Problem Set 3
Due March 2, 2007

1. a. What is the difference (conceptually) between the short run price and income elasticities of the demand for gasoline and the long run price and income elasticities of the demand for gasoline?

Ans: Conceptually the difference lies in the how a consumer can change his/her behaviour in the short versus the long run. In the case of gasoline the difference is usually in the choice of car or vehicle. In the short run the consumer can not change the vehicle which he/she drives however in the long run the consumer may switch to a more fuel efficient form of transport when the car is no longer useable

   b. Why are measured long-run elasticities larger than measured short-run elasticities?

Ans: Consumers can switch to more fuel efficient forms of transport in the long run compared to the short run.

   c. Assume that the government offered a payments of (say) $1000 to car owners who scrapped cars older than 8 years. How would this affect the measured long-run price elasticity of the demand for gasoline?

Ans: This would make the long run price elasticity of demand more elastic. Consumers would be more willing to scrap their old cars and switch to newer versions. Therefore the turn over of the capital (vehicle) stock would be on average faster so the responsiveness of demand would be greater to price changes.

2. Assume that a consumer has a choice between the following three different air conditioner models that have the same cooling capacity but different energy efficiency ratings. The air conditioners last for ten years

Model	Purchase Price	Annual Operating Cost
1	$200	$75
2	$250	$60
3	$300	$50

a. Calculate the total life-cycle cost for each model assuming that the AC unit is purchased at the beginning of year 1 and the annual interest rate is 10% per year

Ans: I assume that the operating costs are discounted at the end of the year in which they are incurred.

Model 1 = $660.84
Model 2 = $618.67
Model 3 = $607.23

b. Which model would a consumer with a 10% discount rate choose?

Ans: Model 3

c. Which model would a consumer with a 15% discount rate choose?

Ans: Model 1 = $576.41
        Model 2 = $551.13
        Model 3 = $550.94

Chooses Model 3

d. How high would a consumer's discount rate have to be for her to choose Model #1?

Ans: 27.3%

3. There is a fixed amount of coal (Q) available that can be consumed in period 1 (q_1) and/or period 2 (q_2). The demand function for coal in each period is the same and is qiven by

$$q_1 = 200 - p_1$$

$$q_2 = 200 - p_2$$

$$Q = q_1 + q_2$$

where p_1 and p_2 are the prices for coal in each period. Assume that the marginal extraction cost is zero.

a. Calculate the equilibrium price and quantity in each period assuming that Q = 169, the discount (interest) rate used by coal suppliers is 10% per year, and coal suppliers are price takers (behaves competitively)

Ans: Use the no arbitrage condition: $P_1 = P_2/1.1$

Substitute it into the above equations and use Q = 169 to get: $169 = 400 - 2.1P_1$

Solution: $P_1 = 110$; $P_2 = 121$; $q_1 = 90$; $q_2 = 79$

b. Calculate the equilibrium price and quantity in each period assuming that Q = 169, the discount (interest) rate used by coal suppliers is 20% per year, and coal suppliers are price takers (behaves competitively).

Ans: Use the no arbitrage condition: $P_1 = P_2/1.2$

Substitute it into the above equations and use $Q = 169$ to get: $169 = 400 - 2.2P_1$

Solution: $P_1 = 105$; $P_2 = 126$; $q_1 = 95$; $q_2 = 74$

c. Calculate the equilibrium price and quantity in each period assuming that $Q = 400$, the discount (interest) rate used by coal suppliers is 10% per year, and coal suppliers are price takers (behaves competitively).

Ans: Use the no arbitrage condition: $P_1 = P_2/1.1$

Substitute it into the above equations and use $Q = 400$ to get: $400 = 400 - 2.1P_1$

Solution: $P_1 = 0$; $P_2 = 0$; $q_1 = 200$; $q_2 = 200$

d. How would an increase in the interest rate to 20% in (c) affect your answer and why?

Ans: No here it would not because the market effectively clears at the same level it would absent the resource constraint.

e. Calculate the equilibrium price and quantity in each period assuming that $Q = 169$, there is a <u>monopoly</u> coal supplier that owns the entire resource, and the monopoly uses a discount (interest) rate of 10% per year.

