MIT 14.41 – Problem Set 1

QUESTION 1: [25 points]

For each government policy below, please describe the following:

- Does the government policy aim to address an externality? If yes, what is the externality? Describe it, including references to whether it is positive or negative, and whether it is a consumption or production externality. If no, is there another reason for the government to intervene?
- If the policy is addressing an externality, is there an alternate private (Coasian) solution that can fully address the externality? Why doesn't a private solution arise (i.e. why must the government intervene)?

1. (5 points) The US government provided large grants to firms developing Covid-19 vaccines.

Solution:

- Yes, there is a positive production externality from producing vaccines. Firms are less likely try to produce vaccines than than is socially efficient because they do not profit from the herd immunity effects of vaccination (because individuals who are getting vaccinated do not privately value the positive health effects that their vaccination has on others).
- One Coasian solution would be if the health insurance companies took up a collection to pay the firms producing vaccines for the positive health benefits that the ability for people to get vaccinated would have on unvaccinated people. There are a lot of health insurance companies to bring together (and a lot of uninsured people!) but even if you could do that, it would be impossible to define the spillovers that each insurance company would experience (for example each insurance company is differentially likely to have clients who are likely to go uninsured, and vaccination rates in the areas that their clients live will may or may not be high enough to achieve herd immunity). Also, there would be a free-rider problem: no individual firm has an incentive to make a payment to the company investing in vaccine R&D if all of the other companies are doing so.

Grading notes: 2 points for noting that it is a positive production externality, 2 points for a reasonable Coasian solution that involves payments to the vaccine-producing firms from e.g. health insurance companies or the unvaccinated. 1 point for any explanation of why this is not feasible (defining the spillovers and responsibility of each insurance company for example, or the free-rider problem.

2. (5 points) Federal and state governments provide assistance to low-income families through SNAP (also known as food stamps).

Solution:

- No; the point of government assistance is redistribution

Grading notes: 3 points for noting that it is not an externality and 2 points for noting that the aim of the policy is redistribution. Up to 2 points for coming up with creative ways it could be a fiscal externality.

3. (5 points) New York City's transportation authority introduces congestion pricing on vehicles entering Manhattan during rush hour.

Solution:

- Yes; each driver does not take into account the effect that adding his car to the road has on average wait times or the likelihood of accidents. These externalities are increasing in the number of people on the road, so charging higher tolls at rush hour to try to deter drivers from joining the throng is an attempt to internalize these externalities. This is a negative consumption externality.
- The other drivers on the road are the ones who are affected by these externalities. A Coasian solution would require coordination among all drivers, and for drivers to correctly report the marginal cost to them of being in a traffic jam (which they have no incentive, and likely are not able to, do). It's also not possible to give property rights to the people on the road at any given time.

Grading notes: 2 points for noting that it is a negative consumption externality on other drivers on the road, 2 points for reference to conditions of Coase theorem e.g. property rights, etc. and 1 point for concluding that it is not possible to coordinate among all drivers. If conclude Coase does apply, subtract 1 or 2 depending on the explanation.

4. (5 points) Municipal government budgets pay for 4th of July fireworks in most towns and cities.

Solution:

- Yes; a big fireworks display has large positive consumption externalities. If one person put on a fireworks display, lots of people would get to enjoy it.
- Alternatively, you can answer that there is not an externality but it is a public good.
- There is no Coasian solution because the good is non-excludable. Everyone has an incentive to free-ride, and hope that someone else puts on a big firework display that everyone can enjoy. One individual's private marginal benefit is unlikely to be as high as the marginal cost of providing a big show.

Grading notes:

- Option 1: 2 points for noting that it is a positive consumption externality, 3 points for there being no Coasian solution because the good is non-excludable. Up to 2 points for correctly explaining the logic of a Coasian solution in this case and concluding it is possible.

- Option 2: 1 point for saying it's not an externality, 4 points for saying it's a public good.
- Full credit requires noting that the Coasian solution does not result in the socially optimal outcome due to the public goods nature of fireworks.

5. (5 points) The average cigarette smoker pays about $3 in state and federal excise taxes every time they buy a pack of cigarettes.

