Economics 3250 Dr. Lozada
Spring 2016 Final Exam

This exam has 50 points. There are ten questions on the exam, each worth 5 points.

Put your answers to the exam in a blue book or on blank sheets of paper.

Answer the questions using as much precision and detail as the time allows. Correct answers which are unsupported by explanations will not be awarded points.

**Answer all of the following ten questions.**

1. **[5 points]** Read the following excerpt of a recent news article:[1]

> Caracas (Agence France-Presse, Feb. 17, 2016)—Venezuela's President Nicolas Maduro ramped up gasoline prices for the first time in two decades, from $0.01 to $0.60 per liter, and devalued the bolivar currency in a bid to salvage the economy from crisis.
>
> The oil giant's socialist leader said the pump price of premium gasoline would jump from just under 0.1 bolivars per liter to six bolivars—an increase of roughly 6,000 percent from the current super-low level.
>
> Under the new exchange rate gasoline will cost the equivalent of $0.60 per liter [$2.27 per gallon]...
>
> Venezuela has the biggest known oil reserves in the world....

   What relevance does this article have to our class discussion on "government failure?" What environmental effects do you think the previous policy had?

2. **[5 points]** It has often been observed that "willingness to pay" is less than "willingness to accept." What problems could this cause for cost-benefit analysis? Provide an example using numbers.

3. **[5 points]** Draw a graph to help explain your answer to the following question:

   > Is the following statement true or false: "if a pollution tax is imposed on firms, they will just pass the tax on to their consumers."

4. **[5 points]** Tell me everything you know about the "Precautionary Principle."

5. **[5 points]** In the chapter on the fishery, the textbook compares "biological rate of growth plus growth in capital value" to the "discount rate." In class, we modified this slightly, comparing

   "biological rate of growth" + "% change in fish price"

[1] http://news.yahoo.com/venezuela-announces-first-gasoline-hike-20-years-224043881.html

to the discount rate. Explain everything you know about this relationship: for example, is it a relationship of equality or inequality? What type of fishery (what type of market structure) does it pertain to? Why is the discount rate important—and, more generally, what is the intuition for the result?

6. **[5 points]** The "Institute for Lifecycle Environmental Assessment" wrote[2]

> With packaging contributing 50% to municipal solid waste by volume, determining the amount of energy and environmental impacts for packaging is important. Tellus Institute assessed plastic, paper, glass, aluminum, and steel.[3] Each packaging type was measured by environmental impact of production and the environmental impact of disposal.
>
> To measure the impact of each packaging material, Tellus used a monetary scale. Environmental impact costs were represented by the price society is willing to spend to prevent pollutants from entering the environment. These prices are not the actual price to sustain our environment, but they are useful for comparison.
>
> For each material, Tellus included all direct energy use and controlled emissions. They also included all indirect energy and controlled emissions within a one step range. As an example, the electricity used in production was included, as was the coal to produce the electricity. However, the resources used to mine and process coal were excluded as they are outside of the one step range.

They concluded:[4]

> What causes less harm to the environment: six aluminum cans of soda or one plastic jug? [. . . ]
>
> Six [aluminum] cans hold about the same amount as a 2 liter [plastic] jug. According to the Aluminum Association, pop cans are made from 42% post-consumer product. At this level the environmental impact of six [aluminum] cans is 1.2 cents. When made from 100% recycled aluminum, the impact is 0.30 cents.
>
> The environmental impact of one 2 liter [plastic] jug is much less dependent on recycling rate, and is about 0.12 cents. [. . . ]

[2] `http://iere.org/ILEA/lcas/Tellus.html`

[3] Tellus Institute, "Tellus Packaging Study." Boston: Tellus Institute of Resource and Environmental Strategies, 1992.

[4] `http://iere.org/ILEA/downloads/ILEAsodabottles.pdf`

> For the jug, ILEA believes recycling may slightly increase its impact [because] plastics take up a lot of volume per weight, [and] while garbage trucks compact [(crush)] their load, recycling trucks don't [(because their loads have to be taken apart and sorted)], resulting in [recycling trucks generating] more fuel use and pollution [than garbage trucks].
> Though recycling [aluminum] cans reduces their impact substantially, even compared to [...] 100% recycled cans, a plastic jug is still best.

After reading these passages, answer the following questions:

(a) What techniques that you learned about this semester were probably involved in this study?
(b) What kinds of environmental or resource-depletion impacts were clearly taken into account in this analysis? (This is an easy question to answer.)
(c) What kinds of environmental or resource-depletion impacts may have been missed in this analysis?

