

**FINAL EXAMINATION SKETCH OF SOLUTIONS**  
**2002**

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**Instructions:** You have three hours to complete this exam. This exam is closed-book: no books or notes are allowed. In addition, you may *not* use a graphical calculator or one that stores words, user-specified functions, or spreadsheets. Answer *all* questions in the blue books that are provided. Be sure to write your name and the name and number of the course on all blue books that you hand in and indicate how many blue books you are handing in, in total. Be as clear and legible as possible. The exam consists of 3 parts and 9 questions in total. Please note that ALL work must be shown to receive credit.

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**Part I:** Short Question and Answer Section. (Total points: 30) Please limit your response to NO LONGER than 3 or 4 sentences (take into account that each question is only worth 5 points).

1. A classic way of introducing pollution regulation into an urban area is the “rollback” method. First, you determine the maximum tolerable level of a particular pollutant,  $X_s$ . Next, you find the maximum current concentration of that pollutant in the urban area,  $X_m$ . Presumably, it is the case that  $X_s < X_m$  (otherwise, there is no problem). Regulations then require all polluters in the city to reduce emissions from their current level of  $e_m$  to  $e_s = e_m (X_s/X_m)$ . Discuss the efficiency of this approach.

*We don't know whether the maximum tolerable level is efficient in terms of maximizing TB - TC. But, even assuming it is, if we have heterogeneous costs of abatement, the emissions reductions required by polluters doesn't equate the MC of abatement across polluters: so it's not least cost.*

2. Chris has been hired by the city of Cambridge to design a hazardous waste landfill and she is trying to decide whether it is worth spending \$1,000,000 to install a special liner that reduces the probability of a leak from 0.001 to 0.0001. If a leak does occur, the expected number of fatal cancers in Cambridge can be expected to rise by 100. Suppose that Chris recommends the installation of the special liner. What do we know about her valuation of a life saved? (I am looking for a numeric response here.)

*If Chris installs the lining, the change in the expected number of deaths would be  $(0.001 - 0.0001) * 100 = 0.09$ . So,  $\text{cost} = \text{value of life} * \text{change in probability of death}$ : Value of life must be at least  $\$1,000,000 / (0.001 - 0.0001) * 100 = \$11,111,111.11$ .*

3. The development of microwave transmission technology in the 1950s is often given as a reason why the long distance telephone market stopped being a natural monopoly as sending long distance telephone signals over microwave transmission stations require a much lower fixed cost than doing so over wires. Microwave transmission stations, however, have been largely replaced by fiber optic wire in the 1990s, which has meant a return to stringing wires between locations. Why might long distance telephone not be a natural monopoly industry, even with this technological change?

*Other technologies still exist: satellite transmission of microwave signals allows for cell phones to be used for long distance, etc. Lots of competition that doesn't require fiber optic technology, so no longer a natural monopoly. Demand has increased so dramatically, that we no longer are in the subadditive portion of the cost curve. Fiber optic technology can carry very large amounts of information (far more than other technologies) and the costs can be shared across groups – lowering the costs faced by any individual group using the technology.*

4. Demsetz has suggested that one way to avoid natural monopoly regulation is by auctioning off the right to be a monopolist in a particular market through a franchise license. Does franchise bidding necessarily lead to an efficient outcome? Why or why not?

*Even with franchise bidding, we won't be able to get marginal cost pricing. If we have small numbers of bidders, we won't even get average cost pricing by the lowest bidder since he only needs to bid epsilon less than the second lowest bidder. We also need to worry about multidimensional products eg. when we have multiple levels of quality that are possible.*

5. During regulation, airline prices were fixed above cost and airlines could not compete in price. What was the result of this regulatory practice with respect to food quality and safety, and can you justify the airlines' response in these two areas?

