

Homework Problem #6

Economic Efficiency & the Optimum Amount of Pollution Clean-up

PRINT YOUR NAME _____
(LAST) (FIRST)

The human and environmental damage caused by industrial pollution often arouses public attention. While it would be desirable to reduce the damage caused by pollution, pollution clean-up is costly, and dollars used for clean-up can be used elsewhere. Some sort of balance, therefore, must be struck between the costs of undesirable pollution and the costs of pollution clean-up. In this homework problem, we apply marginal analysis to determine an optimal amount of pollution and environmental clean-up in an imaginary community. Part I uses a tabular approach in which only whole "units" (tons, gallons, etc.) of pollution emissions and clean-up are considered. Part II introduces a graphical approach where fractional units of clean-up are possible. In each part you should read carefully and answer the questions posed.

The **marginal** social benefit of cleaning up pollution usually tends to decline as additional units of pollution are cleaned up. The **marginal** social cost of cleaning up pollution usually tends to increase as additional units of pollution are cleaned up. If society has accurate information about the total social (public and private) benefits and costs of various amounts of clean-up, therefore, it should be able to get as close as possible to the most efficient (or optimum) level of clean-up (and/or pollution), where the **marginal** social benefits = the **marginal** social costs. (If you are not all that clear on the ideas of marginal benefit and marginal cost, you might want to read the section on "Fundamentals of Marginal Analysis" in Appendix I for a general explanation.)

IMAGINE A COMMUNITY IN WHICH TWO FIRMS EMIT FOUL SLUDGE INTO TWO LOCAL LAKES (ONE FOR EACH FIRM). NATURAL PROCESSES GRADUALLY BREAK DOWN THE SLUDGE, RENDERING IT HARMLESS, BUT AS LONG AS EMISSIONS CONTINUE A CERTAIN "EQUILIBRIUM" LEVEL OF HARMFUL SLUDGE REMAINS IN THE LAKES. IF EMISSIONS ARE LOWERED THIS EQUILIBRIUM LEVEL WILL BE REDUCED. THE OPPOSITE OCCURS IF EMISSIONS ARE INCREASED. CURRENTLY EACH FIRM EMITS 5 UNITS OF FOUL SLUDGE EACH WEEK AND CAUSES \$1,000 WORTH OF ENVIRONMENTAL DAMAGE, SO THE TOTAL COST TO THE COMMUNITY IS \$2,000 PER WEEK.

GIVEN THE INFORMATION IN THE TABLES BELOW, YOU SHOULD BE ABLE TO DETERMINE THE OPTIMUM LEVEL OF EMISSIONS FOR THIS COMMUNITY. FILL IN ALL OF THE BLANKS IN THE TABLES BELOW, AND USE THIS INFORMATION TO ANSWER QUESTIONS 1 THROUGH 4. ASSUME THAT BENEFITS OBTAINED AND COSTS INCURRED FOR CLEAN-UP AT ONE LAKE HAVE NO IMPACT ON BENEFITS AND COSTS AT THE OTHER LAKE.

FIRM 1

Reduction of Foul Sludge Emissions	Total Social Benefit of Clean-up	Marginal Social Benefit of Clean-up	Total Social Cost of Clean-up	Marginal Social Cost of Clean-up	Net Gain	
					Marginal (MSB-MSC)	Total
0	0	-----	0	XX	XX	XX
1	300	300	60	60	240	240
2	550	250	130	70	180	420
3	750	-----	220	-----	-----	-----
4	900	-----	340	-----	-----	-----
5	1000	100	500	160	-60	500

