Assignment #2 for **Environmental and Resource Economics**
Economics 359M, Spring 2018

Due date: Wednesday, February 28, 2018

Readings: Chapters 3-6 in

Kolstad. *Environmental Economics, 2'nd ed.* OUP.

E. Ostrom, J. Burger, C. B. Field, R. B. Norgaard, and D. Policansky. Revisiting the commons: local lessons, global challenges. *Science*, 284(5412):278–282, 1999.

Abstract, Intro, and Section 1 (pp. 1-10) of

A. Aizer, J. Currie, P. Simon, and P. Vivier. Do low levels of blood lead reduce children's future test scores? *American Economic Journal: Applied Economics*, 10(1):307–41, 2018.

Social Choice

A. Kolstad, Ch. 3, problem 1.
B. Kolstad, Ch. 3, problem 3.
C. Kolstad, Ch. 3, problems 8 and 9.

Efficiency

D. The aggregate endowment of good 1 is 12, the aggregate endowment of good 2 is 10. There are two consumers, a and b. For each of the following utility function and allocations, determine whether or not it is Pareto optimal. If it is not Pareto optimal, give the set of allocations that Pareto improve on it. If it is Pareto optimal, give prices which, if faced by the two consumers, would leave them no incentive to move away from the allocation.
  1. The utility functions are $u_a(x_1, x_2) = \log(x_1) + 2\log(x_2)$, $u_b(x_1, x_2) = 2\log(x_1) + \log(x_2)$, and the allocation is $(6, 5)$ for both consumers.
  2. The utility functions are $u_a(x_1, x_2) = \log(x_1) + 2\log(x_2)$, $u_b(x_1, x_2) = 2\log(x_1) + \log(x_2)$, and the allocation is $(12, 10)$ for consumer a and $(0, 0)$ for consumer b.
  3. The utility functions are $u_a(x_1, x_2) = \log(x_1) + x_2$, $u_b(x_1, x_2) = \log(x_1) + \log(x_2)$, and the allocation is $(6, 9)$ for consumer a and $(6, 1)$ for consumer b.
  4. The utility functions are $u_a(x_1, x_2) = \log(x_1) + x_2$, $u_b(x_1, x_2) = \log(x_1) + \log(x_2)$, and the allocation is $(3, 7)$ for consumer a and $(9, 3)$ for consumer b.

E. Kolstad, Ch. 4, problem 1.
F. Kolstad, Ch. 4, problems 4 and 5.
G. A society consisting of individuals a and b has 100 units of a consumption good. If it sacrifices s of the consumption good, it can produce $y = 10\sqrt{s}$ of a public good. The utility functions are $u_a(x, y) = \log(x) + \log(y)$ and $u_b(x, y) = \log(x) + 2\log(y)$.
  1. Solve the problem $\max_{x,y} u_a(x, y)$ subject to $y \leq \sqrt{100 - x}$. This gives person a's choice if they are the only person in the economy.
  2. Solve the problem $\max_{x,y} u_b(x, y)$ subject to $y \leq \sqrt{100 - x}$. This gives person b's choice if they are the only person in the economy.
  3. For $\theta > 0$ being the weight on person a solve for $x_a^*(\theta)$, $x_b^*(\theta)$, and $y^*(\theta)$ in the problem

$$V(\theta) = \max_{x_a, x_b} [\theta u_a(x_a, y) + u_b(x_b, y)] \text{ s.t. } y \leq \sqrt{100 - (x_a + x_b)}.$$

4. For θ very large, show that $x_a^*(\theta)$ and $y^*(\theta)$ is very close to the a's choice if they are the only person in the economy.
5. For θ very small, show that $x_b^*(\theta)$ and $y^*(\theta)$ is very close to the b's choice if they are the only person in the economy.