*Non-price competition arose because airlines couldn't differentiate themselves through price. This led to airlines competing on things like safety and quality of food. Both were very very high (or good).*

6. A large petroleum refinery was located directly across the street from an elementary school in a small community outside of the Los Angeles Greater Metropolitan area. The pollution from the refinery posed a potential health threat to the children at the school. But, because the community and the petroleum refinery were on good terms (also, because the petroleum refinery's owner's children attended the elementary school), they had negotiated between themselves about how much pollution could be allowed, and in return, the refinery donated money to the school to build a large indoor play-space for the children. The Governor of California has just recently learned about the placement of the school next to the refinery and has decided to place a pollution tax on the refinery for every unit of pollution it emits. Comment on this policy.

*This would lead to an inefficient outcome: too little pollution. This can occur when you have Coasian bargaining and then you regulate on top of that. The Coasian bargaining will lead to the optimal level of pollution. If you place a tax on top of the bargaining solution, you distort the costs facing the polluter. This leads to inefficiency – too little pollution.*

**Part II:** Numeric Problems. (Total points: 50). Be sure to show all of your work.

7. (25 points) There is a company that is the sole producer of zippers. Its cost function is  $C(q) = 50 + 2q$  and the market demand is  $D(P) = 100 - P$ . There is a large pool of potential entrants, each of which has the same cost function as this company. Assume the Bain-Sylos postulate. Let the incumbent firm's output be denoted by  $q^I$ .

(1) Derive the residual demand function facing a new firm.

*Residual demand is given by:  $P = 100 - q_i - q_e$ .*

(2) Given that the incumbent firm is currently producing  $q^I$ , if a potential entrant was to enter, how much would it produce?

*Under the Bain-Sylos postulate, which assumes that incumbent's output will remain the same post entry and pre-entry, a potential entrant's profit function would then be:  $\pi_e = (100 - q_i - q_e) * q_e - (50 + 2q_e)$ . The entrant needs to maximize this with respect to  $q_e$ , taking  $q_i$  as given. This yields:  $q_e = (98 - q_i)/2$ .*

(3) Find the limit price.

*The limit price is the price that the incumbent can choose to prevent entry (or expanded output by an existing fringe set of firms). Here, the incumbent will choose a price that will make entry unprofitable. This would yield a price that is set BELOW the entrant's average cost. So, price  $P = (100 - q_i - (98 - q_i)/2)$  and the entrant's average cost is given by:  $50/q_e + 2$ . Setting these things equal (and plugging in the appropriate expression for  $q_e$ ) yields:  $q_i = 83.9$ ,  $q_e = 7.05$  and  $P_{limit} = 9.05$ . Note that this can also be solved by equating the slopes of the AC and the residual demand curve as well.*

(4) Suppose instead that we assume active firms expect to achieve a Cournot solutions, instead of the Bain-Sylos postulate. Does entry depend on  $q^I$ ? Will there be entry? (You do not need to try and provide a numeric answer: just an explanation.)

*Under Cournot assumptions, the incumbent's quantity choice doesn't matter. Entry will occur up until the point it is no longer profitable for it to occur.*

8. (25 points) Suppose that there are an unlimited number of firms competing to discover a calorie-less fat substitute (that both tastes good and is good for you -- and no, it's not Olestra!). Each firm can only undertake a single research project for the development of this good. The research project is known to have a constant marginal cost of \$1. The probability,  $P$ , that one of the  $n$  firms will develop this new product is a function of the total number of firms engaged in the research race and is given by  $P = 1 - e^{-0.5085n}$ . If this new product is discovered, it will be priced competitively and the present value of total

surplus will be \$25. Research can only take place this year and if the good is not developed this year, it will not be developed in the future.

- (1) From society's point of view, find the optimal number of research projects (firms engaged in the research race).

