**PAI 897** **Professor David Popp**
**Solutions to Problem Set #6** **Fall 2023**

**1.** a) Rawlsian social welfare depends solely on the welfare of the worst off individual in society. In this example, income group E always has the lowest income. Thus, a Rawlsian would support the policy with the best outcome for group E. That is Policy 2.

b) A utilitarian social welfare criterion maximizes the sum of each individual's utility. Each person's utility is given equal weight. Note that the above table provides data on income, not utility. If we assume there are diminishing returns to adding income, a utilitarian social welfare function can support some redistribution. Thus, it is likely that a utilitarian would prefer **Policy 1** over the status quo. To see this, note that the policy transfers $10 from group B to group D. If there are any diminishing returns to income, this increases the utility to group D more than it decreases the utility of group B. Similarly, group A loses $15 while group E gains $10. Thus, total income falls slightly. But, if there are diminishing returns to income, the utility gained by group E is likely larger than the lost utility to group A.

Because your answer depends on how much diminishing returns are assumed, other answers are possible. What was important here was to recognize that it is the total level of *utility*, not the total level of *income* that matters. Simply saying that the current income distribution is preferred because it is the highest total income, without any additional explanation pertaining to utility, was not sufficient.

c) A Pareto improvement occurs when at least one group is made better off without making another group worse off. In this example, each of the proposed policies makes at least one group worse off. Thus, **none are Pareto improvements**

**2.** This is an efficient pricing solution. In the winter, national parks are rarely crowded during the week. As a result, the parks are non-rival. The marginal cost of additional visitors is zero, and so it is inefficient to charge an admission fee.

Some students argued that the pricing solution is efficient because it is a use of peak-pricing. That is also an acceptable answer. I was looking to connect this question with our discussion of public goods, but the logic is the same – the park is only rival during periods of peak use.

**3.** a) The park expansion is both *non-rival* and *non-excludable*. It is usually impossible to keep anyone from enjoying the benefits of a neighborhood park, as unlimited access is usually desired. In addition, it is non-rival. Unless the park becomes very crowded (again, unlikely in a small neighborhood park), more people using the park will not reduce its benefits.

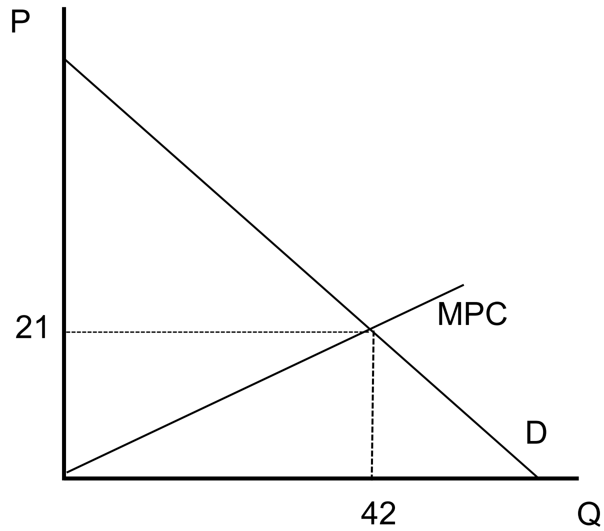
b) It is not efficient to proceed with the park expansion. Since this is a public good, we need to compare the social marginal benefit – that is, the sum of individual marginal benefits – to the marginal cost. The sum of marginal benefits equals $5,750. This does not justify the cost of $6,000 to expand the park.

c) If the expansion is approved, each voter will pay $2,000. To determine whether an individual will vote yes or no, compare the voter's *individual* benefit to their share of the cost:

Tyrone = 2,500 – 2,000 = $500
Tasha = 2,250 – 2,000 = $250
Pablo = 1,000 –2,000 = -$1,000.

