Econ 4545 Environmental Economics

Review Questions- Set 3

October 16, 2016

Non-Market Valuation: Travel-Cost, Contingent Valuation (CVM) and Choice Experiments

General questions about money measures of utility changes:

General questions about non-market valuation techniques:

Questions that are primarily travel-cost questions:

Questions that are primarily CVM questions:

Questions that are primarily hedonic questions:

Questions that are primarily about choice experiments

Other questions that I have either not yet filed into a category, or that would be difficult to put in one of the above categories.

General questions about money measures of utility changes:

1. Consider project A. Implementation of project A will make Wilbur worse off. Let EV be Wilbur's equivalent variation for the change.

In words, define, in terms of indifference, Wilbur's EV for the change. (5 points)

Answer: His EV for the project is how much would have to be added to his income in the initial state to make his utility in the initial state (with the addition) equal to his utility in the new state (with the project in place). Said in terms of indifference, his EV for the project is how much would have to be added to his income in the initial state to make him indifferent between the initial state (with the addition) and the new state (with the project in place).

Is Wilbur's EV positive or negative? (No explanation required.) (2 points)

Edward Morey   Review questions Non-market   Oct 16, 2016

Answer: negative.

Describe, in words, Wilbur's EV in terms of either WTP or WTA. (3 points)

Answer: Wilbur's EV is his WTP to not have Project A implemented.

Comments on answers: The question did not ask about the compensating variation. Saying that "Wilbur is worse off and needs to be compensated" is not a definition of the EV. It is a normative statement: neither the EV nor CV implies anything about what should happen. Simply saying that "the EV is the amount that income needs to be adjusted to achieve indifference" is not sufficient to define the EV; one need to indicate which income needs to be adjusted, income in the new state or income in the original state. Some people were inconsistent in the last part of the question. Consider the following two ways of limiting access to a concert. Tickets go to those who will pay the highest prices in terms of money versus giving the tickets away to those who are willing to stand in line the longest. Discuss who will and will not get to attend the concert with these two different allocation mechanisms.

2. Assume that Fred's demand curve for trips to a recreational site is

$$trips = \alpha - \beta(costs)$$

You have the following data. If cost were zero, Fred would take 20 trips, and if cost where $40 or greater, Fred would take no trips. Draw the graph of Fred's demand function with $ on the vertical axis and trips on the horizontal axis.

What are the values of α and β? How many trips will Fred take if the cost is $10/trip? What is Fred's willingness-to-pay to have the site available at a cost of $10 a trip?

Answer: The demand curve is a straight line that intersects the vertical axis at $40 and the horizontal axis at $20. , the intercept, α, is 20 and β is .5, so the slope is -.5. If the cost was $10, Fred would take 15 trips. Fred's WTP to have the site available at $10/trip is the area under the demand curve above $10. In this case it is $225 (($40-$10)x15/2 = 30x15/2).

Note that $150 is what 15 trips cost at $10/trip, it is not your WTP to have the site available at

$10/trip.

3. An environmental policy is being considered and it will make Wilbur worse off. Define in words Wilbur's compensating variation for this policy. Then tell the reader how his compensating variation for the policy relates to either his WTP or WTA for the policy.

Answer: His compensating variation is how much money would have to be subtracted from his income with the policy in place (in the new state) to make him indifferent between the policy with this amount subtracted from his income and his initial state (before the policy is enacted). Since the policy makes Wilbur worse off, his CV is a negative amount (one would have to add to his income in the state with the policy to make him indifferent between the two states: subtract a negative amount). The negative of his compensating variation, a positive amount, is his WTA for the policy: how much he would have to be paid to voluntarily accept the policy.

Additional thoughts: To get full credit you needed to define the CV, and define it not in terms of WTA. Consider the following answer, "If CV<0, CV is the minus of WTA and WTA is minus the CV." While that statement is correct, it does not tell the reader what the CV is or what WTA is. You need to say something that means the following, "His CV is the amount of money that needs to be subtracted from his income after the policy is in place to make him indifferent between the pre-policy state and the post-policy state with this subtraction." Note two things: the underlined words, and that the term WTA was not used to define the CV. Did you clearly indicate "subtracted" and did you make clear that the subtraction was in the new state and not in the original state.

These two things are what distinguish the CV from the EV. Recollect that the EV is the amount of money that must be added to your income in the original state to make you indifferent between the new state and the original state with this compensation added. If for example I had asked about the EV, rather than the CV, you would have said something like, "Wilbur's EV is the amount of money you would have to add to his income without the policy to make him

indifferent between a world with the policy and the no-policy world with this addition to income. Since, for Wilbur, this policy is a bad, his EV<0 and its absolute value is his WTP to remain without the policy. While both his CV and EV are negative numbers, they will typically not be the same number. It is possible to prove that for a deterioration EV<=CV<0.

To get full credit you also needed to clearly state that for Wilbur WTA = -CV>0

A number of people gave an unclear or incomplete definition of the CV. They said stuff that was often correct, but nothing that added up to a definition. For example saying his CV is negative is true, but just saying that does not tell the reader how to tell the difference between a CV and anything else that takes a negative value.

4. Convince me that WTP and WTA for a change in the level of a nonmarket commodity can significantly differ.
5. Imagine a world where nonuse values are not considered in environmental policy. Ignoring transportation costs, where would toxic waste sites be located in such a world?
6. What is the difference between a market commodity and a nonmarket commodity? As part of your answer define both terms. As part of your answer define commodity.

