PAI 723 **Professor David Popp**
Solutions to Problem Set #6 **Fall 2024**

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**

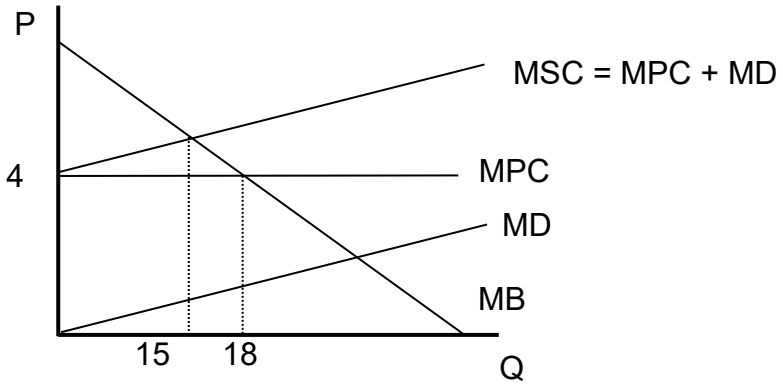
2. a) To find the efficient level of production, we equate the social marginal cost and demand. Social marginal cost is the sum of private marginal costs (4) and marginal damages (0.2Q). (Note that the marginal cost of production is constant at 4, since *each additional bag of marbles* costs $4. It is not correct to use 4Q for marginal cost. 4Q is the *total cost* -- the cost of each unit times total output. To find the optimal point, we must work with marginal values.)

We get:

SMC = 4 + 0.2Q = 22 - Q = demand

1.2Q = 18

Q = 15



b) Without government intervention, Mack's will equate demand and private marginal costs. Overproduction results:

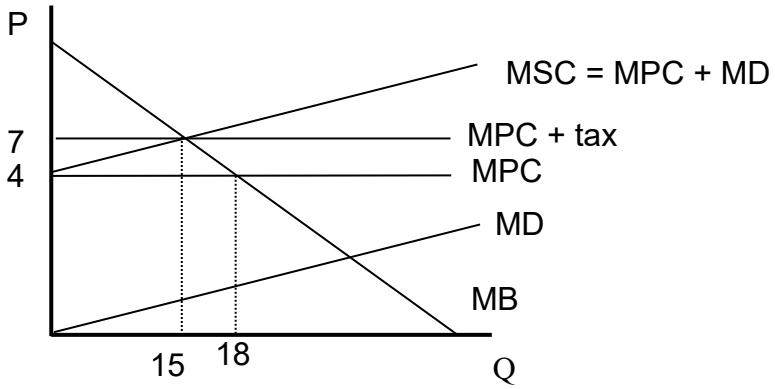
4 = 22 - Q

Q = 18

c) To encourage an efficient level of production, we need to make the firm take the social costs of its production into account. A Pigouvian tax will do this. We set the tax equal to the marginal damage *at the optimal point*. This is equal to **$3** (0.2x15). The firm must pay a $3 tax for each unit produced. With a Pigouvian tax, the firm's MC = 7. Thus:

7 = 22 - Q

Q = 15



3. a) To find the total costs of abatement for each country, we add up the marginal abatement costs for each ton:

For Freedonia, the total cost of abatement = \$15 + \$20 + \$25 + \$30 + \$35 = **\$125**.
For Drusselstein, the total cost of abatement = \$25 + \$35 + \$45 + \$55 + \$65 = **\$225**.

Thus, the combined total costs of abatement are **\$350**.

b) This is not the cheapest way to reduce 10 tons of emissions. To see this, note that marginal abatement costs of the last gallon reduced are not equal. Eliminating the 5th ton of emissions only costs Freedonia \$35. In contrast, eliminating the 5th ton costs Drusselstein \$65. If Drusselstein did not have to eliminate this 5th ton, they would save \$65. At the same time, suppose we ask Freedonia to remove one additional ton (so that total abatement remains at 10 tons of emissions). This would only cost Freedonia \$40. Thus, we could still reduce 10 tons of emissions, but save \$25 (= 65-40).

Such savings are possible any time the two marginal abatement costs aren't equal. Thus, we can continue making such trades until the marginal abatement costs are equal. This occurs when Freedonia removes **7** tons of emissions and Drusselstein removes **3** tons of emissions. Here, the marginal abatement cost of each country equals \$45.

Note that the total abatement costs have now fallen. Freedonia's cleanup costs rise slightly, to \$210. However, Drusselstein now spends only \$105 on pollution abatement. The total abatement cost of \$315 is \$35 lower than in part (a).

c) For firms within a single country, there are a couple of policy options that are commonly used to achieve an efficient allocation of abatement responsibility. One is an *emissions fee*. Consider an emissions fee set just above $45 (e.g. $45.01). For Freedonia, they will not choose to pollute and pay the fee until they have removed 7 tons of emissions, since the marginal abatement cost for the first 7 tons is less than the fee. In contrast, Drusselstein will only remove 3 tons of emissions. After that, it is cheaper to pay the fee than to pollute less.

An alternative policy with the same effect would be to give each firm tradable pollution permits. We could begin by giving each firm enough permits to cover one-half of their pollution. Thus, the starting point is similar to the current policy. However, if firms are allowed to buy and sell permits, Drusselstein will buy permits from Freedonia until their two marginal abatement costs are equal. At that point, no more beneficial trades are possible. For example, beginning with the initial allocation, Freedonia and Drusselstein could negotiate a permit price anywhere between $40 and $50. At this price, Freedonia could sell one permit to Drusselstein. Since Freedonia's marginal abatement cost for the 6^{th} ton is $41, any price above $40 allows them to cover the clean-up costs and save the remainder as profit. Similarly, by reducing one less ton of pollution, Drusselstein saves $65. Thus, they are willing to pay any price up to $65 to avoid the clean-up cost.