Solution:

- Yes; these taxes aim to internalize negative consumption externalities and internalities. Some of the externalities include the effects that smokers have on their loved ones through secondhand smoke, (if the smokers optimize personal rather than family utility), the effects that they have on the average health or fire insurance costs faced by non-smokers which go up because smokers are more expensive to insure, or the negative effects they have on average wages if employers don't offer different contracts to smokers (who are less productive) and non-smokers. The internalities are negative effects of smoking on the smoker that they do not correctly take into account when they first make the decision to smoke (partly due to underestimating how addictive it will be).
- If smokers' spouses and children had legal rights to a smoke-free environment, they could charge smokers an amount equal to their marginal cost of smoking one more cigarette to be able to smoke. Since family units are small, that might be feasible in terms of coordination, but since e.g. children have very little control over their parents' decisions, this is not an area where is is realistic to expect these kinds of property rights to exist. The situations with wages or insurance premiums suffers from coordination issues similar to above. Since internalities affect the person making the decision because of self-control issues or myopia, a Coasian solution would be for a fully sophisticated agent to set commitment devices for their future selves to constrain themselves to smoke less or not smoke.

Grading notes: 2 points for noting that this policy addresses a negative consumption externality on other others and 1 point for noting the possibility of negative internalities as well. Minus 1 point if they say there are also possible positive externalities – that would not be consistent with this policy of *taxing* cigarettes. 1 point for reference to conditions of Coase theorem e.g. legal rights, contracting with the future self, etc. and 1 point for correctly concluding that the solution they gave is or is not be feasible (see sample solutions for some possibilities).

QUESTION 2: [25 points]

The Inflation Reduction Act (IRA), which was enacted in August 2022, includes $369 billion in spending on clean energy and climate change, making it the largest bill aimed at tackling climate change in US history. This question asks you to think about some of the climate provisions of the IRA through the lens of the four questions of public finance.

1. (5 points) **When should the government intervene in the economy?**
   (a) (2 points) Explain the key externality associated with climate change.

Solution: Any production that produces greenhouse gases contributes to climate change, and climate change imposes costs on people around the world, but the person or firm responsible for producing the greenhouse gases doesn't have to pay for these costs. This negative production externality is the key externality associated with climate change.

(b) (3 points) Is the private sector likely to provide adequate solutions to this externality? Explain why Coasian solutions to this externality are likely or unlikely.

Solution: Coasian solutions are unlikely in the context of climate change. Reasonable explanations include:

- It is difficult or impossible to assign property rights for carbon emissions on an international scale.
- It is difficult to calculate the economic value of the damage created by climate change.
- Climate change affects very large numbers of people, and coordinating bargaining on behalf of all of those people is likely to be impossible or at least extremely costly.
- Estimating the economic value of the damage caused by climate change is difficult.
- Some of the people affected by climate change are unborn future generations, who cannot take part in bargaining today.

2. (6 points) **What is the effect of those interventions on economic outcomes?**

One policy in the IRA is subsidies for electric vehicles. Specifically, the IRA provides a $7,500 tax credit for purchases of new electric vehicles. Electric vehicles have lower carbon emissions over their lifetime than gas-powered vehicles, but since some electricity is produced using fossil fuels, they tend to still be carbon intensive relative to public transport, walking or cycling.

(a) (2 points) What is the direct effect of subsidising electric vehicle purchases (the effect if individuals don't change their behavior in response to the subsidy)?

Solution: If people don't change their behavior, the direct effect is to transfer money to people who were going to buy a new electric car anyway, by allowing them to pay less for the vehicle.

(b) (4 points) Describe two possible indirect effects of subsidising electric vehicles purchases, one that would reduce carbon emissions, and one that would increase carbon emissions.

Solution: A possible indirect effect that reduces carbon emissions is that people who were going to buy a gas-powered car change their behavior and buy an electric car instead. This is the effect intended by the subsidy.

A possible counterproductive indirect effect that would increase carbon emissions is if some people choose to buy an electric car when they would have otherwise used public transport or other less carbon-intensive transport.

3. (10 points) **How might the government intervene?**

(a) (4 points) The subsidy on electric vehicles is only available to individuals earning under $150,000 per year,

heads of household[1] earning under $225,000 per year, or couples earning under $300,000 per year. Describe one pro and one con of limiting eligibility for the subsidy by income in this way.

Solution: Limiting the subsidy has an equity benefit, because it means that the government does not transfer as much money to the rich and a larger proportion of the transfers go to the poor. However, it potentially makes the subsidy less effective because fewer people are eligible for it, so it might not reduce carbon emissions as much as a subsidy with no income limit.