Answer: A commodity is a good, service, factor, or activity that, if consumed/experienced by an individual makes that individual either better off or worse off.

A market commodity is a commodity that the individual must purchase (or have purchased for him) to consume; that is, commodities that are bought and sold in the market place. The quantity consumed by an individual is chosen by the individual, subject to her constraints. For most market commodities, the price is exogenous. That is, the individual takes the price as given but, given his or her constraints, gets to choose how many units of the commodity to consume. Commodities we buy in stores are market commodities. So are flights to Paris, meals in restaurants, and ski passes.

A nonmarket commodity has the property that the quantity consumed/experienced is exogenous to the individual. That is, an individual has no control over the amount of the commodity available at a given point in time and space. Examples include the weather in Boulder, environmental quality in Boulder, the level of national defense, and the characteristics of the people one knows. Of course, one can leave town, but if one is in Boulder, for better or worse, everyone is subject to the weather. The marginal value (shadow price) that an individual gets from the exogenous quantity of a nonmarket commodity is a function of the individual's preferences, and will vary across individuals. For example, the marginal value of a war might be positive for some and negative for others.

7. What is consumer's surplus and why do we care about estimating the consumer's surplus associated with different policies. As part of your answer, provide some examples.

8. Assume that, in terms of transportation costs, the value of your time, and direct costs (lift ticket, etc.), it costs you $50/day to ski at Snerd Valley. Given this, you choose to ski there five times per year. Is your per year consumer's surplus from Snerd Valley at least $250? Yes or No and explain. What do we know about how you value these five trips? As part of your answer define *consumer's surplus*. Graphs might help you to explain things.

Answer: $250 is what you paid to ski the five times; it is not your consumer's surplus for having Snerd Valley available for $50 day; your consumer's surplus for this availability could be more or less than $250. Your consumer's surplus for having Snerd Valley available to you at $50 day is your maximum willing to pay for this availability above and beyond what you pay. Assuming you are rational you get at least $250 in total benefits from skiing five times at Snerd Valley; otherwise, you would not have paid the $250 to ski there five times. We also know that your benefit from the 5th day was $50: if it was something more or less, you would have chosen to ski more or less than five days.[1] In terms of your inverse demand function (WTP curve) for ski days at Snerd Valley, WTP for an extra day is $50 when days = 5. See the example inverse-demand functions below. In summary, we know that your total benefits are at least $250 and that your

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[1] A bit of qualification is required. If we assume you must buy ski days in integers, it might be the case that you value the 5th day more than $50 and your 6th day less than $50, causing you to stop at five days.

marginal benefit from the 5th trip is $50. What else do we know? Nothing. The three example inverse-demand functions are all consistent with choosing to ski five days when the cost is $50 a day.