1. Using the data from Firm 1:

- A. The marginal social benefit (MSB) of reducing pollution emissions by the fourth unit of foul sludge is \$_____ and the marginal social cost (MSC) of reducing emissions by the fourth unit is \$_____. For this unit, the marginal social benefit (MSB) is (greater than/equal to/less than) the marginal social cost (MSC), so that it (would/would not) be economically efficient to require Firm 1 to reduce pollution emission by the fourth unit, since the marginal net gain to society (MSB-MSC) would be (+/-) \$_____, for a total net (gain /loss) of \$_____
- B. The marginal social benefit (MSB) of reducing pollution emissions by the fifth (last) unit of foul sludge is \$_____ and the marginal social cost (MSC) of reducing emissions by the fifth unit is \$_____. For this unit, the marginal social benefit (MSB) is (greater than/equal to/less than) the marginal social cost (MSC), so that it (would/would not) be economically efficient to require Firm 1 to reduce pollution emission by the fifth unit, since the marginal net gain to society (MSB-MSC) would be (+/-) \$_____, for a total net (gain /loss) of \$_____

FIRM 2

Reduction of Foul Sludge Emissions	Total Social Benefit of Clean-up	Marginal Social Benefit of Clean-up	Total Social Cost of Clean-up	Marginal Social Cost of Clean-up	Net Gain Marginal (MSB-MSC)	Total
0	0		0	XX	XX	XX
1	300	300	140	140	160	160
2	550	250	320	180		230
3	750	200	540		-20	
4	900	150	800	260	-110	100
5	1000	100	1100	300	-200	-100

2. Using the data from Firm 2:

- A. The marginal social benefit (MSB) of reducing pollution emissions by the second unit of foul sludge is \$_____ and the marginal social cost (MSC) of reducing emissions by the second unit is \$_____. For this unit, the marginal social benefit (MSB) is (greater than/equal to/less than) the marginal social cost (MSC), so that it (would/would not) be economically efficient to require Firm 2 to reduce pollution emission by the second unit, since the marginal net gain to society (MSB-MSC) would be (+/-) \$_____, for a total net (gain /loss) of \$_____
- B. The marginal social benefit (MSB) of reducing pollution emissions by the third unit of foul sludge is \$_____ and the marginal social cost (MSC) of reducing emissions by the third unit is \$_____. For this unit, the marginal social benefit (MSB) is (greater than/equal to/less than) the marginal social cost (MSC), so that it (would/would not) be economically efficient to require Firm 2 to reduce pollution emission by the third unit, since the marginal net gain to society (MSB-MSC) would be (+/-) \$_____, for a total net (gain /loss) of \$_____ .

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3. If this community decides to adopt a pollution control ordinance aimed at **maximizing economic efficiency**, how should it evaluate each of the following three proposals (A-C), all of which are based on the data presented above? (Write a brief **economic** evaluation in the space provided after each of the following proposals. **Be sure to use the concepts of marginal social benefit and marginal social cost in your analysis.**)

Proposal A. "Foul sludge emissions should be reduced (by five units) to zero in each firm because we should eliminate all pollution from our lakes regardless of the cost." In this community the total net gain of this proposal would be \$ _____ (_____), and this proposal (would/would not) maximize economic efficiency, because:

Proposal B. "Firm 1 should be forced to reduce emissions (by five units) to zero because the total social benefit of clean-up (\$1000) exceeds the total social cost of cleaning up (\$500). But Firm 2 should not be forced to clean-up at all, because the total social benefit of clean-up (\$1000) is less than the total social cost of reducing emissions to zero (\$1100)." In this community the total net gain on this proposal would be \$ _____ (_____), and this proposal (would/would not) maximize economic efficiency, because:

Proposal C. "In the interest of equal treatment for all, each firm should be forced to clean-up (reduce emissions) by 3 units." In this community the total net gain of this proposal would be \$_____ (\$_____ Table on page 39), and this proposal (would/would not) maximize economic efficiency because:

4. Using the data presented above what do you think is the optimum level of clean-up (emission reduction) for each firm? Firm 1 _____ units. Firm 2 _____ units. Explain briefly why you chose the numbers that you did, and enter the total net gain of this proposal in the _____ Table on page 39.