(b) (6 points) The state of California, as well as the European Union, plan to completely ban the sale of new gas-powered cars by 2035. Describe two pros and two cons of a policy of banning the sale of new gas-powered vehicles, compared to the policy in the IRA of subsidising purchases of new electric vehicles.

Solution: This is an open-ended question with many possible answers, but some reasonable points include:

- Banning new gas-powered cars would reduce their use more than subsidising electric cars and thus possibly reduce carbon emissions more.
- Banning new gas-powered cars might cause people to switch to less efficient used gas-powered cars instead of switching to electric cars.
- Subsidising electric cars but not banning gas-powered cars means that people who have a high marginal cost of switching to electric cars are still able to use them.
- Banning gas-powered cars would not cost the government anything, whereas a subsidy could be expensive.
- Zero might be below the socially optimal number of gas-powered cars being used.
- The subsidy involves giving money to people buying new cars who might tend to be rich (even though there is an income cap), so banning purchases entirely might be better for equity.
- We generally think that for climate change getting the reduction amount exactly right isn't important, so price regulation might work better than quantity regulation.

4. (4 points) **Why do governments choose to intervene in the way that they do?**

According to the textbook, tax credits and subsidies for alternatives to a negative externality-producing activity "are generally inferior to taxing the negative externality–producing activity" directly. Suggest at least one reason why the government chose to subsidise electric vehicle purchases rather than adding an additional tax to purchases of gas-powered vehicles. These can include political reasons as well as economic reasons.

Solution: Again, this is an open-ended question, but some some answers include

- Politically, taxes are viewed more negatively than subsidies
- Since inflation is relatively high at the moment, the government doesn't want to be seen to directly increase the price of goods.

[1] This refers to people who aren't married but pay a large part of the living costs for at least one relative who lives with them, such as single parents.

- The subsidy distributes money towards car-owners rather than away from car-earners,
- Broadly, any reasonable political considerations are acceptable.

QUESTION 3: [25 points]

Amy and Ben live in separate units of an apartment building that has central heating controlled by a thermostat. Unfortunately, the two units' heating cannot be controlled separately, so both units always need to be set to the same temperature. Utilities are included in Amy and Ben's rent, so they do not have to pay more for heating when the temperature is set to a higher level.

Amy and Ben have different preferences about the temperature. Amy prefers the house to be relatively cool, with an ideal temperature of 68°F, but she does not care too strongly about the temperature. Her utility on each day is given by

$$u_A = x_a - (t - 68)^2$$

where x_A is the amount of dollars she has to spend that day, and t is the apartment's temperature in Fahrenheit. She has a budget of $200 per day.

Ben prefers the apartment to be warmer, with an ideal temperature of 73°F. He also feels quite uncomfortable when the temperature changes and cares more about the temperature of the apartment. His utility is given by

$$u_B = x_B - 4(t - 73)^2$$

and he earns less than Amy and has a budget of $100 per day.

The thermostat for the building is located in one of the two people's units. Assume that the leases for both units say that the person who rents the unit with the thermostat has the right to set the temperature to whatever level they like.

1. (3 points) What temperature would a social planner with a utilitarian social welfare function set for the apartment?

Solution: The utilitarian social welfare function is just the sum of the individual's utilities, that is

$$SWF = x_A + x_B - (t - 68)^2 - 4(t - 73)^2$$

Differentiating with respect to t gives the first-order condition:

$$-2(t - 68) - 8(t - 73) = 0$$

which implies the socially optimal temperature is

$$t^* = 72.$$

Grading notes: 2 points for setting up the FOC correctly; 1 point for setting up the SWF correctly.

2. For this part, assume that for some reason, Amy and Ben hate interacting with each other and refuse to discuss any bargains about the temperature. Also assume that the thermostat is in Amy's unit.

   (a) (1 point) What temperature will Amy set the thermostat to?

   Solution: Without bargaining, Amy will ignore Ben's preferences and set the thermostat to her ideal temperature, which is 68F.

   (b) (2 points) Is there any deadweight loss from Amy's choice? If so, calculate it.

   Solution: Yes: note that social welfare at the social optimum is 280, while when the temperature is set to 68F, social welfare is only 200. Thus there is \$80 worth of deadweight loss.

   Grading notes: One point for attempting to calculate the difference in social welfare with a mistake in the calculation.

3. For this part, assume that Amy and Ben get on well enough with each other that they are able to costlessly bargain about the temperature. They are willing to make side payments between each other so that they can both agree on a temperature, with no social awkwardness.

