Econ 362 - Government Regulation of Business
College of William and Mary
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Final Exam - Solutions

You have until 3:30pm to complete the exam, be certain to use your time wisely. Answer all questions directly on the exam. You must show all of your work to receive full credit. Non-graphing calculators may be used (no graphing calculators or phones can be used). You may leave answers as fractions. Unless a problem says otherwise, you can assume that firms can produce fractions of units and charge non-integer prices (so a firm could produce 82.4 units and sell at a price of \$5.325 per unit). Remember to put your name on the exam. Good luck!

Name: **ID Number:**

1. (15 points) A politician is proposing the elimination of auto safety standards, claiming that an unregulated market for new automobiles will lead manufacturers to choose the efficient level of safety features.

   (a) Explain how the unregulated market could in theory provide the efficient level of safety.

   The key to the unregulated market is that people are willing to pay extra for additional safety. More specifically, an individual would be willing to pay a premium for a new car with an added safety feature up to the marginal benefit of that safety feature to the consumer. Manufacturers would be willing to include this additional safety feature only if this price premium exceeds the marginal costs of adding the feature. Therefore, the market should provide any safety feature for which marginal benefits exceed the costs but would not provide any safety feature for which the marginal costs exceed the marginal benefit (consumers wouldn't be willing to pay enough to cover firm costs). This is precisely the efficient outcome, every safety feature that provides a net benefit to society is produced while every safety feature that would provide a net loss to society is not produced.

   (b) Explain two reasons that the unregulated market would lead to inefficiently low levels of safety.

   There are several possible answers you could give here. Two key issues are a lack of information on the consumer side and misinterpretation of risk by consumers. For the lack of information, if firms do not reveal the relevant safety information to consumers, consumers cannot price that risk into their willingness to pay for a new car. The mechanism described above that gets us to the efficient level of safety would therefore not work. For the misinterpretation of risk, if consumers over- or underestimate risk of accidents and the injuries or fatalities resulting from those accidents, they will end up either over- or underpaying for safety features relative to the efficient level.

2. (20 points) There are two factories in Williamsburg polluting the local rivers. Without spending any money on pollution controls, each factory's runoff would add 200 units of pollution to the rivers. It costs Factory A \$40 to eliminate an additional unit of pollution regardless of its current level of pollution reductions. It costs Factory B \$60 to eliminate an additional unit of pollution regardless of its current level of pollution reductions. The marginal benefit of reducing water pollution by one more unit is given by:

$$MB(R) = 100 - \frac{1}{4}R \tag{1}$$

where R is the current level of pollution reductions made by both factories combined.

(a) Suppose that the government decides to fine the factories for each unit of pollution they produce. The government decides to set this fine at \$55 per unit of pollution. Given this fine, determine how much money each factory will spend in fines and how much money each factory will spend on pollution reductions.

Let's begin with Factory A. For each potential unit of pollution, Factory A has to decide whether it is more profitable to pollute and pay the fine or to pay the costs to eliminate the unit of pollution and avoid the fine. If it pollutes, the factory's spending on fines goes up by \$55. If it eliminates the pollution, it's pollution reduction costs go up by \$40. Clearly eliminating the pollution is cheaper than paying the fine. Since the fine and the marginal costs of reducing pollution are constant across all units of pollution, this logic will hold for every unit of pollution: the firm will decide to eliminate all of its pollution and pay nothing in fines. So the factory's spending on pollution reductions and on fines will be:

$$C_R^A(200) = 40 \cdot 200 = 8000$$

$$C_{fines}^A(0) = 55 \cdot 0 = 0$$

For Factory B, the same reasoning leads to the opposite conclusion: it is always cheaper to pollute and pay the fine than to pay the costs to reduce pollution. So Factory B's spending on pollution reductions and on fines will be:

$$C_R^B(0) = 60 \cdot 0 = 0$$

$$C_{fines}^B(200) = 55 \cdot 200 = 11000$$

(b) Does this fine lead to the efficient level of pollution reductions? Use numerical evidence and a written explanation to support your answer.

