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## Final Exam - Solutions

You have three hours to complete this exam from the time you first look at the questions. Please indicate your starting time and stopping time on the exam. You may answer all questions directly on the exam, type your answers, or use a combination of handwritten and typed responses. Return the completed exam either to my mailbox in the economics department office or under the door of my office. Exams do not need to be turned in immediately after finishing them. They must be returned by 5pm on Friday, May 3rd. Answer all questions completely but concisely. Including additional incorrect information in an otherwise correct answer may result in the loss of points. Good luck!

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**ID Number or Exam Code:**

**Time Started/Time Stopped:**

1. (10 points) The federal government is concerned about the effect of mortgage foreclosures on the American economy. Suppose that Congress decides to institute a new program in which the federal government sets up a fund to guarantee mortgages in much the same way the FDIC guarantees bank deposits (all home loan borrowers would pay into the fund and then if a borrower went bankrupt, the fund would be used to pay off the borrower's mortgage). Discuss the economic efficiency implications of this plan.

There are a variety of ways to answer this question for full credit. However, a complete answer should address at least these two different aspects of efficiency: the role of the guarantee in avoiding the economic consequences of another housing market collapse and the role of the guarantee in incentivizing loans that should not be made.

On the first point, the key issue is that foreclosures generate negative externalities when they lead to investors panicking and ultimately a crash in markets. The inefficiencies of these crashes are not so much the result of people getting low or negative returns on their assets (this is really just a transfer of surplus). Instead, the inefficiency stems from the panic leading to investors being unwilling to lend (or unable to lend) even when those loans would generate net surplus for society.

The second point is a bit more straightforward. We considered how financial markets can be efficient, with lenders settling on the projects or people with the best business plan or strongest financial position and making the loans only if the expected benefits of the loan are positive. This leads to money being lent to those with the highest return and only those for which the expected return is positive (otherwise the loan wouldn't be made). Shielding the banks and borrowers from the risk through this guarantee will lead to loans with negative returns being made (banks and borrowers are not taking into account the probability and costs of default on the loan, even though that default still represents a cost to society). So there will be loans made that actually reduce total surplus in expectation.

2. (25 points) A pharmaceutical company is deciding whether to increase spending on research and development to come up with a new treatment for the common cold.

- (a) Consider a graph showing the firm's marginal costs and marginal benefits of increasing research and development spending. What sign would you expect for the slopes of each of these curves? Explain your answer.

We would expect the pharmaceutical company to do the highest bang-for-the-buck research and development first and only move on to the more costly, lower probability of success types of R&D after exhausting the low cost, high probability types. Doing the lowest costs types of research first and then the higher cost ones later suggest that the marginal cost of research and development will be increasing as total research and development increases. Doing the highest probability of success types of research first and then moving on to the lower probability of success research suggests that the marginal benefits of research will be decreasing as the total level of research increases (the overall benefits of successful research are the same, success means a viable treatment for the common cold, but if the probability of being successful is decreasing the expected marginal benefits are decreasing). So we would expect the marginal cost curve to be upward sloping and the marginal benefit curve to be downward sloping.

- (b) Now suppose that the government decides to decrease the length of pharmaceutical patents and streamline the process for generics to be approved at the end of the patent period. How would this impact the marginal cost and marginal benefit curves you described in part (a)? Be certain to fully explain your answer.

The length of the patent and the ability of generics to enter the market both impact the profits from a successful cold remedy, they do not affect the research and development costs of discovering that remedy. Therefore, we would expect the marginal cost curve to remain the same but the marginal benefit curve to change. In particular, shorter patent length and greater competition from generics would both tend to decrease the profits from a remedy, shifting the marginal benefit curve down.

- (c) Would you expect the actions described in part (b) (the shorter patent length and easier generic entry) to increase overall total surplus or decrease total surplus? Explain your answer.

The immediate effect of the actions would be to reduce the research and development efforts of the pharmaceutical company: with the marginal benefit curve shifting down the point at which the marginal benefits of research equal the marginal costs will occur at a lower overall level of research. This will make the discovery of the remedy less likely. This by itself would tend to decrease total surplus: if the remedy is never developed neither the company nor the consumers benefit from it. However, if the remedy is still discovered total surplus will increase because there will be fewer periods of deadweight loss generated by monopoly power. The expected change in total surplus therefore depends on both the change in the probability of the remedy being discovered and the present value of the deadweight loss that would be avoided relative to the present

value of the total surplus generated by the market. The bigger the change in probability is the more likely it is that the actions will lead to a decrease in expected total surplus. The bigger the avoided deadweight loss is relative to the overall total surplus from the market the more likely it is that the actions will lead to an increase in expected total surplus.