Since two of the three voters have positive net benefits, the park expansion will be approved. Both Tyrone and Tasha will vote for the expansion. The problem here is that the yes/no referendum does not reflect the intensity of an individual's preferences. The two who vote for the expansion have only a small positive net benefit. Pablo, the only one who opposes the expansion, has large negative net benefits. However, his no vote has only as much weight as one of the two yes votes.

**4.** a) In a competitive market, we use marginal cost to get the supply curve. Thus, we set demand equal to the marginal private costs to find the quantity sold. Note that, since nothing is done about pollution in this question, we ignore the damages caused by pollution. In this case, marginal private costs equal $0.5Q$.

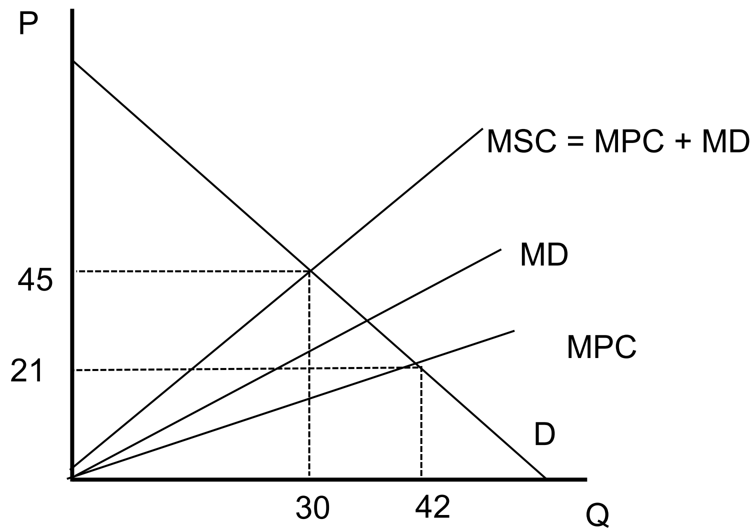



$$105 - 2Q = 0.5Q$$
$$105 = 2.5Q$$
$$Q = 105/2.5$$
$$\boldsymbol{Q = 42}$$

To find the price, plug this quantity into either supply or demand to get ***P* = $21:**

$$P = 105 - 2(42) = \$21$$
or
$$P = 0.5(42) = \$21$$

b) To find the efficient level of production, we equate the social marginal cost and demand. Social marginal cost is the sum of private marginal costs (0.5$Q$) and marginal damages ($Q$). Thus, social marginal costs equal 1.5$Q$.




We get:

$$SMC = 1.5Q = 105 - 2Q = \text{demand}$$
$$3.5Q = 105$$
$$Q = 105/3.5$$
$$\boldsymbol{Q = 30}$$

To get the price, plug the quantity of 30 into demand:

$$P = 105 - 2(30) = \$\mathbf{45}.$$

c) The tax should make producers to incorporate the cost of pollution into their decisions. Thus, the tax should equal to the marginal damage at a quantity of 30. Since MD = $Q$, the tax equals **$30**.

Note that the price does not increase by the full $30. That is because the producer price falls – both consumers and producers bear the burden of the tax. At a quantity of 30, the marginal private cost equals $15. As marginal private cost represents the original supply curve in a competitive market, this is the price that suppliers will receive after the tax. When the price received by producers falls from $21 to $15, the difference between the consumer price ($45) and producer price ($15) equals the Pigouvian tax of $30.

A common mistake was to use the difference between $45 and $21 as the tax. This equals $24. However, this tax will not be sufficient to reduce the equilibrium quantity to 30, as shown below, here I add the tax to the marginal private cost curve:

$$105 - 2Q = 0.5Q + 24$$
$$81 = 2.5Q$$
$$Q = 32.4$$

**5.** a) To find the total costs of abatement for each firm, we add up the marginal abatement costs for each gallon abated:

For Woody's Woodworking, the total cost of abatement = $2 + $4 + $6 + $8 + $10 + $12 = **$42**.
For Custom Built Dams, the total cost of abatement = $6 + $12 + $18 + $24 + $30 + $36 = **$126**.