7. **[5 points]** If Arctic permafrost melts, it releases methane. How could this constitute a "tipping point"? A tipping point of what? How? What is a tipping point anyway?

8. **[5 points]** In class, we studied an equation of the form $\Delta S = H/T$. What does the equation (and each term in it) mean, and what is its relevance to this class?

9. **[5 points]** If the rate of human population growth is judged to be too high, name (and explain) an economic policy instrument which could decrease that rate (at least somewhat). State the advantages or disadvantages of such a policy compared to a command-and-control policy, such as the one-child policy (now, a two-child policy) of the People's Republic of China.

10. **[5 points]** Briefly discuss how each of the following economists' ideas have influenced environmental and natural resource economics:

(a) Thomas Robert Malthus (late 1700's, early 1800's)
(b) David Ricardo (late 1700's, early 1800's)
(c) A.C. Pigou (around 1920)
(d) Harold Hotelling (1931).

Answers to Econ. 3250 Final Exam,
Spring 2016

(1)

"Government failure" refers to the observation that governments sometimes do not act in a way that is socially optimal concerning the environment. This could be because of unwillingness or because of inability. In the case of gasoline subsidies, the government's good intentions — to reduce income inequality, or to alleviate poverty, or to distribute the fruits of Venezuela's oil wealth widely — or just to do something which would be politically popular — had the bad environmental consequence of encouraging fossil fuel use. This could lead to over-exploitation of oil (that is, too-rapid extraction) and an increase in air pollution, including greenhouse-gas emissions.

(2)

"Willingness to pay" ("WTP") is typically less than "willingness to accept" ("WTA").

↘ WTP for a proposed policy that would improve a person's welfare

↗ WTA compensation (monetary compensation, or compensation with some other good) for a proposed policy that would worsen a person's welfare

Suppose the cost of a project is $C$ and suppose that

$$WTP < C < WTA .$$

If the project's benefit is measured by WTP, then $WTP < C$ ⇒ cost exceeds benefit and the project should not be adopted.

" " WTA, then $C < WTA$ ⇒ cost falls short of benefit and the project should be adopted.

Since WTP and WTA are equally valid ways of measuring the value of a project, if $WTP < C < WTA$, there is no way to decide whether society should undertake the project or not.

| | "pro" People the project would benefit | "con" People the project would harm | Decision Rule |
|---|---|---|---|
| If the project is done | $WTP_p$ | $WTA_C$ | Do the project if $WTP_p + WTA_C > C$ (I) |
| If the project is not done | $WTA_p$ | $WTP_C$ | Don't do the project if $WTA_p + WTP_C < C$ (II) |

"C" = cost of project

If $WTP_p = WTA_p$ and $WTA_C = WTP_C$ (so "WTP = WTA"), then

$WTP_p + WTA_C$ (=, =) $WTA_p + WTP_C$ — these would be the same. Call that number "WTP + WTA". Then

"WTP + WTA" is either $> C$ → do the project

or it is $< C$. → don't do the project

So society could always decide.

However, since

$WTP_p + WTA_C$ ($\wedge$, $\vee$) $WTA_p + WTP_C$ — these will in general be different. In this case, it's possible for both (I) and (II) above to be true, and also possible for both (I) and (II) above to be false.

example: $WTP_p = \frac{1}{4}$ ($\wedge$) $WTA_p = 2$; $WTA_C = \frac{1}{2}$ ($\vee$) $WTP_C = \frac{1}{4}$; $C = 1$