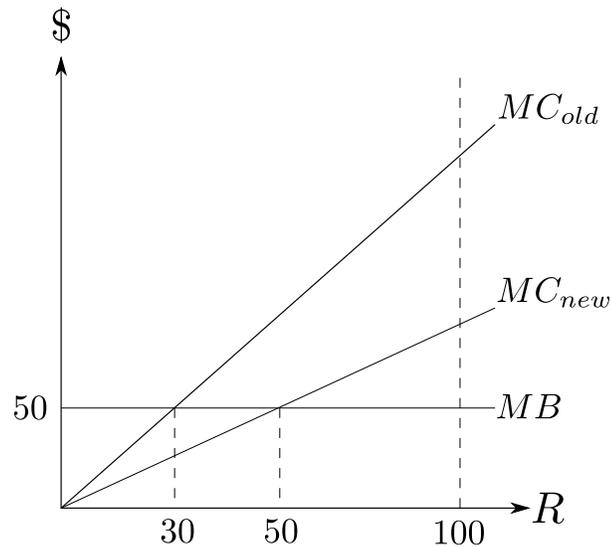
- (d) Suppose that the pharmaceutical company does discover a cure to the common cold. A politician argues that the common cold afflicts so many people that it is too costly to society to allow the company to price the drug as a monopolist. Instead, the politician proposes passing a special exemption to patent laws that would place price controls on this particular drug, allowing the firm have price markups just large enough to cover the research and development costs for the firm. The politician argues that this is fair to the firm (the firm is being compensated for the research and development costs) and will create far more consumer surplus. Explain the likely efficiency and equity consequences of following through with this plan.

There are a variety of issues you could discuss in your answer. Several key points to consider in your response are the following:

- The effect of this plan on future research and development by firms. If they are uncertain about whether patents will be enforced they will be less likely to invest in research and development. This will tend to reduce total surplus because fewer new drugs will come to the market.
- The effect of this plan on the market for the common cold cure. The plan is basically forcing the firm to produce at a larger quantity, producing units that generate net gains to society but wouldn't have been produced under the patent, increasing efficiency.
- The fairness of the plan to the firm. The direct costs of research and development for the cure likely do not reflect the total research and development expenditures of the firm related to the cure. The firm's true costs should include all of the research that led to dead ends or products that weren't commercially viable. The returns on the successful drugs need to be high enough to cover not only those drugs' costs but also the costs of the failed drugs to make research worthwhile.
- The fairness of the plan to consumers. If you consider the common cold cure something people should be entitled to regardless of their willingness or ability to pay, this plan may improve equity.

3. (25 points) A manufacturer of water bottles uses a type of plastic that is a known carcinogen. Using one of these water bottles increases a consumer's risk of dying from cancer by five in one million. Additionally, trace amounts of the carcinogen are in the factory's runoff that goes into the local watershed leading to an increase in the cancer risk of local residents of one in one million. A new alternative plastic has just been developed that is not a carcinogen and is safe for both users of the water bottles and for the local watershed. However, this material is more expensive than the type of plastic currently being used.
- (a) Explain what information you would need to determine whether it is socially efficient for the factory to switch to the new, safer plastic.
  - (b) Suppose that it is socially efficient for the firm to switch to the new material. Explain two reasons why the market may lead to the inefficient use of the older, carcinogenic plastic in the absence of any government regulation.
  - (c) The government is considering two possible approaches to regulating the manufacturing and sale of water bottles. The first approach would be to ban the use of the older plastic. The second approach would be to still allow the use of the older plastic but to require anything made with the older plastic to have a warning label that explains the dangers of the plastic. Which of these approaches would you recommend? Be certain to fully explain your answer, addressing the benefits and drawbacks of both approaches.

4. (25 points) Suppose that there are two power plants in Williamsburg, an old plant and a newer plant. If the plants spend no money on pollution controls, each will produce 100 units of pollution. The old plant has marginal costs of reducing pollution that start at zero and increase linearly with the amount of reductions made. The new plant also has marginal costs of reducing pollution that start at zero and increase linearly but they increase at a slower rate than the old plant's marginal costs. These marginal cost curves are shown below. Also shown is the marginal benefit to society of a reduction in pollution which is a constant \$50.



- If a regulator wants to set a single standard (a level of pollution reductions both plants must meet), what standard should the government choose? On the graph, show the deadweight loss associated with this standard. Be as specific as possible, you may not be able to state an exact number for the standard.
- Now suppose that the government issues each firm an equal number of pollution credits. The plants can buy and sell these pollution credits from each other. What is the efficient number of pollution credits to issue?
- Explain what will happen in the market for pollution credits being as specific as possible about how many credits will be sold, who the buyer would be, and how much money the buyer will spend for those credits.
- Suppose that new technology makes it cheaper for the new plant to reduce pollution. The old factory is not set up to implement this new technology so there is no affect of the technology on the old plant's pollution control costs. Explain why the number of tradeable credits in part (b) will no longer lead to the efficient outcome.
- Propose an alternative approach to regulating the plants that would ensure the efficient level of pollution even if the plants' technology is changing in ways unobservable to the regulator. Be certain to fully explain your answer.

5. (15 points) Consider the contingent valuation approach to valuing the environmental damage done in the Exxon Valdez oil spill.
- (a) Describe one change in the survey design that would have likely led to a larger estimate for the nonuse value of the Alaskan environment. Be certain to explain why it would lead to a larger estimate.
  - (b) Describe one change in the survey design that would have likely led to a smaller estimate for the nonuse value of the Alaskan environment. Be certain to explain why it would lead to a smaller estimate.
  - (c) Why would overestimating the nonuse value of the environment potentially lead to inefficient outcomes?