand function:
   \[ P_d = 40 - .15q_d \]
   and the Supply curve (which represents the oil producers) is:
   \[ P_s = 5 + .10q_s \]
   where \( P_d \) and \( q_d \) are price and quantity demanded respectively. Notice that \( P_s \) is the price charged by the suppliers and \( q_s \) is the quantity supplied.
   a) Find the optimal quantity and price in the oil market. (5 Points)
   b) Assume that the oil world price is $12. Find the quantity produced by U.S. firms and quantity demanded by U.S. consumers. (5 Points)
   c) How many units U.S. will import? (5 Points)
   d) Assume that the vulnerability premium is equal to $5. Find the new quantity produced by U.S. firms and new quantity demanded by U.S. consumers. (5 Points)
   e) Identified the new quantity of oil imported from foreign countries. (5 Points)
   f) Draw a graph (label everything carefully) and identify the size of efficiency loss. (10 Points)
g) Determine the price elasticity of demand when the new price is $12. Is the demand elastic or inelastic? Explain, in your own words, the result. (5 Points)

6. Suppose a product can be produced using virgin ore at a marginal cost given by $MC_1 = 0.7q_1$ and with recycled materials at a marginal cost given by $MC_2 = 10 + 0.2q_2$.
   a) If the inverse demand curve were given by $P = 15 - 0.4(q_1 + q_2)$, how many units of the product would be produced with virgin ore and how many units with recycled materials? (4 Points)
   b) If the inverse demand curve were $P = 30 - 0.4(q_1 + q_2)$, what would your answer be? (4 Points)
   c) Illustrate your answer on a clearly labeled graph (2 Points)

Solutions

Exercise #1

The time of transition is earlier under price controls and the transition is abrupt, with prices suddenly jumping to new, higher levels. Both are detrimental. The first effect means we would not be using all of the natural gas available at prices consumers were willing to pay. Among other things, this could cause a transition to the substitute before the technologies to use it were adequately developed.
**Exercise #2**

In the case of constant MExC, we know that the Total Marginal Cost is increasing a rate \( r \) (interest rate). Therefore, if the interest rate rises, we should expect to observe the following:

- Switch point to a renewable resource will be earlier in time
- It increases the opportunity cost of the current consumption
- Since the Total Marginal Cost increases at a higher rate (interest rate), then the oil price increases as well

**Exercise #3**

The case of SUV’s and oil, we know that this two goods are complements. Therefore, if the price of oil increases the quantity demanded of SUVs decreases. Graphically:

![Graph showing the relationship between SUV price and quantity demanded.](image)

Therefore, the price of SUVs decreases from \( P_0 \) to \( P_1 \) and the quantity demanded decreases from \( Q_0 \) to \( Q_1 \).
In the case of SUVs and mountain bikes they are substitute goods. Therefore, when the price of oil increases the quantity demanded of mountain bikes increases (people prefer to ride the bicycle- and consume less fossil fuel- than use the car). Graphically:

Therefore, the price of Mountain Bikes rise from $P_0$ to $P_1$ and the quantity demanded increases from $Q_0$ to $Q_1$

Finally, Milk is an inferior good (or a good of first necessity), which means that people will not stop consuming milk in order to consume more oil. However, an increase in the oil price will increase the price of milk (for instance, it is more expensive to transport milk from the farm to the supermarket. Therefore, it increases the production costs)

An increase in Milk price will slightly reduce the quantity demanded (since it is an inferior good).
Exercise #4

If the quantity demanded decreases it means that firms will use more virgin materials than recyclable materials (see graph). Note that $Q_{1}^{VO} < Q_{0}^{VO}$ and $Q_{1}^{RM} > Q_{0}^{RM}$

b) The decrease in demand reduces prices and as a consequence the value of wood. We know that the decision to harvest the forest depends on the maximum net benefit. In this specific case, we assume that planting and harvesting cost do not change. In addition, the rate of growth of the forest is the same. Therefore a change in prices should not affect the optimal rotation period for forests.

Exercise #5

a) In order to find the optimal quantity you have to equalize demand and supply:

$$40 - .15q_d = 5 + .10q_s$$

$$35 = .25q$$

$q = 140$ and $p = 40 - .15 \times 190 = 19$

b) Assume that the world price is $12. The quantity produced by U.S. firms is obtained from the supply curve:

$$P_s = 5 + .10q_s$$

we have to analyze what is the quantity that U.S. firms are willing to produce when price is $15. Therefore:

$$12 = 5 + .10q_s$$

$7 = .10q_s$ Solving by $q_s$ we have that: $q_s = 70$
The quantity demanded by U.S. consumers is obtained from the demand function:

\[ P_d = 40 - 0.15q_d \]

We have to analyze what is the quantity that U.S. consumers are willing to consume when price is $15. Therefore:

\[ 12 = 40 - 0.15q_d \]

\[-28 = -0.15q_d \]

Solving by \( q_d \) we have that: \( q_d = 186.67 \)

c) U.S. will import: \( q_d - q_s = 186.67 - 70 = 116 \) barrels of oil

d) Vulnerability premium is equal to $5. Therefore, the new price will be:

\[ P(\text{new}) = \text{World price} + \text{Vulnerability premium} = 12 + 5 = 17 \]

Therefore the new quantity produced by the domestic firms when price is $17:

\[ 17 = 5 + 0.10q_s \]

\[ 12 = 0.10q_s \]

\[ q_s = 120 \]

And the quantity demanded by domestic consumers is:

\[ 17 = 40 - 0.15q_d \]

\[-23 = -0.15q_d \]

\[ q_d = 153.33 \]

e) U.S. will import (new price $16): 153.33 - 120 = 33.33 \) barrels of oil (domestic country produced more, therefore imports are zero!)

f)
g) The price elasticity of demand: 

\[ E_{pd} = \frac{\text{Change in quantity}}{\text{Change in price}} \]

\[ \text{Change in quantity} = \frac{Q_{\text{new}} - Q_{\text{original}}}{Q_{\text{original}}} \times 100 = \frac{186.67 - 140}{140} \times 100 = 33.34\% \]

\[ \text{Change in price} = \frac{P_{\text{new}} - P_{\text{original}}}{P_{\text{original}}} \times 100 = \frac{12 - 19}{19} \times 100 = -36.84\% \]

\[ E_{pd} = \frac{33.34\%}{-36.84\%} = |0.90| \text{ therefore the demand is relatively inelastic (absolute value close to one).} \]

Price elasticity of demand for a good is relatively inelastic (-1 < EPd < 0), the percentage change in quantity demanded is smaller than that in price. Hence, when the price is raised, the total revenue rises, and vice versa.

**Question 6 (10 Points) -- Solution**

a) \[ 0.7q_1 = 15 - 0.4q_1 \]
\[ 1.1q_1 = 15 \]
\[ q_1 = 13.63 \text{ (2 Points)} \]

\[ 10 + 0.2q_2 = 15 - 0.4q_2 \]
\[ 0.6q_2 = 5 \]
\[ q_2 = 8.3 \text{ (2 Points)} \]

b) \[ 0.7q_1 = 30 - 0.4q_1 \]
\[ 1.1q_1 = 15 \]
\[ q_1 = 27.27 \text{ (2 Points)} \]

\[ 10 + 0.2q_2 = 30 - 0.4q_2 \]
\[ 0.6q_2 = 20 \]
\[ q_2 = 33.33 \text{ (2 Points)} \]

c) (2 Points)