Ans: Use the no arbitrage condition: $(MR_1-c)=(MR_2-c)/1.1$

Noting that $c=0$; $MR_i = 200-2q_i$;

Then $1.1(200-2q_1) = 200 - 2q_2$

Now using $169 = q_1 + q_2$ we can solve.

$P_1 = 114.8$; $P_2 = 116.2$; $q_1 = 85.2$; $q_2 = 83.8$

4. About 75 million barrels per day of oil were produced and consumed globally just prior to the war in Iraq and the world market price (P) was \$30/barrel. At the beginning of the war in Iraq about 3.0 million barrels per day of Iraqi supplies were taken off of the market.

a. Assume that the short-run world demand (Q_d) for oil can be characterized by the following demand curve and that the short-run supply (Q_s) of oil from other suppliers is perfectly <u>inelastic</u>:

$$Q_D = 78.75 - .125P$$

$$Q_S = 75 - \text{curtailments}$$

What is the effect on world market prices of curtailments of 3 million barrels per day?

Ans: Supply is inelastic so the price must change to allow the market to clear.

$dQ_D/dP = -0.125$ therefore if $dQ_D = -3$ then $dP = -3/-0.125 = \$24$ increase

b.   Assume instead that there is some short run supply response that can be characterized by the short-run supply function:

$$Q_S = (67.5 - \text{curtailments}) + .25P$$

What is the effect on world oil prices of curtailments of 3 million barrels per day under these short-run supply conditions?

Ans: Now both supply and demand can adjust so:
$dQ_D/dP - dQ_S/dP = -0.125 - 0.25 = -0.375$

$dQ = 3$ so $dP = -3/-0.375 = \$8$ increase

5. Adherents to Hubbert's "peak oil" theories have continually had to revise their projections upward for the year that global supplies of petroleum would peak and begin to decline. List and discuss briefly four reasons for this phenomenon.

Ans:
This theory is primarily flawed because it uses a particularly myopic view of the world. That is prices, technology, knowledge of fields etc will all remain fixed.
Some problems with this are:

1) Firstly these theories misunderstand what is meant by reserve. At any point in time the size reserves is determined by current economic conditions (price of oil). As the price of oil goes up it becomes economically viable to extract oil from many already known sources. An example given in class is the Alberta Tar sands which is not viable at low prices but above $40-$50 a barrel is viable.

2) These theories also ignore the rationing of oil by the market so that if production falls then basic economics tells us that prices increase to ration the oil. That is there is no "short fall" of oil but rather a higher price.

3) When the production of oil begins to fall relative to demand (or demand increases relative to supply) then the price of oil increases. This provides incentives for exploration and technological innovation. That is resources are devoted to increasing the efficiency of oil extraction and finding new resources because the rewards to doing so are now greater.

4) Furthermore even given existing prices there is learning from doing and investment in technological improvement which will increase the size of reserves in the future.

6. Discuss (briefly) how you would go about determining empirically whether or not OPEC is an effective cartel?

A good place to start for answering this question is Smith's article on the reading list. He observes that perfect competition would entail frequent uncorrelated production adjustments between firms across time. On the other hand a cartel model of behaviour would entails correlated production adjustments because the cartel acts in unison to changing market conditions which symmetrically affect members. Note this is a particular assumption the author is making about the type of cartel which exists. By testing whether OPEC countries adjustments are more highly correlated with each other than with non-OPEC countries the author can test for cartel like behaviour.

<u>For those enrolled in 14.444 only</u>

7. Discuss briefly the reasons why the rate of extraction of an exhaustible natural resource produced by profit maximizing firms in a competitive market may differ from the socially optimal rate of extraction? In which direction is it likely to deviate and why?

Ans: So the primary reason we may think a competitive market may lead to a rate of extraction different from the socially optimal rate is that competitive firms may have different discount rates from the discount rate of a social planner. Firms will use a discount rate equal to the cost of funds during any one period which is the interest rate. The social discount rate could differ from this for any number of reasons. For instance if there is an externality associated with the consumption of the natural resource then these two rates will not coincide. One obvious example of this is the emission of CO_2 from the burning of fossil fuels, but it may also be applied to such things as habitat conservation and diversity of animal species. In this case the rate of extraction by the competitive firms will be too fast.