This will only be efficient if all of the units of pollution reduction for which the benefits exceed the costs have been undertaken while all of the units of reduction for which the costs exceed the benefits have not been undertaken. We know the marginal costs of pollution reduction, \$40 for Factory A and \$60 for Factory B. What we haven't yet found are the marginal benefits of reducing pollution. Those are simply:

$$MB(R_A + R_B) = MB(200 + 0)$$

$$MB(200) = 100 - \frac{1}{4} \cdot 200$$

$$MB(200) = 50$$

So at the current level of pollution reductions, it would be a net loss to have Factory A decrease its level of reductions (there would be \$40 in cost savings but \$50 of benefits lost). It would also be a net loss to have Factory B increase its level of reductions (there would be a \$60 increase in costs but only a \$50 increase in benefits). Therefore the fine is achieving the efficient level of pollution reductions. Note that we do not need to consider increasing R_A or decreasing R_B as R_A is already as large as possible and R_B is already as small as possible.

(c) Suppose that instead of using fines, the government decides to create tradeable permits for pollution. Each permit allows a firm to produce one unit of pollution. The government allocates 150 permits to each firm. After the firms have a chance to buy and sell permits from each other, what will the final equilibrium allocation of permits be?

The factories will trade permits as long as there is a difference in marginal costs of pollution reduction between the two factories. If there is a difference in the marginal costs, both firms will agree to a trade where the low-marginal cost factory sells a permit to the high-marginal cost factory at a price in between the two marginal costs. At this price, the low-marginal cost factory will receive more in payment for the permit than it will cost them to reduce its pollution by one more unit. By getting to pollute by one more unit, the high-marginal cost factory will have a reduction in its costs that is greater than the payment it makes for the permit. Given that Factory A always has lower marginal costs of pollution reduction than Factory B, Factory A will always be the factory selling permits and Factory B will always be the factory buying permits. No matter how many permits have been traded, it will still make sense for them to trade one more permit. So trading will continue until Factory B reaches the point where it has 200 permits, enough to cover all of its potential pollution. This requires Factory A selling Factory B 50 permits, leaving Factory A with 100 remaining permits.

(d) Would you recommend that the government increase the total number of permits, decrease the total number or keep it the same? Be certain to fully justify your answer.

Notice that at Factory A's current level of pollution, a reduction in pollution of one unit would cost Factory A \$40. The benefits of the unit of reductions would be:

$$MB(R_A + R_B) = MB(100 + 0)$$

$$MB(100) = 100 - \frac{1}{4}100$$

$$MB(100) = 75$$

So we are clearly not at the efficient level of reductions. Additional reductions by Factory A would lead to a net benefit to society ($MB > MC$). To get these additional reductions to take place, we would need to decrease the total number of available permits.

3. (20 points) We discussed in class how OSHA does not necessarily set safety standards in the way an economist concerned with efficiency would. Recall that the 1970 Occupational Safety and Health Act was intended to "assure so far as possible every working man and woman in the Nation safe and healthful working conditions." The graph below shows the level of saftey in workplace settings and the marginal cost to a company of increasing the level of safety by an additional unit. The dashed line represents the level of safety at which there is no longer any risk of accidents in the workplace.

   (a) Show the level of safety that would correpsond to the way OSHA determines workplace saftey standards. Label this level of safety S_{OSHA}. Explain in one or two sentences why you chose this point.

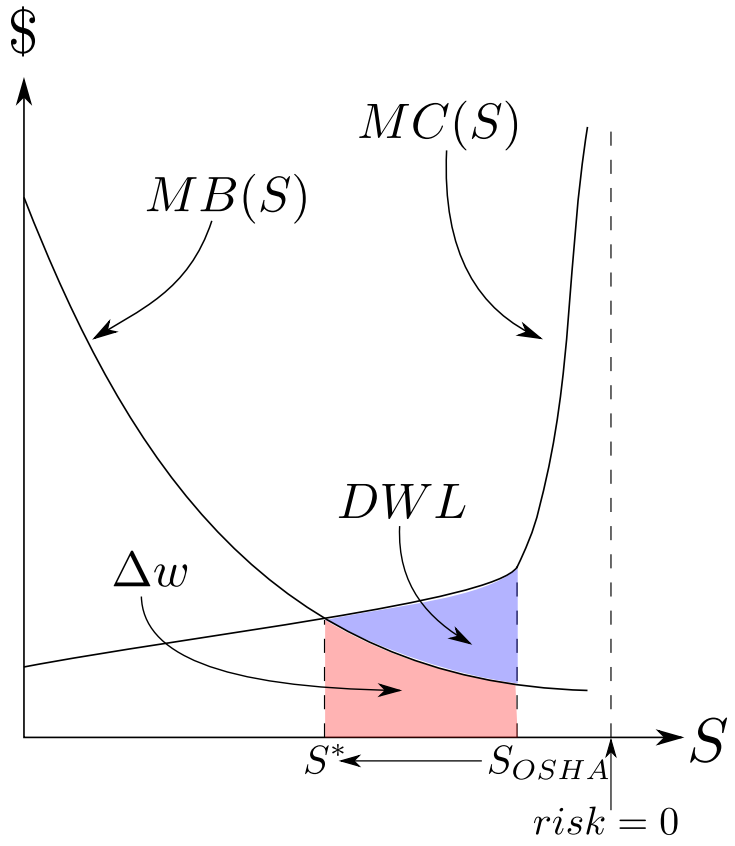
   OSHA tends to set safety standards based solely on the marginal cost curve. Any units of safety with relatively low marginal costs are required to be provided. Therefore, OSHA tends to choose the level of safety at which the marginal cost curve goes from being relatively flat to relatively steep. This is labelled as S_{OSHA} on the graph.

