Exam 1: Econ 3300
September 19, 2013

There are a total of 100 points on the exam. Show all of your work. This is closed book exam. You are not allowed to use your textbook, notes, or any other resource besides what I have given you. If you do not understand a question or find the question vague, ask me about it. Likely other people will be having the same trouble. If you decide you need to make additional assumptions after asking me, clearly state your assumptions when completing the problem.

You may use calculators for arithmetic but no functions (or other short-cuts). Good luck!

Short Answer Questions (*40 pts.*)

Please answer the following questions. Where appropriate, you are encouraged to draw pictures / diagrams to help explain your answer.

1. What is the Coase Theorem. Give an example of how it can be used / implemented. (***5 pts.***)

   Solution. *The Coase Theorem states that if property rights are well defined and transaction costs are low, then the socially optimal level of output can be achieved regardless of who has the initial property rights. An example of how this can be used is if one person's or firm's actions are creating an externality for another, we can assign property rights over that externality to either group and they will negotiate and sell/buy the property rights such that the efficient outcome is achieved.*

2. Define the equimarginal principal and explain its practical meaning. (***5 pts.***)

   Solution. *The equimarginal principal states that when controlling emissions from several polluters, all emitting the same pollutant, efficiency requires that the marginal cost of abatement be the same for all polluters. Thus, in practice, to efficiently abate pollution, we either need to know all firms marginal cost of abatement function or institute a regime in which firms have an incentive to truthfully reveal their marginal cost of abatement functions such as a cap-and-trade system or emissions tax.*

3. What is the difference between nominal and real interest rates? Give a numerical example. (***5 pts.***)

   Solution. *A real interest rate is the extra spending power you get from your investment with a return, r. It strips inflation out of the equation. A nominal interest rate is the real interest rate plus inflation. Usually this is the "advertised" interest rate. If I my bank pays an annual interest rate of 5% and annual inflation is 2%, then my real rate of interest is 3%.*

4. Does Hotelling's Rule suggest that non-renewable resource prices should increase in nominal or real dollars? Why? (***5 pts.***)

   Solution. *Hotelling's rule suggests that non-renewable resource prices should increase in real dollars. This is because there is an opportunity cost to not selling my resources today. I could sell my resource today and get a real interest rate on that money or use the money from selling my resource today to consume other goods. Therefore the price of the resource should increase at the same rate as my opportunity cost which is the real interest rate. (Note: The price should also increase in nominal dollars so long as inflation is greater than zero.)*

5. What are the First and Second Welfare Theorem of Economics? What conditions need to be met in order for the theorems to hold? (***5 pts.***)

   Solution. First Welfare Theorem: *In a competitive economy, a market equilibrium is Pareto optimal.*
   Second Welfare Theorem: *In a competitive economy, any Pareto optimum can be achieved by market forces provided resources are distributed appropriately before the market operates.*
   Necessary Conditions: *1.) atomistic participants, 2.) complete information, 3.) no transaction costs, 4.) complete property rights.*

6. What is an externality? Give an example of a positive and negative externality and how much of the externality producing good we expect a competitive market to provide relative to the social optimal. Explain your answer. (***5 pts.***)

   Solution. *Externalities result when the actions of one individual or firm have a direct, unintended, and uncompensated effect on the well-being of other individuals or firms. Investing in R&D creates a positive externality since once the knowledge is created, all others can benefit from that knowledge. Burning fossil fuels creates a negative externality since incomplete combustion creates air emissions that have harmful effects on other people and the environment. In a competitive market we would expect actions with positive externalities to be under provided since the providers don't get to capture all of the marginal benefits but pay the full costs. Contrastingly, we expect actions that create negative externalities to be over provided since the producers of the externality don't have to pay the full costs of their actions.*

7. Define a Nash Equilibrium and draw a game that has only one Nash Equilibrium. Circle the equilibrium. (***5 pts.***)

   Solution. *A Nash Equilibrium is an equilibrium of a game where neither player has a unilateral incentive to deviate from her current strategy. In the game below, the (shirk, shirk) strategy is the only Nash equilibrium.*

		Neighbor A: Contrib	Neighbor A: Shirk
Neighbor B	Contrib	1, 1	-1, 3
	Shirk	3, -1	0, 0

8. How should a monopoly firm decide how much of a good to produce? Explain. (***5 pts.***)

   Solution. *A monopoly should produce its product up to the point where the marginal cost of production is equal to the marginal revenue of selling that good. If the marginal revenue is more than the marginal cost, the firm would get more money back than it cost to make that good. If the marginal revenue is less than the marginal cost then the firm received less extra money than it cost to make the good, meaning the firms profits must be lower.*

Analytical and Longer Questions (*60 pts.*)

Answer all of the following questions.