Thus, the combined total costs of abatement are **$168**.

b) Each firm will choose to abate a gallon of pollution if the marginal abatement cost is cheaper than the emissions fee. Thus, each firm cleans up pollution if the marginal abatement cost is lower than $18.25. Woody's Woodworking will clean up **9 gallons** of pollution, and Custom Built Dams will clean up **3 gallons** of pollution.

c) Once again, to find the total costs of abatement for each firm, we add up the marginal abatement costs for each gallon abated:

For Woody's Woodworking, the total cost of abatement = $2 + $4 + $6 + $8 + $10 + $12 + $14 + $16 + $18 = **$90**.
For Custom Built Dams, the total cost of abatement = $6 + $12 + $18 = **$36**.

The combined total costs of abatement are now just **$126**.

The emissions fee lowers the total costs of abatement because it encourages the firm with lower costs to do more clean-up. Total costs are minimized when the marginal abatement cost is equal across polluters. That is now the case. The marginal abatement cost equals $18 for the 9$^{th}$ gallon cleaned up Woody's Woodworking and for the 3$^{rd}$ gallon cleaned up by Custom Built Dams.

To see how this saves money, consider our initial setting where each firm cleaned up 6 gallons. By asking Woody to clean up one more gallon, costs go up by $14. However, to keep total clean up the same, this allows Custom Build Dams to clean up one less gallon. The marginal abatement cost of the 6$^{th}$ gallon for them is $36. Thus, CBD saves $36, while Wood's costs only go up by $14. We get a net savings of $22. Additional savings are possible until we reach the point where the marginal abatement cost is equal for each firm.

A common error here was to include the cost of the tax. While it is true that the total payments by firms do increase, the tax payments are a transfer. Resources spent on abatement are used up. Tax payments are money transferred from firms to the government. The money is still available to be spent, just by a different actor.

**6.** a) Actuarially fair insurance is when the premium equals the expected payout. Here, there is a 1% chance of an accident that will lead to a $20,000 payout. Thus, the expected payout is 0.01 X $20,000 = **$200**.

While the calculation above is all you needed to answer this question, note how this relates to the example we did in class. Either with or without insurance, this driver would have the same expected income:

- EV(with insurance) = 100%($20,000 - $200) = $19,800
- EV(no insurance) = 0.99($20,000) + 0.01($0) = $19,800

b) Here, there is a 5% chance of an accident that will lead to a $20,000 payout. Thus, the expected payout is 0.05 X $20,000 = **$1,000**.

While the calculation above is all you needed to answer this question, note again how this relates to the example we did in class. Either with or without insurance, this driver would have the same expected income:

- EV(with insurance) = 100%($20,000 - $1,000) = $19,000
- EV(no insurance) = 0.95($20,000) + 0.05($0) = $19,000

c) The insurance company needs the price to cover its expected payouts. If one-half of drivers have a 1% chance of an accident, and one-half have a 5% risk, the average risk is 3%. Thus, the expected payout is 0.03 X $20,000 = **$600**.

d) At a price of $600, safe drivers will choose not to buy insurance. Their expected income is higher without it:

- EV(with insurance) = 100%($20,000 - $600) = $19,400
- EV(no insurance) = 0.99($20,000) + 0.01($0) = $19,800

This is an example of **adverse selection**. Adverse selection occurs because insurance is more attractive to people with a high probability of suffering a loss. If the insurance company is unable to identify which drivers are safe, or if government regulations do not allow them to charge higher prices to riskier drivers, the resulting price will be based on average risk. Such a price discourages low-risk drivers from buying insurance.

A common error here was to say this is an example of moral hazard. While moral hazard is relevant for insurance, that is not what this example shows. Moral hazard is when a person takes unnecessary risks because they are not responsible for the full cost of their actions. Even if the insurance company could charge a higher price to Speedsters, those drivers could still take greater risks because insurance will pay the costs if an accident occurs.