*Expected social benefit =  $(1 - e^{-0.5085n}) \times 25$ . To find the optimal number of firms, you want to maximize expected benefits - expected costs:  $\text{Max} ((1 - e^{-0.5085n}) \times 25 - n)$ . So, this leads to expected marginal benefits being set equal to marginal costs:  $0.5085(e^{-0.5085n}) \times 25 = 1$ .  $n^* = 5$ .*

- (2) Assume now that a competitive R&D industry exists and that  $n$  is determined by the zero profit condition (that is, there is free entry into the research race). If the government promises the firm that discovers this new product the entire social benefit of \$25, show that 25 firms will enter the patent race assuming that each firm is equally likely to make the discovery.

*Firms will continue to enter into the research race so long as THEIR expected returns are positive. If each firm is equally likely to win the race, then, the probability of winning would be  $P(n)/n$ . And their expected benefits would be  $[P(n)/n] \times 25$ . Cost is equal to 1. So, so long as  $25 \times (1 - e^{-0.5085n})/n > 1$ , you will continue entering the race. This leads to  $n^{**} = 25$ .*

- (3) Briefly explain why your answer in (i) differs from the number of firms that would enter a competitive patent race from as shown in part (ii).

*You get too much entry and too much R&D in this problem because of the "common pool" problem.*

**Part III:** Short Essay (Total points: 40).

9. The Toxics Release Inventory (TRI) is a regulation that forces manufacturing plants to publicly disclose their toxic releases to a publicly available data base maintained by the US Environmental Protection Agency. Prior to TRI regulations, there was no tracking of toxic releases in this country. There is no other formal regulation concerning toxic releases (although toxic substances are heavily regulated through command and control strategies which dictate how the substances are stored, transported, and disposed). Only toxic releases for 600 listed toxic substances need to be reported -- and only if the plant either uses or manufactures more than some threshold level of the substance. Examples of some toxic substances that require reporting under TRI include dioxin (a known carcinogen), ammonia (a common household cleaner), and arsenic (a metal which is fatal when ingested or absorbed). TRI data are self-reported -- that is, plants report their own level of toxic releases. Since TRI reporting began in 1987, reported releases (aggregated over all toxics in tons) have declined by over 40 percent nationwide. The EPA claims that TRI regulation has been a huge success.

Discuss this regulation in terms of (1) potential motivations of the EPA for choosing information

disclosure over command and control strategies for the toxic releases (including efficiency); (2) how this regulation is supposed to work, theoretically (including the potential effectiveness of this regulation in reducing toxic releases); and (3) any potential weaknesses of using mandatory disclosure rules for toxic releases. Try to use specific examples and evidence from class to support your views.

- *this regulation would be cheaper than command and control All EPA needs to do is maintain a public data base. No other monitoring per se would be required*
- *this is also cheap for polluters as they can decide if they will abate (they aren't forced to do so), and presumably if they do decide to abate, they can do so however they want to. This ought to lead to cheaper abatement - -those that can abate most cheaply will do so.*
- *this regulation is supposed to work by correcting for some kind of asymmetric information in the marketplace. The government basically must believe that people don't know what kinds of toxic releases the manufacturing plants are releasing down the street from where they live or work. By providing NEW information to people, they will be able to respond appropriately. Responding appropriately probably means invoking the Coase Theorem and negotiating or pressuring firms to clean up.*
- *potential weaknesses: we have to assume that new information is being provided by the regulation. And this information must be useful to the household or individual. This may not be the case. There's no evidence that TRI information is capitalized in house prices. And, the risks of bad outcomes from toxic exposure is very small. We're not good at evaluating those low risks. And, we don't know if firms have actually abated. They could have substituted from listed to unlisted substances. Or maybe they are lying on their reports: it is self-reported data and it's not easily verifiable. Also, what prices will move to motivate firms to clean up? This is not the same type of regulation as forcing firms to provide information to workers (who can then demand a wage differential to deal with the risk), or providing information on food nutrition (if you don't like the amount of fat in a hotdog, you can always eat a tofu dog if you're desperate!). If you live in a community and you find out that the plant located behind you is basically a toxic waste dump, what can you do? If you try to move, remember that your house is now basically worthless since it's located next to a toxic waste site. Most of your capital is tied up in your house. It is very costly to move.*