$

cs

Inverse
demand
function

$50

cost

5   days

$

cs is the whole
area above $50

Inverse
demand
function

$50

cost

5   days
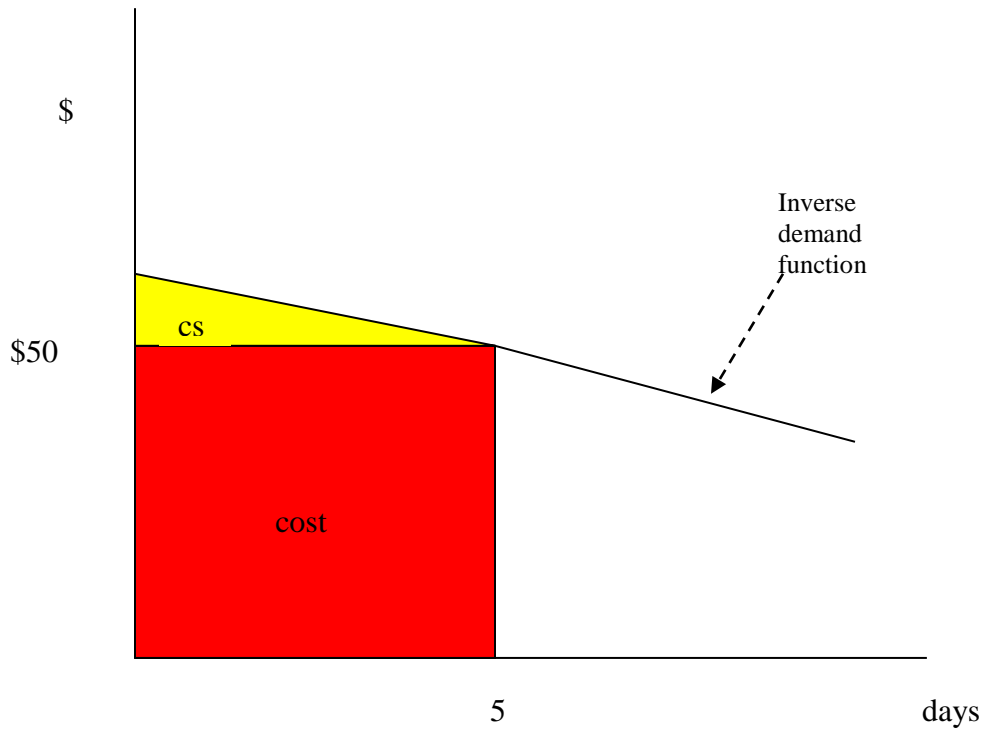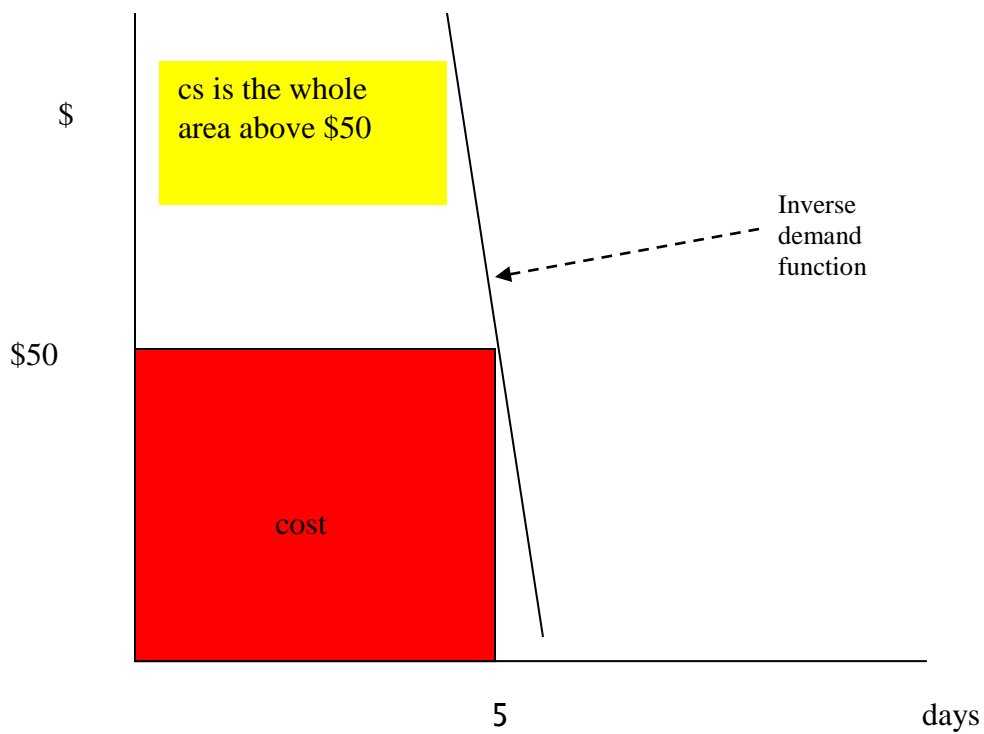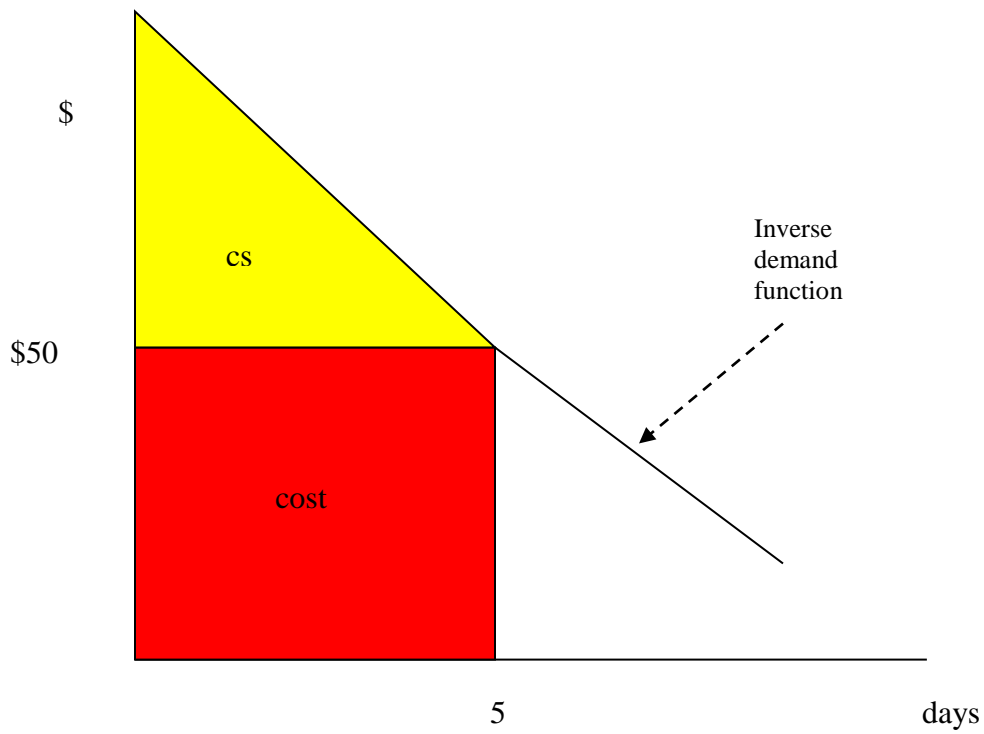
With the first inverse-demand function cs is small, in the second large, and in the third humongous.

9. Consider again your inverse demand function for skiing at Snerd Valley. Currently the cost to you of skiing Snerd Valley is $50 a day and you choose to ski there five days a year. If Snerd Valley raises lift-ticket prices by $10 a day how much worse off will you be? Or said another way, what is your WTP per year not to have the price raised by $10? Is it possible to determine your exact WTP given the information provided? Yes or No? If no, what can you determine from the information given? A graph or graphs might help you to explain things.