   (a) (3 points) What temperature is the thermostat set to:

      i. When the thermostat is in Amy's unit?

      ii. When the thermostat is in Ben's unit?

   Solution: With costless bargaining, in both cases the temperature will be set to 72F. When Amy controls the thermostat, Ben will be willing to pay Amy a little more side payment to raise the temperature, and Amy will be willing to accept this deal, as long as the marginal utility he gets from raising the temperature is less than the marginal utility that Amy loses from raising the temperature. You can show that this will be the case whenever $t \leq 72$. Similarly, when Ben controls the thermostat, Amy will be willing to pay Ben a little more to lower the temperature, and Ben will accept the deal, as long as the marginal utility she gets from lowering it is greater than the marginal utility that he loses from lowering it, which is the case whenever $t \geq 72$.

   Grading notes: two points for realising that the temperature will be the same in both cases; full credit if the answer is consistent with answer to part 1.

   (b) (4 points) In what range will the side payments between Amy and Ben lie in the following cases:

      i. Case 1: the thermostat is in Amy's unit.

   Solution: If the thermostat is in Amy's unit, Ben has to pay Amy a side payment for her to raise the temperature to 72F. The maximum amount of money he is willing to pay for this is the amount that makes him exactly indifferent between having the temperature at 68F with no side payment, and having the temperature at 72F with a side payment of T_A. This amount must satisfy the equation

$$100 - 4(68 - 73)^2 = 100 - T_A - 4(72 - 73)^2$$

   which is solved at $T_A = 96$, so Ben is willing to pay at most \$96. Similarly, the minimum side payment Amy will accept satisfies

$$200 - (68 - 68)^2 = 200 + T_A - (72 - 68)^2$$

which is solved at $T_A = 16$. Thus Ben will make a side payment to Amy, and any side payment between \$16 and \$96 is feasible.
Grading notes: full credit for solving for the range correctly. 1/2 points for setting up one of the indifference conditions correctly but making a calculation error.

ii. Case 2: the thermostat is in Ben's unit.

Solution: If the thermostat is in Ben's unit, Amy has to pay Ben a side payment for him to lower the temperature to 72F. The maximum amount of money she is willing to pay for this is the amount that makes him exactly indifferent between having the temperature at 73F with no side payment, and having the temperature at 72F with a side payment of T_B. This amount must satisfy the equation

$$200 - (73 - 68)^2 = 200 - T_B - (72 - 68)^2$$

which is solved at $T_B = 9$, so Amy is willing to pay at most \$9. Similarly, the minimum side payment Ben will accept satisfies

$$100 - (73 - 73)^2 = 100 + T_B - 4(72 - 73)^2$$

which is solved at $T_B = 4$. Thus Amy will make a side payment to Ben, and any side payment between \$4 and \$9 is feasible.
Grading notes: full credit for solving for the range correctly. 1/2 points for setting up one of the indifference conditions correctly but making a calculation error.

(c) (1 point) Intuitively, why do the side payments differ in these two cases?

Solution: Ben cares more about the temperature deviating from his ideal than Amy, and so is willing to pay more to Amy than she would to him (and vice versa: Ben is willing to accept less from Amy than she would from him).

(d) (2 points) What are Amy and Ben's utilities:

i. When the thermostat is in Amy's unit?

ii. When the thermostat is in Ben's unit?

Solution: In both cases utilities are given by

$$u_A = 200 - (72 - 68)^2 + T_A = 184 + T_A$$
$$u_B = 100 - 4(73 - 72)^2 + T_B = 96 + T_B$$

where $T_A = -T_B$ (the transfer values from part 3b should be substituted in correctly in both cases).

(e) (3 points) Does it matter which unit the thermostat is located in? Explain why it may or may not matter, and if it matters, which unit you think it should be located in.

Solution: Adding up Amy and Ben's utilities in both cases shows that there is no difference in total social welfare between the situations when Amy controls the thermostat and when Ben controls the

thermostat. Thus a purely utilitarian social planner would not care which unit the thermostat is located in. However, the individual welfare of Amy and Ben does change depending on who controls the thermostat. In particular, since Amy earns more than Ben, utility is much more unequal when the thermostat is in Amy's unit. Thus if the social planner has a preference for equity, they would prefer to put the thermostat in Ben's unit, since this improves equity while not reducing total social welfare.

