MIT 14.41 – Problem Set 1

Due September 30, 2022
Submit **online** by 5pm ET using Gradescope

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 Coasian solution? Why doesn't a Coasian solution arise (i.e. why does the government have to intervene)?

1. (5 points) The Massachusetts state legislature is charging higher tolls on the highway during rush hour.

2. (5 points) The US government provided large grants to firms developing Covid-19 vaccines.

3. (5 points) Federal and state governments provide assistance to low-income families through TANF.

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

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

QUESTION 2: [25 points]

A network of small private schools is setting its Covid policies for the next year. They can use a variety of tools to reduce the infection rate among their students, including providing free masks, vaccine and mask mandates, deep cleaning the schools every night, hiring more teachers and bus drivers to allow more social distancing, etc. Together, this allows the private school network to reduce the rate of infections in a given week at a cost $C_1(r) = 40r$, where r is the reduction in the rate of infections. The private school network derives a benefit of $100r - 2r^2$ from a reduction in the rate of infections.

1. (2 points) Sketch a graph depicting the private marginal costs and benefits of reducing the rate of infections, and label the private market equilibrium as r'. Make sure to indicate the equations underlying your graph.

2. (4 points) But, when kids at school get Covid, there are spillovers on the community at large: teachers, bus drivers, and parents are all more likely to get Covid from their children. As such, the local health department calculates that the benefit to the community for reducing the rate of infections is $200r - 2r^2$.

   On the same graph as in the previous question, sketch the social marginal costs and benefits of reducing the rate of infections, and label the efficient outcome $r^\star$. Indicate the DWL if the health department takes no action. Make sure to indicate the equations underlying your graph.

3. (3 points) Calculate the reduction in the rate of infections that is socially efficient and the reduction in the rate that is privately optimal for the network of private schools.

4. (3 points) If the health department taxes the private school network based on their infection rate, what specific tax ($t^\star$) will reach the socially optimal reduction in the rate of infections?

   The health department is considering either taxing the private school network at $t^\star$ or instituting a maximum infection rate after which they will close the school (which is infinitely costly to the private school network). However, they have some uncertainty over the costs and benefits described above, and aren't sure whether the tax or the mandate will get them closer to the socially efficient infection rate.

   Because of ever-evolving public opinion, the true private benefit to the network of reducing the rate of infections by one percentage point *might* change to $60r - 2r^2$. But the health department knows the social benefit is truly $200r - 2r^2$.

   Costs are also uncertain, because of supply chain issues. There may be shortages of masks, cleaning supplies, and teachers and bus drivers may be in high demand and strike for higher wages. So, costs *might* increase to $C_2(r) = 50r$.

5. (5 points) Suppose the health department institutes the tax from (4), and the school network learns that their true benefit is $60r - 2r^2$ and the true cost is $C_2(r) = 50r$. Illustrate the problem graphically and indicate the DWL relative to the social optimum. What level of infection rate reduction will the private school network choose? Label that value as r'' and calculate its value. What is the socially efficient outcome? Label that value as $r^{\star\star}$ and calculate its value. Calculate the DWL.

6. (3 points) Suppose that instead, the health department institutes a mandatory maximum infection rate before schools must close based on the information in (1) and (2), but that true costs and benefits are as in (4). Illustrate the problem graphically and indicate the DWL relative to the social optimum. What level of infection rate reduction will the private school network choose? Label that value as r'''. Calculate the DWL.

7. (5 points) Given the uncertainty in the costs and benefits of reducing the infection rate, which strategy makes the most sense for regulating schools in this context? Mathematically, how do you know this is true? Intuitively, discuss what is driving this result.

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?

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?

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

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?

   (b) (5 points) What are the side payments (if any) between the two people:
      i. When the thermostat is in Amy's unit?
      ii. When the thermostat is in Ben's unit?

   (c) (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?

(d) (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.

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?

(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?

QUESTION 4: [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.
   (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.

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)?
   (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.

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.

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[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.

(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.

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.