However, since these are countries, rather than firms, implementing such policies would be difficult. No international agency has the authority to tax countries or to punish them if they do not have a sufficient number of permits.

The above answer on countries, rather than firms, would be sufficient. To provide additional background, note that international agreements can be reached to set up such enforcement systems. The World Trade Organization is an example. However, even these agreements can have flaws. For instance, in the case of climate change, the U.S. joined the Paris Agreement to reduce emissions under President Obama, but pulled out under President Trump. The U.S. faced no penalties for pulling out of the Paris Agreement. Some governments are trying to address this problem using tariffs. For example, the European Union uses emissions trading to reduce emissions within the EU. It has begun charging tariffs to countries whose emission regulations are weaker than the EU, so that foreign firms do not have a competitive advantage over EU firms.

4. No, I.C. Snow's claim that the rink is a public good is not valid. Although it is true that Clinton Square was built with public funds, and that the rink is run by the Parks and Recreation Department, it does not meet the definition of a public good. A public good must be *non-rival* and *non-excludable*. Neither applies here. The rink is rival, because if too many people skate at once, the rink will be overcrowded. Thus, it is important to limit the number of skaters on the rink at one time. Charging a fee is one way to do this. Moreover, charging a fee is possible (not surprising, since it is currently being done), because the rink is excludable. It is possible to limit access points to the rink, which makes it feasible to require payment of the $3 fee before entering. Given this, as well as the need to avoid congestion, it does make sense to charge a fee for admission to the rink.

5. a) For a public good, we should compare the sum of the benefits received by all user to the cost of providing the public good. In this case, any location which provides more than $1,500 of benefits is worth building. The sum of benefits for each location are:

Gryffindor: $1400
Hufflepuff: $1800
Slytherin: $2400

Thus, it would be efficient to build rec centers at Hufflepuff and Slytherin. A common mistake was to simply rank the sites and pick the highest ranked site (Slytherin). Note that *any* location which has a positive net benefit is efficient, not only the site with the highest ranking. Even after building the site at Slytherin, building a second rec center at Hufflepuff generates $1800 of benefits while only costing $1500, for a net gain of $300.

b) Each voter will vote for any location in which the benefits to their house exceed their house's share of the cost, which is $500. For each location we have:

		voters: Harry	Cedric	Malfoy	
location:	Gryffindor	1000 YES	400 NO	0 NO	Doesn't pass
	Hufflepuff	600 YES	800 YES	400 NO	Pass
	Slytherin	200 NO	200 NO	2000 YES	Doesn't pass

The outcome of the vote is efficient for Gryffindor and Hufflepuff, but not for Slytherin. Even though the total benefits exceed the total costs of building a rec center there, only Malfoy will support the project.

The problem here is that majority rule voting does not allow each voter to indicate the strength of their preferences. The benefits to Malfoy's house of a rec center in

Slytherin is higher than the benefits received from any other location, and exceeds their share of the cost by $1500. Nonetheless, even though the costs to the other two houses are just $300 greater than the benefits they receive, their no votes receive as much weight as Malfoy's yes vote.

c) Since a yes vote now means that all three centers will be built, each house will need to pay a total of $1500 if approved. Thus, only houses who receive at least $1500 of benefits from all three rec centers will vote yes:

location:	voters: Harry	Cedric	Malfoy
Gryffindor	1000	400	0
Hufflepuff	600	800	400
Slytherin	200	200	2000
TOTAL BENEFIT	1800	1400	2400
VOTE	YES	NO	YES

Thus, both Harry and Malfoy will vote for the combined projects, and all three will be built. This helps Harry and Malfoy, as neither of their preferred rec centers were built in part (b), despite having the two highest individual benefits. By combining forces, Harry and Malfoy's strong preferences are recognized. They don't mind taking on a share of the cost of other rec centers in order to get the one they support the most.

However, even though it is still efficient to build the Hufflepuff location, combining the projects into a single vote hurts Cedric. The benefit his housemates get from having a rec center built at Hufflepuff is cancelled out by the cost they must pay to support the other two rec centers.

A key lesson from this question is that different voting mechanisms can yield different results, but there is no guarantee that one will be more efficient than the other. In part (b) an efficient project (Slytherin) doesn't pass, and in part (c) an inefficient project (Hufflepuff) does pass.

6. a) The insurance premiums collected by an insurance company should cover the expected value of claims they will pay out. Utilities in California are likely to have larger claims for damages caused by wildfires than utilities in other states. As a result, if California utilities can buy insurance from private companies that also insure utilities elsewhere, the average expected payouts to *all utilities* will be less than the average expected payouts only to *California* utilities. The cost of a policy sold to all utilities will be less than the cost of the payment to the state fund, which only covers California utilities.

Intuitively, in the case of nationwide insurance, the risk of wildfires is spread across utilities in all 50 states, including both high-risk and low-risk utilities. In the case of insurance for California utilities only, the risk is only spread amongst utilities at high-risk for causing wildfire damages.

b) This is an example of moral hazard. Once a utility is insured, it can take greater risks, because it will not pay the full cost of a negative outcome. They can save money by taking fewer precautions to reduce fire risk, as the insurance fund, not the company, will pay the cost of damages.

Some people said that this was an example of adverse selection. Adverse selection occurs when insurance is more attractive to people with a high probability of suffering a loss. I gave partial credit for this answer. It is true that the utilities that take fewer precautions will benefit more from insurance. However, the problem with adverse selection is that high-risk clients buy into insurance, but low-risk clients do not. By mandating that all utilities pay into the fund, that is not an issue here. That is, it is the mandate for all utilities to buy insurance that addresses adverse selection.