Answer: With just this information the researcher doesn't know your WTP to not have the price raised $10, but she does know that it is less that $50. How does she know this? How much worse off can you be due to the $10 price increase? If you continues to ski five times a year, you are worse off to the tune of $50 ($10 extra cost for the five days); but, this is only what you would do if your inverse-demand function for ski days was vertical. In this extreme case, your WTP is $50 to not have the price increase $10. However if your demand curve is downward sloping but less than vertical, the $10 price increase will cause you to ski fewer than five days and your damages will be less than $50. You minimize the impact on you of the price increase by skiing fewer times at Snerd Valley – maybe you went to Guber Valley instead, or spend more quality time with the boyfriend.
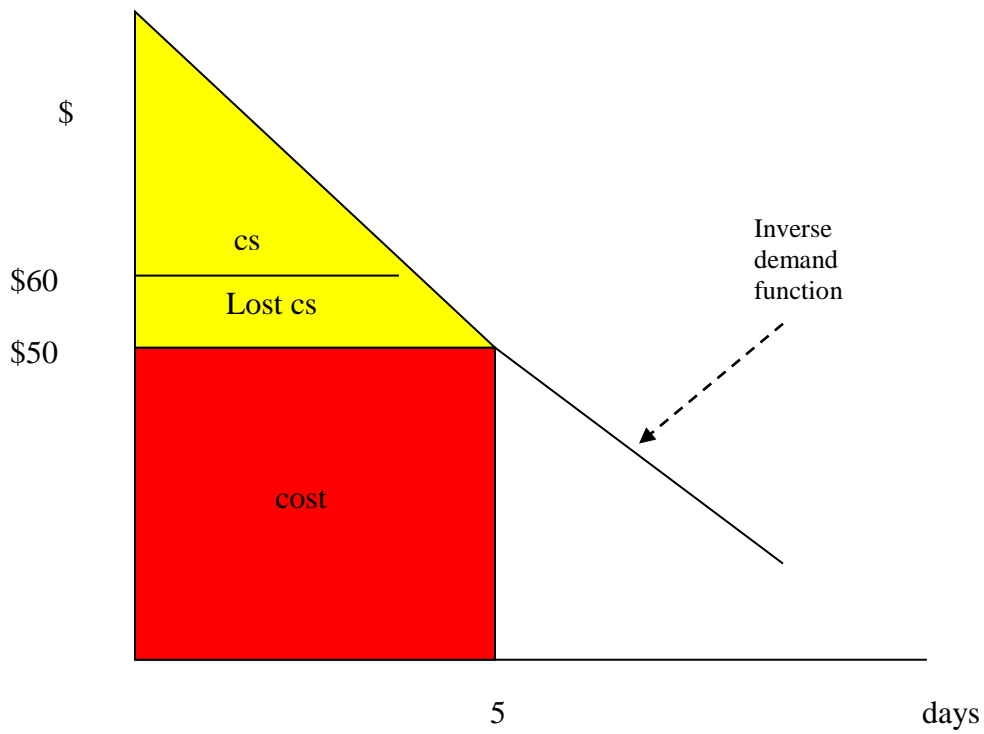
In the above example, the loss is less than $50. In the next example, with a vertical demand function, the loss is as large as it can be, $50.

$

cs

$60

Lost cs

$50

cost

Vertical
Inverse
demand
function

5   days
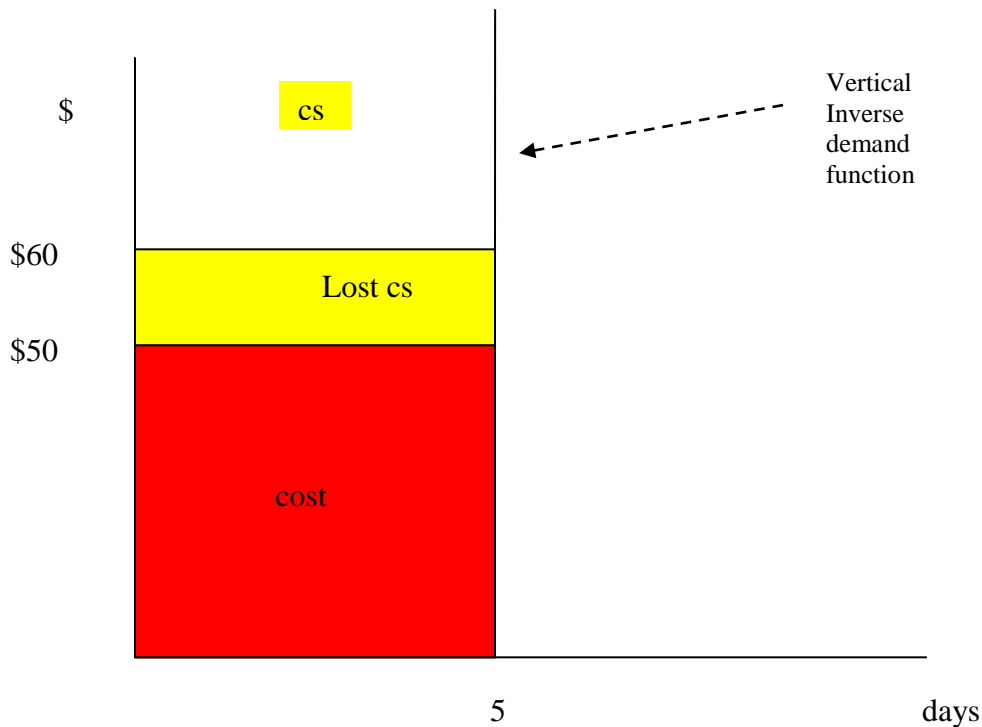
10. For a given policy, assume you know each individual's consumer's surplus, specifically
the compensating variations. How can you use this information to evaluate the policy in
terms of whether it is social welfare increasing? Whether the policy is a Pareto
improvement? And, whether the policy is a potential Pareto improvement? As part of
your answer, define consumer's surplus in general and compensating variation in
particular. Note that this question has 5parts.