Grading notes: two points for making either one of these arguments. Full credit requires discussing both total social welfare and equity.

4. For this part, assume that there is a cost of bargaining: Amy and Ben can bargain about the temperature, but they both find the experience socially awkward, and would both be willing to give up $10 if it meant they could avoid having to discuss the temperature. We can then write their utility functions as

$$u_A = x_A - (t-68)^2 - 10b$$
$$u_B = x_B - 4(t-73)^2 - 10b$$

where b is a variable that is equal to 0 if they do not bargain (that is, if there are no side payments between them) and equal to 1 if they do bargain.

(a) (3 points) Explain whether, and why or why not, bargaining will still happen:

i. When the thermostat is in Amy's unit?

ii. When the thermostat is in Ben's unit?

Solution: With a $10 cost of bargaining, a bargain will only happen when both people are at least $10 better off with the bargain than without the bargain. When the thermostat is in Amy's unit, then this is possible: if Ben gives Amy a side payment between $26 and $86, then they will both prefer bargaining to not bargaining even though bargaining is costly, because they gain enough from the bargain. However, when the thermostat is in Ben's unit there will be no bargaining, because Amy is not willing to pay Ben enough to make him $10 better off with the bargain than without the bargain.

(b) (3 points) Does this alter your conclusion from part (3d) about whether it matters which unit the thermostat is located in? If so, which unit do you think it should now be located in when there is a cost of bargaining, and why?

Solution: Placing the thermostat in Ben's unit now results in social utility $u_A = 200 - (73-68) = 175; u_B = 100; SWF = u_A + u_B = 275$. Whereas when the thermostat is in Amy's unit bargaining, they need to bargain to get the efficient outcome, so $u_A = 200 - (72-68)^2 - 10 = 174; u_B = 100 - 4(72-73)^2 - 10 = 86; SWF = 174 + 86 = 260$. So total social welfare is now strictly higher when the thermostat is in Ben's unit, so it arguably should be put there. However, putting the thermostat in Ben's unit is still better for equity, so if you care strongly enough about equity it would be reasonable to still put the thermostat in Ben's unit.

QUESTION 4: [25 points]

Climate change is one of the defining issues of our time. This question asks you to think about climate policy and the social cost of carbon – described by economist Michael Greenstone as "the most important number you've never

heard of" – using cost-benefit analysis tools and looking through the lens of externality theory.

1. (6 points)

   (a) (2 points) Suppose there are two jobs – logging and accounting – which are identical (in hours worked per week, enjoyment, etc.) except that logging carries a 1.5% risk of death each year. Logging pays $60,000 more each year. Infer the value of a life from the compensating wage differential associated with logging.

   Solution: Since individuals must be compensated by $60,000 to accept the 1.5% risk of death associated with being a logger rather than an accountant, they value their lives at $\frac{\$60,000}{0.015} = \$4,000,000$.

   (b) (2 points) Why might we prefer estimates of the value of a life obtained from revealed preference (namely the jobs they choose to work) over those obtained from stated preference (asking people how much their life is worth)?

   Solution: People might simply not know how much they value their life at, given that such a question would probably be very far-removed from their day-to-day concerns. Therefore, their answers may not reflect their true willingness-to-pay for their life. Any reasonable answer also gets credit.

   (c) (2 points) Explain two threats to the accuracy of the estimate obtained from the compensating differential approach.

   Solution:

   - Strong information assumptions: people may not actually have accurate perceptions of the risk associated with dangerous jobs.
   - Even if people did know the risk associated with dangerous jobs, they may not be well-prepared to evaluate the trade-off between the risk of death and a higher income. For instance, a large behavioral literature shows that individuals overestimate small risks and underestimate large risks.
   - People may value their lives differently, or have different tolerances for risk. People who are more risk-loving will select into the dangerous job, so the value of life estimated only reflects a risk-loving individual's value of life, and underestimates the median member of society's value of life.

   Grading notes: 1 point for each reasonable answer.

2. (6 points)

   (a) (1 point) Suppose that for each ton of carbon dioxide emitted today, 0.0002 lives will be lost in 50 years' time. This is the only consequence of carbon emissions. Using the value of a life you estimated in Part 1(a), what is the social cost of carbon (per ton of CO_2) using a 5% discount rate? Round to the closest dollar. At this discount rate, what tax should be imposed on carbon emissions today to maximize social welfare?