Public Goods/Bads

H. Kolstad Ch. 5, problem 1.

I. Kolstad Ch. 5, problem 6.

J. There are two routes into the business district, a Bridge and a Tunnel. There are 400,000 people who make the daily commute, there is no car-pooling. The time it takes to commute by the Bridge is $30 + \frac{n_B}{20{,}000}$ minutes if n_B people use the Bridge, the corresponding figure for the Tunnel is $40 + \frac{n_T}{5{,}000}$.
   1. Suppose that each of the 400,000 people chooses so as to minimize their time commuting. This means that, in equilibrium, the commute times are equal. What are the equilibrium n_B and n_T? And what is the equilibrium total commute time in people-hours?
   2. Give the n_B and n_T that minimize the total commute time. Valuing a person-hour at \$6 (that is, \$1 for every 10 minutes), what is the daily value of the equilibrium inefficiency?
   3. Except for congestion, there is a 0 marginal cost to having commuters on either route. Suppose that 10 minutes of commute time is worth \$1 to a commuter. Find tolls t_B and t_T for the Bridge and Tunnel, one of them equal to 0, that have the property that equilibrium for the commuters is the one that minimizes total commute time. What revenues are generated?
   4. Suppose that 1/4 of the commuters car pool with 2 people in each car (so that there are 350,000 cars per day). Recalculate the minimal possible total commute time and the value of the potential savings.

K. (A common pool resource) There are I different organizations, countries or firms, that can put out fishing fleets to catch from schools of fish. Use the number $a_i \geq 0$ to represent the number of fishing boats in the fleet of organization i, $i = 1, \ldots, I$ and let $a = \sum_i a_i$ denote the total size of the fishing fleet. The marginal cost of a boat is constant, and equal to c, the **per boat** return is $R(a) = 100{,}000 - \frac{1}{10}\sqrt{a}$.
   1. Verify that $R'(a) < 0$ and $R''(a) < 0$ for $a > 0$.
   2. Let $V(c) = \max_a [aR(a) - c \cdot a]$. Before you do any work, why should you expect that $a^*(c)$ is decreasing in c? Give the FOCs, give $a^*(c)$, and give $V(c)$.
   3. Now suppose that $I = 2$ and that the two countries choose a_1 and a_2 to solve
   $$\max_{a_1} \; a_1 R(a_1 + a_2) - c \cdot a_1 \text{ and}$$
   $$\max_{a_2} \; a_2 R(a_1 + a_2) - c \cdot a_2.$$
   Give the FOCs for the equilibrium, $a_1^e(c)$ and $a_2^e(c)$. Show that $a^e(c) = a_1^e(c) + a_2^e(c)$ cannot solve the FOCs from the previous problem. Give, as a percentage, the efficiency losses when $c = 10{,}000$.
   4. Repeat the previous for I being any integer ≥ 2.

L. Referring to the previous problem, Oström *et al.* describe a solution when the fish in question are north Pacific halibut. The solution involved changing the open access rules into another one of the four property-rights systems used to regulate CPRs. Which one? Explain.

If the fish in question are near the bottom of the food chain, in what way are the efficiency calculations in the previous problem mis-leading? Which part of the arguments in Oström *et al.* does this relate to? Does this necessarily depend on where the fish are in the food chain? Explain.

M. One part of the Oström *et al.* article describes how the introduction of modern and technologically superior irrigation systems can reduce agricultural productivity. To what forces do the authors attribute this outcome?

Discounting and Decisions

N. Kolstad Ch. 6, problem 1.

O. Kolstad Ch. 6, problem 2.

P. The production function turning today's investment, which is foregone consumption today, s_0, into consumption tomorrow is $c_1 = 10\sqrt{s_0}$. You have x_0 available to consume today, $c_0 \leq x_0$. The remainder, $s_0 = x_0 - c_0$, is invested and turned into consumption tomorrow. The utility function is $u(c_0) + \beta u(c_1)$ where $u(c) = 3\log(c+1)$. Let $V(x_0) = \max_{0 \leq s_0 \leq x_0} [u(c_0) + \beta u(c_1)]$ subject to $c_1 \leq 10\sqrt{s_0}$.
1. Verify that the production function and the utility function are increasing (have positive first derivative) and concave (have negative second derivative).
2. Without doing any FOC calculations, how do savings/investment, s_0, depend on β? Explain.
3. Without doing any FOC calculations, how do savings/investment, s_0, depend on x_0? Explain.
4. Without doing any FOC calculations, how does $V(\cdot)$ depend on x_0? Explain.
5. Give the FOCs for $V(x_0)$ and solve them for $s_0^*(\beta, x_0)$.

