

Econ 431-01: Public Finance
Prof. Sarah West
Homework 2
50 points

1. (12 points) *Environmental economists tell you that:*

*Consumer demand for wind power can be represented by the equation $P = 300 - Q$.
The supply of wind power can be represented by the equation $P = Q$.
The marginal environmental (external) benefit (MEB) of wind power equals $0.5Q$.*

Prices and benefits are in dollars and quantities are kilowatt hours per minute.

a. What are the socially efficient price and quantity of wind power?

Set $MSB = MSC$:

$$300 - Q + .5Q = Q$$

$$300 = 1.5 Q$$

$$Q^* = 200$$

Plug Q^* into the supply function and solve for P^* :

$$P^* = \$200$$

(Hey, that's a totally unreasonable price per KWH!)

b. What is the amount of the optimal subsidy per kilowatt hour (kwh)? What price would consumers pay (after they get the subsidy) per kwh? What price would suppliers of electricity get? Show on a graph and solve for the numbers.

The optimal subsidy is equal to the marginal external benefit at the optimal quantity:

$$0.5 (Q^*) = 0.5 * 200 = \$100$$

c. What are the net social benefits (net welfare gains or net efficiency gains) of the subsidy program? Show the area on a graph and calculate the number.

The net social benefits are the sum of the distances between the MSB and the MSC between Q_{market} and Q^* .

Solve for Q_{market} :

$$300 - Q = Q$$

Q market = 150.

The integral of $((300 - .5Q) - Q)$ between 150 and 200 gives us the answer (or calculate the area of the triangle...see me for the graph).

The area is \$1875.

2. (14 points) Consider the problem of the efficient control of garbage. Toxic chemicals from garbage can leach into the soil and contaminate ground water. An alternative to garbage is recycling, which involves a cost (you may assume that garbage has no private cost).

Start with a model of an economy with n identical consumers. The representative consumer buys goods (c) that have garbage as a byproduct, recycling services (r), and all other goods (x). Aggregate garbage waste (G) negatively affects utility. Garbage per unit of goods (GPC) is a function of recycling, where $(GPC(r))$ decreases as recycling increases. The representative consumer's utility can be represented:

$$U = U(c, r, x, G)$$

a. Set up and derive the first-order conditions of the social planner's problem. The first step you should take is to mathematically define aggregate garbage G .

4. a. Social Planner's Problem

$$\mathcal{L} = \max_{c, r, x, \delta} U(c, r, x, n \cdot GPC(r)) + \delta [Y - P_c c - P_r r - x]$$

Assume $P_x = 1$

$$\frac{\partial \mathcal{L}}{\partial c} = \frac{\partial U}{\partial c} + \frac{\partial U}{\partial G} n \cdot GPC(r) - \delta P_c = 0$$

$$\frac{\partial \mathcal{L}}{\partial r} = \frac{\partial U}{\partial r} + \frac{\partial U}{\partial G} n c \frac{dGPC(r)}{dr} - \delta P_r = 0$$

$$\frac{\partial \mathcal{L}}{\partial x} = \frac{\partial U}{\partial x} - \delta = 0$$

$$\frac{\partial \mathcal{L}}{\partial \delta} = Y - P_c c - P_r r - x = 0$$

b. Now, set up and solve the household problem. Be sure to include taxes (or subsidies) on c , recycling, and garbage (G) in the household's budget constraint.

b. Household problem

$$Z = \max_{c, r, x, \lambda} U(c, r, x, G) + \lambda [Y - (p_c + t_c)c - (p_r + t_r)r - (1 + t_x)x - t_g c G P_L(r)]$$

$$\frac{\partial Z}{\partial c} = \frac{\partial U}{\partial c} - \lambda (p_c + t_c) - \lambda t_g G P_L(r) = 0$$

$$\frac{\partial Z}{\partial r} = \frac{\partial U}{\partial r} - \lambda (p_r + t_r) - \lambda t_g c \frac{\partial G P_L(r)}{\partial r} = 0$$

$$\frac{\partial Z}{\partial x} = \frac{\partial U}{\partial x} - \lambda (1 + t_x) = 0$$

c. Solve for the optimal tax on garbage, and show that this tax alone induces consumers to make all the right choices.

④ c. to solve for t_G , set all other taxes = to zero.

Use FOC for c :

$$\overset{SP}{\frac{dU}{dc} + \frac{dU}{dG} n(GP(c,r)) - \delta p_c} = \overset{HH}{\frac{dU}{dc} - \lambda p_c - \lambda t_c - \lambda t_G GP(c,r)}$$

This = 0 ($t_c = 0$)

↑ From the FOC for x , $\delta = \lambda$
So we can cancel

$$\frac{dU}{dG} n(GP(c,r)) = -\lambda t_G GP(c,r)$$

$$t_G = \frac{-\frac{dU}{dG} n}{\lambda} \quad \left(\text{which is } \left(\frac{-U_G n}{\lambda} \right) \right)$$