   Solution:
   At a 5% discount rate, the SCC is

   $$\frac{\$4,000,000 * 0.0002}{1.05^{50}} = \$70/\text{ton}$$

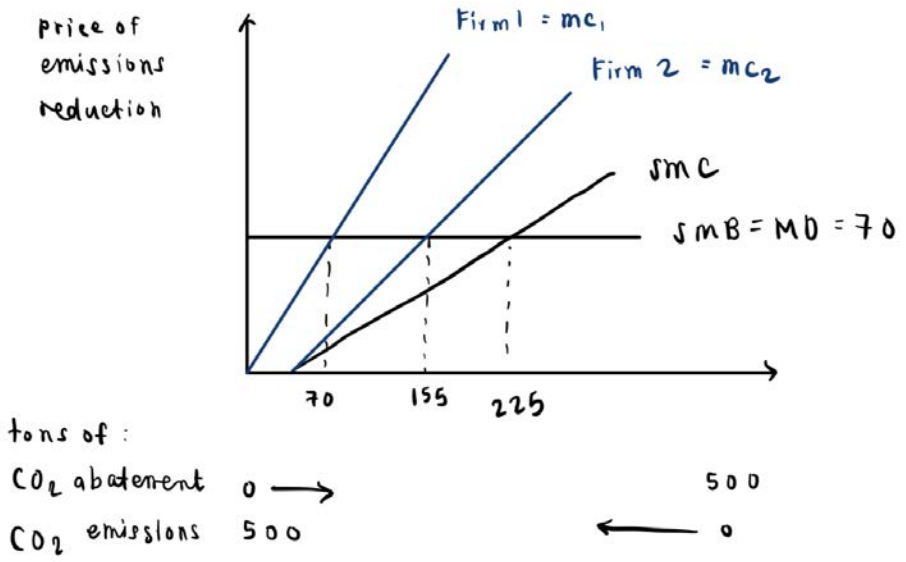
The tax should be set to \$70/ton.

(b) (2 points) Now suppose that there are two firms $i \in \{1, 2\}$ in the economy. In the absence of carbon pricing, each firm emits 250 tons of CO_2, for a total of 500 tons. With a carbon price of p, firm i is willing to abate q_i tons of CO_2 in the amounts:

$$\text{Firm 1: } q_1 = p$$
$$\text{Firm 2: } q_2 = 2p + 15$$

Draw: (1) the firms' cost curves, (2) the social marginal cost curve for abatement (hint: add the cost curves horizontally), and (3) the social marginal benefit of abatement curve using your response to 2(a). Solve for the optimum quantity of carbon abatement.

Solution:



$q^{tot} = p + 2p + 15 = 3p + 15$

Solving for $p, SMC = \dfrac{q^{tot} - 15}{3}$

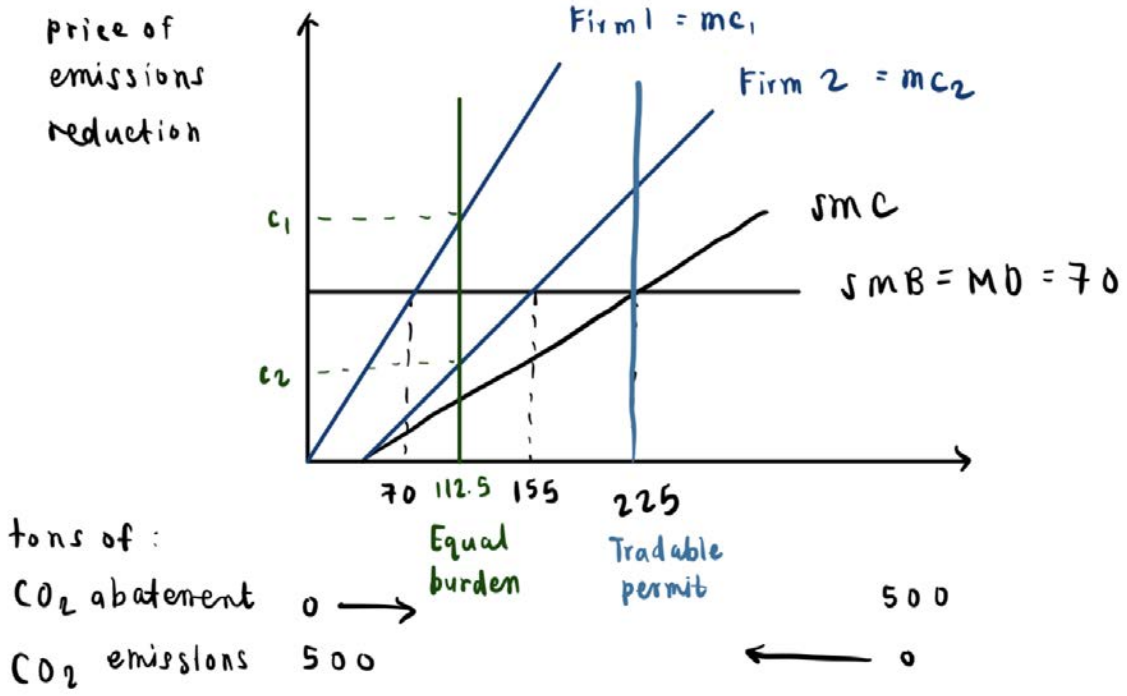
Optimality requires SMB of abatement = 70 = SMC of abatement = $\dfrac{q^{tot} - 15}{3}$