- **Answer**: An individual's consumer's surplus associated with a policy that makes them better
off is their maximum willingness to pay to initiate the policy. If the policy makes them worse
off, it is how much that would have to be compensated (paid) to accept the policy, a WTA.
- More specifically, the compensating variation associated with a policy change is how much
money has to be subtracted from the individual's income in the new state to make him or her
indifferent between the original state and the new state with the subtraction. It is positive for
improvements and negative for deteriorations. For an improvement, CV is willingness to pay,

in the new state, for the new state. For a deterioration, the absolute value of the CV is what the individual would have to be paid, in the new state, to voluntarily accept being in it.

- In general, one cannot tell if a policy is social welfare increasing with just knowledge of each individual's consumer's surplus associated with the policy. The exception is if the consumer's surplus associated with the policy is positive for some individuals in society and negative for no individuals. In which case, the policy is social welfare increasing, and a Pareto improvement.[2] If a policy makes some member of society better off and some worse off, one needs to know how society wants to weight each individual in terms of their contribution to social welfare to determine whether the policy is social welfare improving. Just because a policy is efficiency increasing does mean it is necessarily welfare increasing from society's perspective.

- If the CV associated with the policy is positive for some members of society and negative for none, the policy is a Pareto improvement. If they are negative for some members of society, it is not a Pareto improvement. Consumer's surplus non-negative for each member of society is necessary but not sufficient for the policy to be a Pareto improvement. The necessary and sufficient condition is that it is positive for some and negative for none.

In general, a policy will make some individuals better off and some worse off. The CV for those made better off will be positive, and the CV for those made worse off will be negative. If the sum of the compensating variations over all members of society is positive, the policy is a potential Pareto improvement; that is, the gain to the gainers is greater than the loss to the losers, in $. In which case, there is the *potential*, through transfers or side payments, to achieve a Pareto improvement. Note that if these transfers actually take place such that after the policy is in place no one is worse off, then the policy is a Pareto improvement. Imagine a world where nonuse values are not considered in environmental policy.

11. Consider a state change which results from some policy. Assume the policy makes some

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[2] This statement is not quite correct. It is correct for social welfare functions that have the property that social welfare increases if some members of society are made better off and none are made worse off. That is, if the function assumes a P.I. is always welfare increasing. Most would impose this property on a SWF.

member of the society better off, and some worse off.

(a) Define, in words and notation, individual i's compensating variation, CVi, for a change from some initial state to some proposed state. (2 points)

(b) What can one determine if one knows everyone's CV for the change? (4 points) Explain your answer and make sure to define any terms you use.

(d) Assume you know the sum of the CVs. Can you determine whether the policy increases social welfare? Explain. (3 points)

Answer: (a) (2 pts))An individual's compensating variation associated with a change from some initial state to some new state is the amount of money that must be subtracted from her income in the new state to make her indifferent between the new state, with the amount subtracted, and the initial state. Said in terms of utility levels, it is the amount of money that must be subtracted from her income in the new state to make her utility in the new state, with the subtraction, equal to her utility in the initial state. If the individual prefers the new state to the initial state, her CV is positive and equal to her willingness to pay, WTP, in the new state to make the new state happen. If the individual prefers the initial state to the new state, her CV is negative and, in absolute terms, is how much she would have to be compensated in the new state to voluntarily accept the new state, her WTA

In functional notation defined as: $\{y^0_i, P^0, C^0\} \sim \{y^1_i - cv, P^1, C^1\}$

Note that $\{.\}$ is not a number, it is a vector of numbers. And $\sim$ means the individual is indifferent between the two vectors, not that the two vectors are equal/identical. Indifferent between the two states does not mean that everything is the same in both states.

(b) (4 pts)

First with knowledge of everyone's CV, one can determine whether the policy is a Pareto Improvement (makes some better off and no one worse off). This would require that none of the CVs are negative and that at least some are positive. The question assumed it was not a PI. With knowledge of everyone's CV, one can also determine whether the policy is a Potential Pareto Improvement (PPI); it will be a PPI if, and only if, the sum of the CVs is positive. PPI are called that because there is the potential for a Pareto Improvement (a change that makes some members of society better off and no members worse off). Note that the policy can be a PPI but not a PI.

That is, only if the sum of the CVs is positive is there the potential for the gainers to compensate the losers fully for their losses and not become losers themselves. In explanation, if the sum of the CVs is positive, the total WTP of the gainers to bring about the change is a larger amount of money than the losers would have to be compensated to be made whole, their total WTA. Remember, for those who like the policy, CV is positive and WTP, and for those who dislike the policy, the absolute value their CVs is their WTA the policy.

Give one point for saying one can determine if it is a PI and one point for explaining why. Give 1 pt for saying one can determine if it's a PPI and one point for explaining why.