1. A small town of 20 people (10 adults and 10 children) has a cement plant in it. As part of the production process, the cement plant emits volatile organic compounds into the local environment that causes health problems for the 20 local residents. The owner of the plant can reduce the amount of volatile organic compounds it releases through a technology that costs \$12 per pound of volatile organic compounds reduced per week. The owner knows that the emissions cause health problems for him (and everyone else), so he is willing to reduce his profits to do some pollution abatement to improve only his health. His (and all of the other adults) marginal benefit of abatement curve is $P = 18 - 2Q$ where Q is the reduction in emissions per week. The marginal benefit of abatement curve for the children is $P = 9 - Q$.

   (a) How much abatement does the owner engage in if he only cares about himself? (***10 pts.***)

   Solution. *If the owner only cares about his health, he will set the marginal cost of pollution reduction equal to his private benefit from pollution reduction. Since the*

marginal cost is \$12, we need to solve the equation:

$$12 = 18 - 2Q$$
$$Q = 3$$

Therefore he reduces pollution by 3 pounds of mercury per week.

(b) What is the social willingness to pay for this level of pollution abatement? (***10 pts.***)

Solution. *Clearly pollution reduction in this case is a public good since it is people can't be excluded from breathing the cleaner air and is non-rival since everyone gets the clean air. Therefore, since this is a public good, we want to add the demand curves for the good (abatement) vertically. Thus, the demand curve for abatement from adults is* $P = 180 - 20Q$ *and the demand curve for abatement from children is* $P = 90 - 10Q$*. Thus the town level demand curve is* $P = 270 - 30Q$*. Therefore the social willingness to pay for the last unit of abatement where* $Q = 3$ *is* $270 - 30(3) = \$180$*.*

(c) What is the socially efficient level of abatement? (***10 pts.***)

Solution. *The social optimum comes where the marginal social benefit of reduction is equal marginal cost of reduction.*

$$12 = 270 - 30Q$$
$$Q = 8.6$$

Thus, the socially optimal level of abatement is 8.6 pounds of volatile organic compounds per week.

2. The market demand function for gasoline is $Q = 200 - 20P$. There are 100 firms producing and selling gasoline so that the market can be considered competitive. Each firm has a marginal cost curve of $MC = 3$.

(a) What is the market clearing price and quantity of gasoline? What is the social welfare at this price and quantity? (***7 pts.***)

Solution. *Since the market is competitive, the market price will be the marginal cost. Thus, the equilibrium price is \$3 and the equilibrium quantity is* $Q = 200 - 20 * 3 = 140$*. Social welfare is the sum of producer surplus and consumer surplus. Since we have a constant marginal cost, producer surplus is zero since we have a completely elastic supply curve. Consumer surplus is* $\frac{1}{2} * (10 - 3) * 140 = \$490$*.*

(b) In the search for profits, firms begin to buy out other firms until there are only two firms left, each with a constant marginal cost of production of \$3. What is the equilibrium price and quantity? What is the social welfare now? Who, if anyone, gains and loses from these mergers? (***15 pts.***)

Solution. *Since we have a duopoly, we first want to find the residual demand curve. The residual demand curve for firm 1 is* $q_1 = 200 - 20P - q_2$*. Therefore, the inverse demand curve is* $P = 10 - 0.05q_1 - 0.05q_2$*. Since this demand curve is still linear in* q_1 *(we are taking* q_2 *as fixed), the marginal revenue curve is twice the slope of the demand curve. Therefore, the residual marginal revenue curve* MR^r *is:*

$$MR^r = 10 - 0.1q_1 - 0.05q_2$$

The profit maximizing output, given q_2 *is where* $MR^r = MC$*. Thus, the firms best response function is:*

$$10 - 0.1q_1 - 0.05q_2 = 3$$
$$q_1 = 70 - \frac{1}{2}q_2$$

Since our firms are identical, we know that firm 2's best response function is $q_2 = 70 - \frac{1}{2}q_1$*. We now have a system of two equations and two unknowns, the Cournot-Nash equilibrium occurs at* $q_1 = q_2 = 47$*. Plugging total output of 94 back into the demand curve we get the equilibrium price to be \$5.3 This means we have consumer surplus of* $\frac{1}{2} * (10 - 5.3) * 94 = 220.9$ *and producer surplus of* $(5.3 - 3) * 94 = 216.2$ *for a total welfare of \$437.1. Clearly the consumers lost welfare from all of the mergers and the firms gained substantially.*

(c) The two remaining firms now merge to form a monopoly in the gasoline market. What is the new equilibrium price and quantity? What is the social welfare? (***8 pts.***)

Solution. *We can calculate the inverse demand curve as* $P = 10 - 0.05Q$*, thus since the demand curve is linear, we get that the marginal revenue curve is* $P = 10 - 0.1Q$*. For a monopoly to maximize profits, it should set* $MR = MC$*. Thus, to solve for the equilibrium quantity,* $3 \stackrel{!}{=} 10 - 0.1Q$*, so* $Q^* = 70$*, thus the equilibrium price is \$6.50. Producer surplus is* $70 * (6.50 - 3) = 245$ *and consumer surplus is* $\frac{1}{2} * (10 - 6.5) * 70 = 122.5$ *for a total surplus of \$367.50.*