Show that $t_G = \frac{-\frac{dU}{dG} n}{\lambda}$ makes HH FOC

for r match Social Planner's FOC :

$$\overset{SP}{\frac{dU}{dr} + \frac{dU}{dG} n(GP(c,r)) \frac{dGP(c,r)}{dr} - \delta p_r} = \overset{HH}{\frac{dU}{dr} - \lambda p_r - \lambda \left[\frac{-U_G n}{\lambda} \left(\frac{dGP(c,r)}{dr} \right) \right]}$$

λ 's cancel,
two negatives make a positive, $\frac{dU}{dG} = U_G$

So these FOC match when $t_G = \frac{-U_G n}{\lambda}$

d. A direct tax on garbage is likely to lead to illegal dumping. Solve the model for the optimal tax or subsidy on goods, c , and on recycling, r . State whether each policy is a tax or a subsidy and explain the meaning of each part of your equations.

(4d). Solve for t_c and t_r when $t_g = t_x = 0$

FOC for c:

$$\overset{SP}{\frac{\partial \psi}{\partial c}} + \frac{\partial \psi}{\partial G} n GPC(r) - \cancel{\delta p_c} = \overset{HH}{\frac{\partial \psi}{\partial c}} - \cancel{\lambda p_c} - \lambda t_c$$

$$\frac{\partial \psi}{\partial G} n GPC(r) = -\lambda t_c$$

$$t_c = \frac{-\frac{\partial \psi}{\partial G} n GPC(r)}{\lambda}$$

This is positive because $\frac{\partial \psi}{\partial G}$ is negative.

$$= \frac{-U_G n GPC(r)}{\lambda}$$

FOC for r:

$$\overset{SP}{\frac{\partial \psi}{\partial r}} + \frac{\partial \psi}{\partial G} n c \frac{\partial GPC(r)}{\partial r} - \cancel{\delta p_r} = \overset{HH}{\frac{\partial \psi}{\partial r}} - \cancel{\lambda p_r} - \lambda t_r$$

$$t_r = \frac{-\frac{\partial \psi}{\partial G} n c \frac{\partial GPC(r)}{\partial r}}{\lambda}$$

$$\frac{\partial \psi}{\partial G} < 0, \frac{\partial GPC(r)}{\partial r} < 0$$

So this is negative (a subsidy)

$$= \frac{-U_G n c GPC_r}{\lambda}$$

3. (8 points) Education:

- Under what conditions might education be considered a pure public good? Are these conditions likely to hold? That is, how should economists best model the market for education?
- What are the primary justifications for government involvement in the provision of education? Explain.

c. Use Table 6 in Hanushek's article to describe what is known about the effect of teacher education, experience, and salary on student performance. Be sure to use statistics in your answer.

d. On what grounds have the literature's results on the effectiveness of school resources been challenged?

Discussed in class. See me for clarification.

4. (8 points) *Card and Krueger article:*

a. What are Card and Krueger's three main hypotheses? What motivates their choice of these hypotheses? That is, why did they formulate and test them, versus testing other hypotheses? What debate does their paper inform?

b. Consider the regression results in Table 4. Which coefficients relate directly to Card and Krueger's three main hypotheses? Interpret the meaning of these coefficients—what is the numerical meaning of each of the most important coefficients? And are they statistically significant? How robust are these estimates across regression specifications? What do their regression results imply about the validity of these hypotheses?

c. What does Hanushek say about Card and Krueger's results?

Discussed in class. See me for clarification, particularly with respect to the interpretation of coefficients.

5. (8 points) *Lamm West article:*

a. What hypotheses is West testing in her paper?

West hypothesizes that:

1. Pay for performance initiatives will affect student test scores
2. Decentralized decisionmaking, wherein teachers have substantial say over curricular content and implementation, will enhance (complement) pay-for-performance programs.
3. Evaluations, and the type of evaluations, will enhance P4P.

b. Which coefficients in the specification equations on page 26 provide evidence with regard to the hypotheses West is testing? What do we conclude if the signs are negative? If they are positive?

The coefficients on the interaction terms in specification B tell us whether decentralized decisionmaking and evaluations are complements to P4P. If these coefficients are positive, then decentralized decisionmaking and evaluations are complements to P4P, and enhance the effects of P4P on test scores. A negative coefficient would indicate that the programs' effects counter those of P4P.

c. Describe the role that each of West's control variables plays in her estimation, paying particular attention to her fixed effects. How is her model identified? What does this mean? Provide concrete examples in your explanation.

See page 28 of the paper. Notably, To guard against this, she includes "school-

grade-year student demographics w_{sgt} to control for time-varying observable differences, and school-grade fixed effects to control for time-invariant unobservable differences. The model is identified from within-school-grade, across-time variation. Fixed effects for each year-grade are also included. These terms identify counter-factual year effects for each grade. This is a generalization of difference-in-difference analysis that relies on differences in the timing of adoption across districts to separate time effects from program effects.

So what she is saying is that she isolates the effects of the policy changes by examining how a grade within one school changes over time in response to the program implementation. So how do second graders at Randolph Heights elementary perform after the program versus before the program.

d. What does West conclude?

See pages 29 and 30 for interpretation of West's results.