(d) (3 pts) One cannot determine whether the policy increases social welfare solely on the basis of whether the sum of the CVs for the policy is positive or negative. One can only determine whether it is a PPI. To judge whether the total effect of a policy is good or bad from society's perspective, one needs to know who is helped and who is hurt by the policy, and how much society wants to weigh their respective welfares. Whether a policy increases or decreases social welfare depends on both efficiency and equity issues.

For example, if the sum is positive, one knows that the policy is a PPI. If, in addition, one knew that no one had a negative CV, one would know that the policy increases social welfare, but a

positive sum does not imply all of its elements are positive. Whether a PPI is social welfare increasing depends on how the benefits and costs are distributed and how society values the relative worth of the winners and losers. For example, a society that values rich people more highly than poor people might judge a policy that helps the poor and hurts the rich welfare decreasing, even though it is efficiency increasing (A PPI).

If in this same society, the sum of the CVs for a policy is negative (the policy is not efficiency increasing). But, society might still judge it welfare increasing.

12. What are *use values* and how do they differ from *nonuse values*? Why is the distinction important? As part of your answer define use value and nonuse value. Discuss some of the aspects and implications of including nonuse values in benefits/cost analysis for environmental policies.

Answer: Value is benefits; that is, the value of something to you is equal of the benefits you get (expect to get) from it. Economists often measure value in monetary units: for example, your willingness to pay in $ to save mountain gorillas.

Note that "cost" does not typically equal "value". Assume that you have HIV but that you can be cured with a $5 shot. The cost of the cure is $5, but the value of the cure is likely much greater than $5.

One can obtain nonuse value from an environmental commodity without undertaking any observable action.

To obtain use value from an environmental commodity, one must undertake some observable action.

For example, the benefits one receives from eating a pizza are use benefits, in that one could not

get those benefits without eating the pizza. In contrast, the benefits you get from day-dreaming about eating pizza are nonuse benefits. Note that one does not have to "consume" the commodity to get use value from it. For example, the benefits I get from viewing the Boulder Flatirons are use benefits because I have to be in proximity to them to see them, but my viewing them does not use them up. Environmental amenities often have use value, nonuse value, or both. For example the benefits I get from fishing a trout stream are use benefits, and the benefits I get from knowing that trout thrive in the rivers of Colorado are nonuse benefits.

Benefit-cost analysis should include both use and nonuse values. To do otherwise would possibly omit significant components of either the benefits or costs of a policy. However, there is a tendency to omit nonuse benefits and costs because they are more difficult to estimate. Use values can be estimated by observing behavior (trips, purchases, housing location, etc). Nonuse benefits cannot be estimated by observing behavior. An individual's nonuse value for an environmental policy can only be determined by surveying the individual about his or her preferences. This can be difficult.

If a policy will degrade an environmental amenity, loss of use value is limited to those who visit, or might visit. However, if an environmental amenity is degraded, anyone can experience loss of nonuse values, even if they have never been in proximity to the amenity, and never will be. Therefore, nonuse losses can be significantly higher than use losses. For this reason, polluters do not like the legal implications of nonuse values because they might be legally responsible for such losses if they degrade an environmental amenity, and such losses can be huge.

I learned recently that the State of Michigan passed a law saying that nonuse values can not be included damage claims for environmental injuries. (Apparently it was a compromise between keeping the law as it was (including both use and nonuse damages) and eliminating damage claims completely.)

Consider another review question that I asked.

Imagine a world where nonuse values are not considered in environmental policy. Ignoring transportation costs, where would toxic waste sites be located in such a world? They would be located in the most remote (and pristine) areas because this would minimize use losses.

13. Write a critical response to the Mobil Ad that appeared in *Time* that addresses the ad's discussion of nonuse values. Your audience is the readers of *Time*.

Answer: Mobil is close to saying that nonuse values do not exist, but don't quite say this. They do infer that the whole idea of nonuse values is silly.

We have defined nonuse values as value one can experience from a commodity/policy without taking any discernable action.

An important point is that there are different types of nonuse values. For example, I can get value from knowing that the bears are happy in the woods without going to the woods. This is an example I often use, but nonuse values can be the result of other types of thoughts/feelings. For example, option demand is a type of nonuse value. That is, I value the option of something being available so that in the future I will be able to use it if I want. For example, I do not ski very often at Monarch Ski Area but I value its existence because I want to have to option of skiing there. This is existence value for future use. The future potential use can either be by the individual, her kids, etc.

The example of nonuse value in the Mobil ad, the taxi example, is option demand. Those in Chicago are made worse off because a NY taxi is damaged and they will not have the option of using it if they go to NY. This in theory is legitimate nonuse damage but it is likely to be very small. There are 1000s of taxis in NY, so the loss of one will have not appreciable affect the availability on taxis on the streets of NY. A taxi example with larger damages would be one's wtp to have taxis available in NY.

The editorial gives a general definition of nonuse value but uses the taxi example as their follow-up "definition". Then correctly argue that value will be trivial for their example. The reader who didn't understand the concept before he read the article will be mislead. A lot of people have trouble with the distinction between an "example" and a "definition".

To demonstrate that nonuse values can be significant I might start with an example of the destruction of the World Trade Center towers. Most of us got little use value from them and most us likely had little in the way of option demand for future use. However, most of us were made significantly worse off by there destruction.