$\implies q^* = 225$ tons

Do not deduct points for carrying over a mistake from previous part.

(c) (3 points) Suppose the government requires each firm to abate 50% of the optimal abatement amount you found in part (b). Why is this less efficient than a tradable permits program in which the government issues 275 permits that entitle the bearer to emit 1 ton of CO_2, and these permits are tradable? Calculate the deadweight loss from the equal burden regulation compared to the tradable permits case.

Solution:



When firms are made to share the burden of abatement equally (so each abates 112.5 tons), they end up facing different costs of abatement at the margin due to their differences in abatement technology. In particular, firm 1 faces a relatively higher cost of abatement than firm 2 ($c^1 < c^2$). Society could achieve the same level of emissions at lower cost if some of the abatement requirement were reallocated from firm 1 to firm 2, which faces a lower cost of abatement, until their marginal costs of abatement are equalized.

This is precisely what a tradable permits scheme achieves through the price signal: since the firms emit a total of 500 tons in the absence of government intervention, issuing 275 carbon permits essentially requires the firms to collectively abate 500-275=225 tons of carbon. Starting from the point where the firms are abating equal amounts, firm 2 would be willing to sell, and firm 1 would be willing to buy, a permit at any $p \in \{c^2, c^1\}$. For firm 1, buying a permit for p is cheaper than abating a ton on its own at c^1. For firm 2, the revenue earned from selling a permit is worth more than the cost of abatement c^2. This will continue until the both firms have the same marginal valuation of emissions so all the gains from trade have been realized, at $q^1 = 70, q^2 = 155$ and $p = 70$.

Under equal burden scheme:

Firm 1's total abatement cost $= \frac{1}{2}(MC_1)q = \frac{1}{2}(112.5)(112.5) = 6328.125$

Firm 2's total abatement cost $= \frac{1}{2}(MC_2)q = \frac{1}{2}\left(\frac{112.5-15}{2}\right)(112.5-15) = \frac{1}{2} * 48.75 * 97.5 = 2376.5625$

Total social cost of abatement $= SC_{EB} = 6328.125 + 2376.5625 = 8704.6875$

Under tradable permit scheme, two ways of calculating social cost.

EITHER: Firm 1's total abatement cost $= \frac{1}{2}(MC_1)q = \frac{1}{2}(70)(70) = 2450$

Firm 2's total abatement cost $= \frac{1}{2}(MC_2)q = \frac{1}{2}\left(\frac{155-15}{2}\right)(155-15) = \frac{1}{2}(70)(140) = 4900$

Total social cost of abatement $= SC_{TP} = 2450 + 4900 = 7350$

OR: Total social cost of abatement $= SC_{TP} = \frac{1}{2} * SMC * q = \frac{1}{2} * 70 * (225-15) = 7350$