(I) $\frac{1}{4} + \frac{1}{2} > 1$ false ⇒ don't do the project

(II) $2 + \frac{1}{4} < 1$ false ⇒ do the project

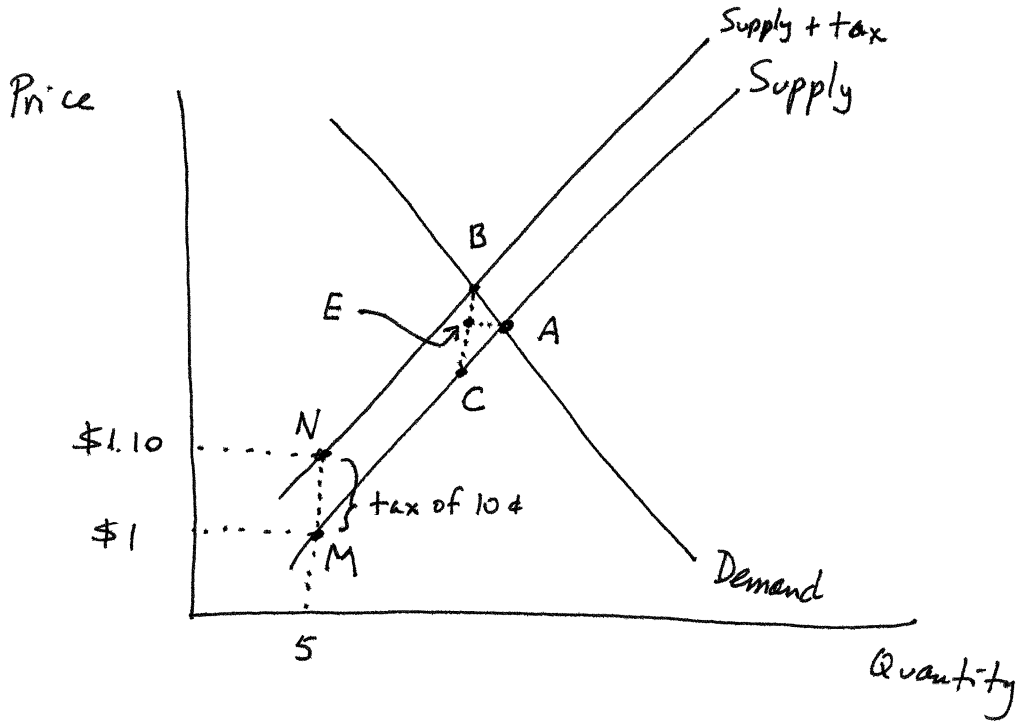
example: $WTP_p = \frac{1}{4}$ ($\wedge$) $WTA_p = 2$; $WTA_C = 2$ ($\vee$) $WTP_C = \frac{1}{4}$; $C = 1$

(I) Do the project if $\frac{1}{4} + 2 > 1$ ⇒ do the project

(II) Don't do the project if $\frac{1}{2} + \frac{1}{4} < 1$ ⇒ don't do the project

In both these examples, society cannot decide what to do.

③




Suppose that before the tax is imposed on the firms, in order to get them to supply 5 units, they need to be paid $1/unit. Then if a 10¢/unit tax is imposed, they'll now demand $1.10/unit to produce 5 units. Hence "M" was on the old supply curve and "N" is on the new supply curve.

The pre-tax equilibrium is at A. The post-tax equilibrium is at B. So the tax causes price to go up by EB. But EB < BC = NM = 10¢. So of the 10¢ in taxes (BC), part is paid by consumers in the form of a higher price (EB) and the rest (EC) is paid by the firm.

The above is true for any tax imposed on the firms; a pollution tax would be one example.

Answer to Question 4.

The "Precautionary Principle" is an alternative to the neoclassical approach of determining the socially-optimal level of an environmental amenity by a careful calculation of its costs and benefits. Proponents of using the Precautionary Principle point out that in many situations there is great uncertainty about the precise location of, for example, the "marginal external cost curve" and the "marginal net benefit curve." While a neoclassical economist would nevertheless use the likely position of those curves to make a social decision (taking the uncertainty into account as much as possible), the Precautionary Principle advocate recommends instead setting a level of environmental quality which will certainly be "safe"—such as the "safe minimum standard"—without regard to the commercial costs of such a level.

For an illustration of the differences in approach: suppose emitting "$x$" tons of pollution causes damages, but we are unsure what those damages are. They could be either $d_1$ or $d_2$ or $d_3$, with $d_1 < d_2 < d_3$. The neoclassical economist will believe that it is possible to assign probabilities to these different levels of damage—for example, that the damage will be $d_1$ with probability $p_1$, the damage will be $d_2$ with probability $p_2$, and the damage will be $d_3$ with probability $p_3$ (so "$p$" here stands for probability, not price). The neoclassical economist will then either calculate the damage caused by "$x$" tons of pollution as $p_1 d_1 + p_2 d_2 + p_3 d_3$, i.e., the "expected value" of damage, or as $p_1\, u(d_1) + p_2\, u(d_2) + p_3\, u(d_3)$, the "expected utility" of damage with utility function $u(d)$. Following the Precautionary Principle will instead simply assign to "$x$" tons of pollution the damage level $d_3$, the highest level of damage conceivable, without any assumption that the probability levels $d_1$, $d_2$, and $d_3$ actually exist, and without having to assume that the utility function $u(d)$ exists, let alone that it takes any particular form.

Answer to Question 5.

The relationship is

"biological rate of growth"+"% change in fish price" = discount rate .

It applies to a privately-owned fishery, that is, one with complete property rights (not to an open-access fishery).