Consider an oil spill example. It would be difficult to argue that many of us have an option demand to visit the site in its pristine state. Do you yearn to fish in remote areas of Alaska? So, if option demand was the only type of nonuse value, the nonuse damages from the Exxon Valdez spill was small. However there are other ways one can be affected by a spill.

The second half of their editorial is tangential to the issue of nonuse values. They are criticizing surveys as a way to estimate nonuse values. This part of the argument has nothing to do with whether nonuse values can exist, only the method of measuring them if they exist. However, some would incorrectly conclude that if something cannot be accurately measured, it does not exist.

Note that nonuse value can be large or small. It will vary case by case.

The argument about wasting the money is an aside to make people mad. How compensation is distributed is an equity issue.

14. The society of Boulder consists on George, Fifi (George's toy poodle), and mountain lions. There is currently 1 mountain lion. Will Toor, the mayor, who is not a member of

society, is considering a policy that will increase the number of mountain lions from 1 to 10. How George, Fifi and the lions would value each additional lion is graphed on the next page. Note that Fifi does not want additional lions. (In the graphs, interpret positive amounts as WTP for that additional lion, and interpret negative amounts as the amount required to accept that lion to Boulder. Provide explanations of what each graph says and why this might be plausible. Is the increase from 1 to 10 a "Pareto improvement"? Yes or no and explain. Is the policy a "potential Pareto improvement"? Yes or no and explain. Given the way I drew the graphs, what is the efficient number of mountain lions from society's perspective.

Answer: Three stories: The mountain lions value each additional lion the same, $4. Assuming that the lions don't care about each other, each lion has a $4 WTP to live in Boulder. Fifi, on the other hand, does not like mountain lions: they make her nervous, and for good reason. Fifi would have to be paid $5 to accept the introduction of the 2nd lion, the same to accept the introduction of the 3rd, 4th and 5th. She would have to be paid $10 to accept the introduction of the 6th. If there are 6 lions, Fifi will be eaten after she has spent the $10. She values her life on the margin at $10, her WTA to accept death by lion when there are already 5 lions around to scare her. Fifi could care less about whether there are more than 6 lions: she is dead. George has mixed feelings: he values highly the introduction of the 2nd and 3rd lions but then starts getting worried about Fifi when the 4th and 5th are introduced (not that worried). The introduction of the 6th would put him in mourning, but not as much as Fifi would hope. Once Fifi is gone, from George's perspective the more lions the better, he has a WTP of $4 for each additional lion above 6. Going from 1 to 10 lions is not a Pareto improvement. Fifi, a member of society, is made worse off to the tune of $30. It is a P.P.I. The lions would pay +$36 and George +$28 for net benefits of $34. If, for example George gives Fifi $15 and the lions pay her $15, everyone would be better off and the change, with the compensation, would be a P.I. (Fifi is dead but it was her choice). Given the way I drew the graphs, the efficient number of lions is infinity: once we get past 6 lions, each additional lion is a Pareto improvement to the tune of $8 a lion. Another way to correctly answer would be to say that there is no efficient number of lions because once you reach a certain

number of lions, one more always increases efficiency.

So, it would seem increasing the number of lions from 1 to 10 is efficiency increasing even though it requires the sacrifice of Fifi, who is also a member of society? Interesting! Imagine Fifi would have to be paid $1 million to accept the introduction of the 6th lion. If society had to choose between 1 and 6 lions, efficiency would dictate they choose 1. But they would still prefer infinity of lions to 1 on efficiency grounds.

Note that in this question we partially addressed the issue of efficient population size for members of society.

Further things to note: If at the current position there is a move that is a P.P.I, the current position is not efficient. For example, one lion is not efficient because a move from one to two results in a net benefit of $8 so with compensation to Fifi of between $5 and $8, everyone would be better off, proving that one lion is not the efficient number of lions. Another example, if one starts at five lions, there is P.P.I if one moves to nine lions, proving that five is not the efficient number.