DWL $= SC_{EB} - SC_{TP} = 8704.6875 - 7350 = 1354.6875$

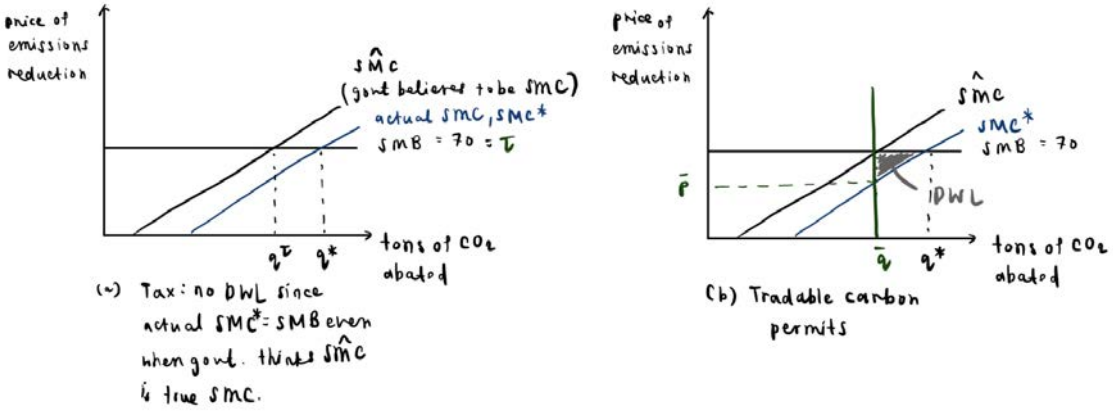
3. (11 points)

(a) (3 points) Now consider the case where the government is uncertain about the private sector's cost of carbon abatement. The market's marginal cost of abatement could be either

$$p = \frac{q-15}{3}, \text{ or}$$
$$p = \frac{q-30}{3}$$

Suppose the government sets policy optimally assuming the first abatement cost curve is the true curve. Draw the social cost and benefit curves under (a) a carbon tax and (b) a tradable carbon credit program. Shade in the deadweight loss that is incurred if the second abatement cost curve is the true curve. Which instrument does the government prefer?

Solution: The government prefers the carbon tax.



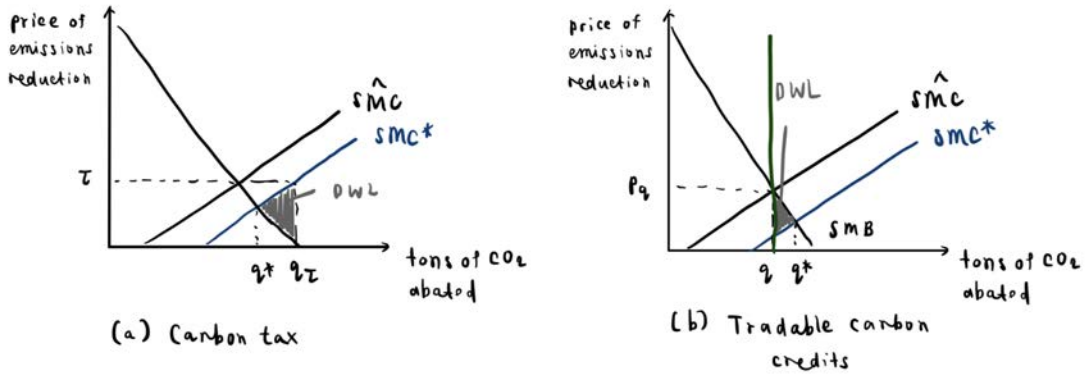
(b) (3 points) Suppose the government severely misestimated the benefits from carbon abatement, and we are

at such a critical point in the climate crisis that the true social benefit of abatement is actually

$$\text{social marginal benefit/ton} = 150 - 2q$$

and the government knows this revised benefit with certainty. Again, draw the social cost and benefit curves under (a) a carbon tax and (b) a tradable carbon credit program. Shade in the deadweight loss incurred if the second abatement cost is the true curve. Which instrument does the government prefer?

Solution: The government prefers the tradable permits program.



(c) (5 points) What can you conclude about the optimal policy instrument under uncertainty about social costs? Provide the intuition behind this result.

Solution: Prices (taxes) are preferred when benefits are relatively flat as the consequences of deviating from the optimal quantity are not so severe whereas the social costs of that deviation can be very high. Quantities (tradable permits) are preferred when benefits are relatively steep so the consequences of deviating from the optimal quantity are severe.

Intuitively, when the SMB curve is steeper, setting a quantity control lets you get "closer" to the true social optimum, whereas a small mistake in the tax rate can cause large quantity changes.

Grading notes: 2 points for conclusion that prices (quantities) are more efficient when social marginal benefits are flatter (steeper) relative to social marginal costs. 3 points for intuition that references the relative steepness of the SMB curve (2 points) and relates it to prices vs. quantities (1 point).

14.41 Public Finance and Public Policy
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