Econ 468 Fall 2013
Problem Set 1 – **Due Tuesday, October 15, in class or before**
Answers will be posted on Thursday, October 17
100 points

Question 1 (30 points): Declare each of the following statements **in bold** to be either true, false or uncertain. Explain clearly because your grade will primarily be determined by your explanation.

a) **Intellectual property has historically been the main way of paying for R&D outputs.** (if you have no clue on this one, take a look at the readings on "The Basics") (6)

b) Suppose that several pharmaceutical companies each have an opportunity to invest $350m in R&D to develop a drug. If the firm makes this investment, it will successfully develop the drug with probability ½. A patent on the drug is worth $800m to a firm. If multiple firms successfully develop the drug, only one firm will receive the patent and this firm is selected randomly with equal probability from the successful firms. The social value of the drug is $1.6b.

(i) One firm will invest in developing the drug. (4)
(ii) One firm investing in the drug is socially efficient. (4)

c) **Given that innovations will be funded by intellectual property rights, it is optimal to give long enough protection so that no innovations are lost due to insufficient profit.** (5)

d) **The market can mitigate the "tragedy of the anti-commons" provided that all actors are allowed to negotiate and trade property rights.** (5)

e) Consider the Schumpeterian growth model discussed in class (from the first 6 pages of Aghion, Akcigit, and Howitt, 2013). Suppose that we also allow the monopolist to try and innovate. Assume that the monopolist has the same productivity of R&D, λ, as all other firms. **Then, the monopolist will optimally choose not to invest in R&D.** (Hint: Find the new value of the innovation, V_{k+1} and consider the research arbitrage condition.) (6)

BONUS QUESTION (5): Now suppose that there is uncertainty as to the length/validity of a patent which we will model as a probability ϕdt that the patent will end in any given instant of time. What is an aspiring entrant's value of the innovation? Derive the derived demand for y and use it to calculate the monopolist's level of output and profits. Lastly, calculate z (the process and the solution should look almost identical to the derivations in class). How does an increase in the uncertainty surrounding a patent, ϕ, change the equilibrium level of z?

Question 2: (28)

Suppose an incumbent firm (Firm 1) has a patent on an invention. An entrant (Firm 2) can develop a technology that is an improvement on the invention. No other firm can develop this improvement. Let x and y be the respective per period value to society of the initial invention and the improvement and that society values the two products for $\overline{\mathbf{T}}$ years. Assume there is no discounting and that $(x + y)\overline{\mathbf{T}} - c_1 - c_2 > 0$. Assume the improvement comes along instantaneously.

Patent Length: Further, let πx and πy be the per period profit that can be generated from the initial invention during the life of the patent T. After the patent expires, the firms earn 0 profits. During the life of the patent, the dead-weight loss to society is *d*x and *d*y per period; assume there is no discounting. The cost of developing the original invention and improvement are c_1 and c_2 respectively.

Patent Breadth: If the patent is broad such that the improvement infringes and Firm 2 nevertheless invests c_2 to develop the invention, it will need a license ex post from Firm 1. Assume that the terms of the license are determined by Nash bargaining with bargaining power such that the gains from licensing are split equally. If the first patent is narrow such that the improvement does not infringe, then there will be no surplus to split (and therefore no ex post licensing).

a) Is there a research exemption in this problem? How do you know? (3)
b) Explain the difference between the social value not received by the firms (x – πx and y – πy) and the dead-weight loss (*d*x and *d*y) in each period during patent life? (3)
c) Describe a situation in which both the incumbent and entrant would be better off under an ex ante license (that is, a license prior to the entrant making its investment in the improvement). Using the above notation, write down the profits for Firms 1 and 2 under ex ante licensing in this case. Clearly state any assumptions and conditions that need to hold (beyond those identified above) for this situation to be true. Explain the expressions. (5)
d) Describe two situations in which the incumbent and the entrant collectively would not gain additional surplus from an ex ante license. Clearly state any assumptions you need to make (beyond those identified above) or conditions that need to hold in order for neither firm to gain from ex ante licensing. What are the profits to each firm in each of these two situations? (5)
e) Is society better or worse off under the situations in (d) compared to (c)? Explain. (4)
f) Now suppose that Firm 2 has the option to imitate Firm 1's invention without violating Firm 1's patent at the same cost c_2, but this generates an inferior product which only yields πz < πy. How does this change your answers in (c) and (d)? Explain clearly, noting the changes to your profit expressions for both firms. (8)

Question 3: (22)

This problem concerns optimal patent length and costly imitation.

Suppose that a firm is able to innovate at a cost of F. If it innovates, the firm receives a patent for T periods. However, infinitely many other firms can potentially create imitation goods which are identical from the consumer's point of view for a fixed imitation cost of K without infringing. Some number M of imitators will enter the market until profits, net of imitation costs, equal zero. Assume market demand is given by $Q = 1 - P$, where $Q = \sum_{i=1}^{N} q_i$ and that the firms engage in Cournot competition. Assume all firms have a constant marginal cost of production, c. The equilibrium level of output and profit for each firm under Cournot competition is given by $q = \frac{1-c}{M+2}$ and $\pi = \frac{(1-c)^2}{(M+2)^2}$.

a) State the relationship among T, F, and M for which the innovator will be willing to develop the invention. Now state the equilibrium relationship among T, K and M for which M imitators will enter the market; in particular, write M as a function of T and K. Explain your work. (6)
b) Now suppose c = ½, F = 1/8 and T = 4. Will the invention be made if the costs of entering the market with an imitation is given by K = 1/10? Explain your answer clearly and show your work. Since I give the answer in (c), all credit will be given for explanation and a clear presentation of your work. (4)
c) Seeing that innovation will not take place for the situation in (b), what might patent length and scope be to give the innovator sufficient incentives to invest? Explain your work. Is the patent policy you found also the socially optimal patent policy? (4)
d) Now suppose that at the patent policy in (b), the innovator offers the first prospective imitator a fixed royalty R and then competes with it in the market. What R will the innovator set? Show that the innovator would be overly compensated in this case if licensing is available. (4)
e) Seeing what's happening, if the government could make scope any value (by making imitation more or less costly) or change T (making it longer or shorter), then how might it alter patent life if licensing is available? No math is required (unless you wish to provide it), just clear economic intuition. (4)

Question 4: Short Essay (20)

Choose two papers in the readings. Describe how they are related. For example, are they different sides of a debate or does one build upon the other? Explain the main economic issue explored in the papers and the key "take away" idea from them. Then, suppose you wanted to write a new paper in the literature that builds upon the two papers you have chosen. Identify an aspect of the papers that you would change and how the change you are proposing would improve the paper in generating interesting results and contribute to the literature. You do not need to go into the mathematics – words and clear economic intuition suffices – but if you wish, you can clarify your points with an equation or graph. Page limit: 1 single-spaced typed page.