   (b) Suppose that the level of safety you identified in part (a) requires inefficiently high spending on safety precautions by firms. Show a curve on the graph representing the marginal benefits to workers of additional safety that is consistent with this statement. Show the deadweight loss generated by OSHA setting S_{OSHA} as the safety standard.

   If S_{OSHA} is inefficiently high, it must be that the marginal benefits of safety improvements are below the marginal costs at S_{OSHA}. Therefore you should show a marginal benefit curve that intersects the marginal cost curve to the left of S_{OSHA} so that it lies below the marginal cost curve at S_{OSHA}. The intersection of this marginal benefit curve and the marginal cost curve would correspond to the efficient level of safety. This intersection is labelled S^* on the graph. On each unit of safety between S^* and S_{OSHA}, there is a net loss to society equal to the difference between marginal cost and marginal benefit. Adding up these losses gives the total deadweight loss from setting safety standards at S_{OSHA}. This deadweight loss is the blue shaded area on the graph.

   (c) Suppose that OSHA eliminated all safety standards. On the graph, show the effect this would have on the equilibrium level of safety, S^*, and on workers' wages when the firms move from S_{OSHA} to S^*.

   The equilibrium level of safety will move down to S^*. For each unit of safety before S^* it is cheaper for the firm to provide the safety than to compensate workers with extra wages ($MC(S) < MB(S)$). For each unit of safety after S^*, it will be cheaper to forgo the safety measures and instead compensate the worker for the additional risk with higher wages ($MB(S) < MC(S)$). The elimination of safety measures between S^* and S_{OSHA} will require compensation to the worker equal to the area under the marginal benefit curve over these units of safety (this area represents the total benefits from safety the worker is losing). This change in compensation is labelled Δw on the graph.


$
MC(S)
MB(S)
DWL
Δw
S
S*
S_OSHA
risk = 0

4. (15 points) We have discussed ways in which the court system and lawsuits might lead to efficient levels of product safety. Briefly explain one reason why relying on the courts may lead to inefficiently low levels of product safety and one reason why relying on the courts may lead to inefficiently high levels of product safety.

   The main concerns with lawsuits leading to inefficiently low levels of product safety is that the expected losses for firms from lawsuits will be lower than the actual losses to customers from unsafe products. This can be the result of settlements being too low or from the probability of firms losing the lawsuit being too low. The firm will provide levels of product safety up to the point where the marginal cost of making the product safer just equals the expected marginal cost of a lawsuit. If this expected marginal cost of the lawsuit is below the actual marginal benefit to consumers of additional safety, firms will provide an inefficiently low level of product safety. On the other hand, if settlements are too high or the probability of the firm losing a case are too high, then the expected marginal cost of lawsuits may be greater than the actual marginal benefit to consumers of additional safety leading firms to choose an inefficiently high level of product safety.

5. (10 points) Under what conditions would you expect innovation to still take place even in the absence of patents? Your answer should focus on cases where innovators have an incentive to innovate in terms of profits (not cases where they innovate for non-economic reasons).

   The main conditions would be where innovations can be kept secret (for example production processes that are very hard to reverse engineer) or cases where there are large first-mover advantages (getting to the market first allows you to gain significant market share and market power or establish valuable brand loyalty).