The left-hand side represents the benefit to waiting for later to harvest a fish. First ("biological rate of growth"): if you wait for later to harvest a fish, it can have offspring, which you can harvest in addition to the parent fish. So waiting until later gets you more fish. Second ("% change in fish price"): if the fish price will be higher later, that is another incentive to wait until later to fish.

The right-hand side ("discount rate") represents the benefit to catching a fish now: you can sell it and put the money in a bank paying the "discount rate" in interest, so that next year your money will have grown by that rate.

If the left-hand side is greater than the right-hand side, it's better to wait to catch a fish rather than to catch it now. If the left-hand side is smaller than the right-hand side, it's better to catch the fish now rather than to wait. If the left-hand side is equal to the right-hand side, the owner is indifferent between catching now or catching later, and so will be happy to do both, which is what's typically observed (and which is what will typically result in equalizing market demand and supply now and in the future, though you do not have to know that).

Answer to Question 6.

(a) Certainly "valuation" techniques were used, in order to put dollar values on environmental impacts such as pollution. It's not clear from the passages what kind of valuation techniques (such as contingent valuation, the travel cost method, or hedonic pricing) were used.

(b) Pollution ("controlled emissions") is mentioned, as is direct and indirect energy use. Presumably the energy use causes not only pecuniary costs but also pollution. The "environmental impact of disposal" is also mentioned. In the concluding passage, the environmental costs of recycling are described, with distinctions made between the environmental impacts of garbage trucks as compared to recycling trucks.

(c) As the passage states, "the resources used to mine and process coal [to produce electricity] were excluded as they are outside of the one step range." Also, the analysis probably did not take into account the opportunity cost of mining coal (or aluminum or petroleum) now, which is that it then can't be mined later. (Optional: this is measured by the "scarcity value" of the exhaustible resource, which equals its marginal profit according to the Hotelling Rule.)

Answer to Question 7.

A cause (permafrost melting) has an effect (methane release). As of now, we can prevent the cause from happening (by taking steps to stop climate change). However, there may come a time when we cannot prevent the cause from happening, because the effect (methane release) causes global warming, which causes permafrost melting, which causes more methane release, in a "vicious cycle" (a "positive feedback loop"). This point is a "tipping point": a point beyond which a situation fundamentally changes, such as the permafrost-methane-release cycle becoming self-sustaining (self-perpetuating). This would cause runaway global warming, at least until some new, higher-temperature equilibrium was reached (say, when all the permafrost has melted).

Answer to Question 8.

The equation is the formula defining the change in entropy of a system, $\Delta S$, as being the heat flow into or out of the system ($H$) divided by the temperature of the system in Kelvin ($T$). While in the past the physical law (the Second Law of Thermodynamics) which says that the entropy of a closed system always increases (or is constant) was interpreted as implying that systems naturally move in a direction of increasing disorder or randomness, which would represent a direction of decreasing economic usefulness, that interpretation is probably wrong. The Second Law is very useful for engineers, and does mean that the Sun will not burn forever, but does not imply that the economy is in a sort of Malthusian struggle for survival amidst a flow of "entropic disorder" because the latter term's intuitive meaning is not scientifically appropriate in the context of thermodynamics.

Answer to Question 9.

Two policies suggest themselves: a tax on births, analogous to a pollution tax; and a birth license scheme, analogous to a cap-and-trade system. Both of these would allow some families to have a greater-than-average number of children as long as a corresponding number of families had a fewer-than-average number of children, thus allowing for diversity in a way impossible under command-and-control policies such as the PRC's. One possible disadvantage could be that the economic incentive instruments could be harder to monitor (to ensure compliance with); though it's not clear whether that would be the case or not.

Answer to Question 10.

(a) Malthus thought resource scarcity was very important, and that the size of the human population ought to be voluntarily limited before famine and disease limited it. His thoughts have inspired the modern "limits to growth" school of thought.

(b) Ricardo emphasized that agricultural land was not of fixed, limited size, but rather exists in various qualities, some high and some low, and that when the high-quality land is all being used, lower-quality land will still be available. Some non-Malthusians apply Ricardo's idea to exhaustible natural resources. They say those resources do not exist in a fixed, limited amount which will some day run out, but rather exist in many different qualities, and that as high-quality deposits run out, lower-quality deposits will remain available for exploitation.

(c) Pigou invented the idea of pollution taxes, or, in general, the idea of using taxes (or subsidies) to correct negative (or positive) externality market failures.

(d) Hotelling invented the Hotelling Rule for exhaustible resources (namely that marginal profit should rise at the rate of interest). (Optional: he also invented the Travel Cost Method.)