Q. From investigative journalist Kevin Drum (of *Mother Jones*), we have the following summary of the connection between crime levels and lead exposure.

> In a nutshell, this article argues that atmospheric lead from gasoline tailpipes rose steadily after World War II, affecting babies born in the late 40s and beyond. The leading edge of this generation became teenagers in the late 60s and was more prone than previous generations to committing violent crime. Every year the population of teenagers with lead poisoning increased, and violent crime increased with it. This is why the 70s and 80s were eras in which crime skyrocketed.
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> In the early 70s the United States began to phase out leaded gasoline and newborns became steadily less lead poisoned. Like clockwork, as the leading edge of this generation became teenagers in the early 90s, the crime wave started to recede. By 2010, an entire generation of teenagers and young adultsthe age group responsible for most crimehad grown up nearly lead free, and the violent crime rate had plummeted to half or less of its high point. This happened across the board: in big and small cities; among blacks and whites; in every state; in every city; and, as it turns out, in every other country that also phased out leaded gasoline.

The abstract of Aizer, Jurrie, Siman and Vivier's "Do Low Levels of Blood Lead Reduce Childrens Future Test Scores?" (*AEJ: Applied Economics*, 2018, 10(1): 1-36) reads

> We construct a unique individual-level dataset linking preschool blood lead levels with third grade test scores for Rhode Island children born 19972005. Using two identification strategies, we show for the first time

that reductions of lead from even historically low levels have significant positive effects. A one-unit decrease in average blood lead levels reduces the probability of being substantially below proficient in reading (math) by 0.96 (0.79) percentage points on a baseline of 12 (16) percent. Since disadvantaged children have greater exposure to lead, lead poisoning may be one of the causes of continuing disparities in test scores.

In the EPA's evaluation of the benefits of lead reduction, the societal cost of the crime wave and the continuing income-based disparities in educational outcomes were not counted. This question concerns three issues. First, what changes in EPA standards are the best response to including these costs? Second, how do different discount rates affect the measured benefits? And third, how does discounting change the optimal standards?

1. Reduction, R, in average exposure to lead has an estimated societal cost $C(R)$ and an estimated benefit $B(R)$. The solution to the problem $\max_{R\geq 0}[B(R) - C(R)]$ is denoted R°. A new benefit, $B_n(R)$ is discovered. Let $R^\dagger$ denote the solution to $\max_{R\geq 0}[(B(R)+B_n(R))-C(R)]$. Under what conditions is $R^\dagger > R^\circ$? Explain your answer economically and mathematically.
2. Current state by state life expectancies in the US range from 72 years to 80 years, and the average is 75. Suppose that the average lifetime benefits to an individual of a reduction R in lead exposure are given by the inflation-adjusted numbers $Ben(t)$, $t = 0, 1, \ldots, 75$. Corresponding to a discount factor β, $0 < \beta < 1$, we have an interest rate $r = \frac{1-\beta}{\beta}$ and present discounted value $PDV = \sum_{t=0}^{75} \beta^t \cdot Ben(t)$. Supposing that $Ben(t) = \$2,000$ for $t = 0, 1, \ldots, 24$ and $Ben(t) = \$7,000$ for $t = 25, 26, \ldots, 75$. This means that the total, undiscounted benefits to the individual are $S = (25 \cdot 2,000) + (51 \cdot 7,000) = \$407,000$.
   Fill in the values for the following table.

β	r	PDV	PDV/S
0.99			
0.98			
0.97			
0.95			
0.90			
0.80			

3. Let us return to the problem $\max_{R\geq 0}[(B(R) + B_n(R)) - C(R)]$, but suppose now that costs, $C(R)$, are incurred up front while benefits accrue later, hence must be discounted. To capture this, we replace $B(R)$ by $B(R;\beta)$ and $B_n(R)$ by $B_n(R;\beta)$. How does the solution to

$$\max_{R\geq 0}[(B(R;\beta) + B_n(R;\beta)) - C(R)]$$

   depend on β? Explain your answer economically and mathematically.