6. (20 points) The City of Williamsburg is concerned about the pollution associated with the generation of electricity. City officials have determined that the marginal environmental damage from an additional kilowatt hour of electricity is given by the following function:

$$MC_{env}(K) = \frac{1}{2}K \tag{2}$$

where K is the current level of electricity being produced. The marginal costs paid by the electric company to produce an additional kilowatt hour of electricy are constant and equal to \$10. Demand for electricty is given by the following equation:

$$D(p) = 200 - 2p$$

where p is the price of a kilowatt hour of electricity.

(a) What will the equilibrium price and quantity of electricity be if there is no regulation of the market and the market is competitive?

Given that this is a competitive market, the equilibrium quantity will be the quantity at which private marginal benefits equal private marginal costs. This is where the demand curve and marginal cost curve intersect. To find this quantity, we first need to rearrange the demand function to get the inverse demand function:

$$D(p) = 200 - 2p$$
$$K = 200 - 2p$$
$$2p = 200 - K$$
$$p(K) = 100 - \frac{1}{2}K$$

Now we can set the inverse demand function equal to the firm's marginal cost function to find the equilibrium quantity:

$$p(K) = MC_{firm}(K)$$
$$100 - \frac{1}{2}K = 10$$
$$\frac{1}{2}K = 90$$
$$K = 180$$

To get the equilibrium price, we simply need to plug this quantity back into the inverse demand function:

$$p(180) = 100 - \frac{1}{2} \cdot 180$$
$$p = 10$$

So the equilibrium quantity will be 180 kilowatt hours with an equilibrium price of \$10 per kilowatt hour.

(b) What is the socially efficient quantity of electricity?

The socially efficient quantity will be where the demand curve intersects the social marginal cost curve which includes both the firm's marginal costs and the marginal costs associated with the environmental damage:

$$p(K) = MC_{firm}(K) + MC_{env}(K)$$

$$100 - \frac{1}{2}K = 10 + \frac{1}{2}K$$

$$K = 90$$

So the socially efficient quantity is 90 kilowatt hours, much smaller than the equilibrium quantity in the absence of regulation.

(c) On a graph with kilowatt hours on the horizontal axis, show the deadweight loss generated by being at the outcome in part (a) rather than the socially efficient quantity you found in part (b). Be certain to clearly label any relevant curves and points.

Your graph should show the demand curve as a downward sloping line, the firm's marginal cost curve as a horizontal line at \$10, and the social marginal cost curve as an upward sloping line with a vertical intercept of \$10. The demand curve and firm marginal cost curve should intersect at the point $(180\text{kWh}, \$10)$ and the demand curve and social marginal cost curve should intersect at the point $(90\text{kWh}, \$55)$. The deadweight loss is the area between the demand curve and the social marginal cost curve from the socially efficient quantity of 90 kWh to the equilibrium quantity of 180 kWh.

(d) The city is considering three possible approaches to regulating the electricity market. Approach A is to simply cap the amount of electricity that can be sold as the efficient quantity you found in part (b). Approach B is to tax the electricity producers, setting the tax per kilowatt hour such that the new equilibrium quantity is the efficient quantity. Approach C is to tax the consumers of electricity such that the new equilibrium quantity is the efficient quantity. Which of these approaches would you consider the most equitable? Which would you consider the least equitable? Be certain to explain your answers.

All three approaches will lead to the efficient quantity, the only difference between the approaches is how surplus is divided at that efficient outcome. Under approach A, firms will end up charging the price consumers are willing to pay at a quantity of 90 kWh which is \$55. This will lead to producer surplus equal to area $B+C$ on the graph. Consumer surplus will be reduced to area A on the graph. There will be no tax revenue. Approaches B and C will lead to the same outcome: consumer surplus equal to area A, producer surplus equal to zero, and tax revenue equal to area $B+C$. In all three scenarios, the environmental damage will be equal to area C.

So when thinking about equity, there is absolutely no difference between approaches B and C. The only question is whether A is more equitable than B and C or whether B and C are more equitable than A. Producers do better under approach A while the benficiaries of government tax revenue do better

uner approaches B and C. Given that there is environmental damage being done, that tax revenue could be used to compensate those people affected by the environmental damage, something not possible under scenario A. The suggests that scenarios B and C are more equitable. (Note: You could certainly have presented a different argument and been correct. The key thing is that you correctly noted the differences in how surplus is distributed.)