$VMM_G \equiv$ value of a marginal mt lion to George

$VMM_F \equiv$ " " to Fifi the poodle

$VMM_m \equiv$ " " to the mt lions

VMMm

VMMG

VMM F

the 6th cat eats Fifi
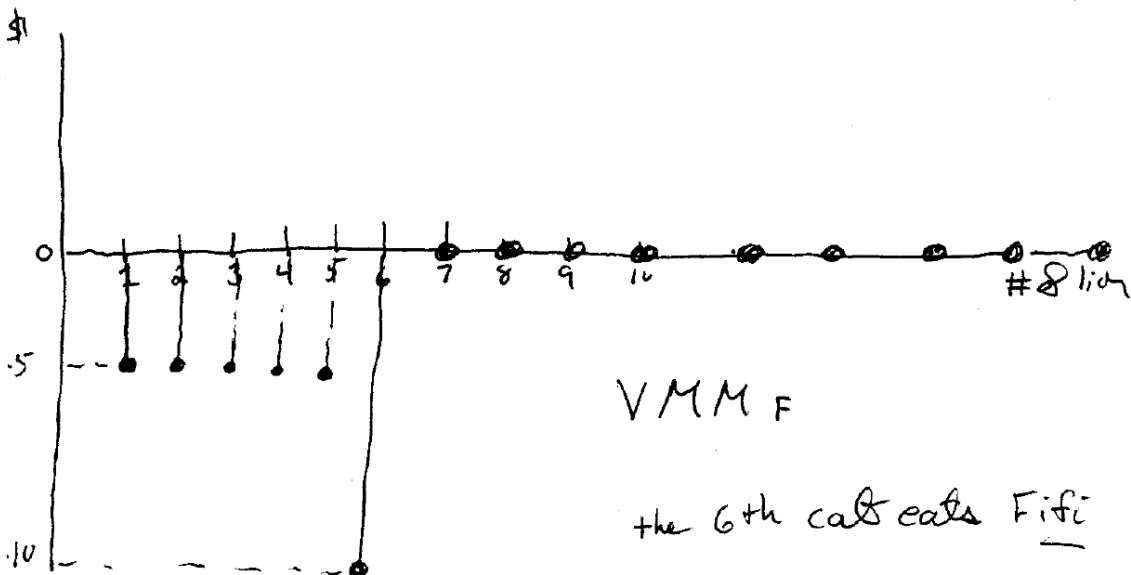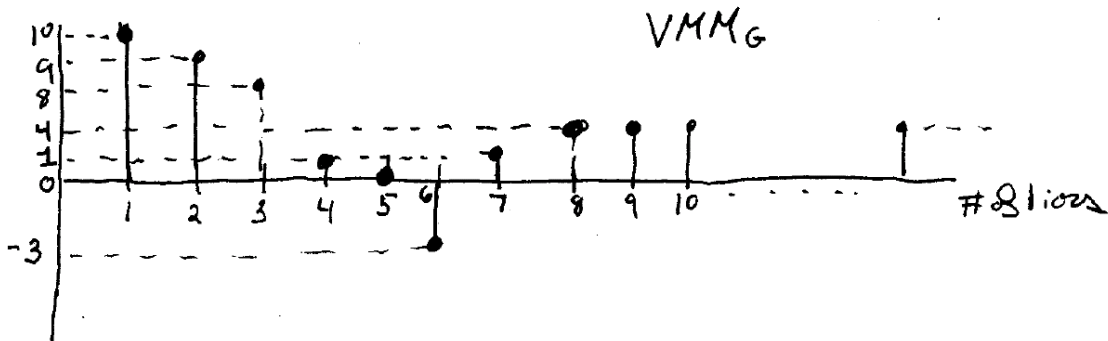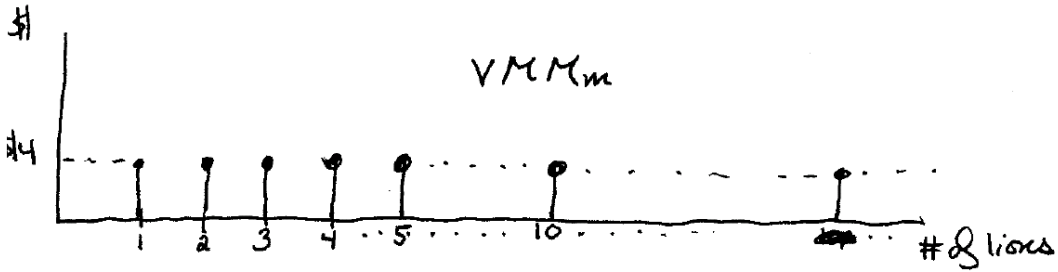
15. Why does industry have such a great interest in passive-use values?

16. The famous economist Herkimer Snerd recently stated in a speech to the *Friends of Finance,* "If in money terms the gain to the gainers from an environmental policy is greater than the loss to the losers, the policy will make society better off and should be enacted." Is Herkimer correct? Discuss. .

17. Consider the designation of a new wilderness area in Colorado. Assume that the economics consulting firm of Snerd, Snerd, and Gomer has accurately determined the CV each hiker and backpacker would associate with designation and that the sum of all these individual CV's is $5 million. Snerd, Snerd, and Gomer included all the aspects of the change in their CV calculation for the hikers and backpackers. However, designation of this Wilderness Area will decrease the availability of water to grow Soy beans on the plains of Colorado. This reduction will cause the price of Tofu to rise by $1 a pound. Assume that before the change, four million pounds of Tofu was produced and sold. This price increase obviously makes Tofu consumers worse off. Note that hikers and backpackers are not in this group; i.e., they never consume Tofu. Convince me whether designating the Wilderness Area is a potential Pareto improvement. What if the price increased by $1.50 rather than by $1?

18. Consumer's surplus is typically measured in monetary units, but it could be measured in other units such as time working, or in terms of a particular commodity such as hazel nuts. If it were measured in units of time, consumer's surplus (the compensating variation) for an environmental commodity would be how much time one would be willing to work to have the environmental commodity available. The hazel nut consumer's surplus associated with having commodity x available at price p would be how many nuts one would be willing to give up to have commodity x available at price p. Would your expect individuals who, relative to other individuals, have a high consumer's surplus in terms of money to also have a high consumer's surplus measured in units of time, and would you expect individuals who, relative to other individuals, have a high consumer's surplus in terms of time to also have a high consumer's surplus measured in

terms of money? Why? Discuss the implications of measuring consumer's surplus in terms of money;.

Answer: Consumer's surplus (the compensating variation) for a valued environmental commodity expressed in units of time is how much time one would be willing to work to have the environmental commodity available. In terms of money, it is how much money one would be willing to give up to have the environmental commodity available.

In general, I would not expect individuals who have a high CS in terms of money to necessarily have a high CS in terms of time.

Consider five types of individuals:

Type 1: Individuals who have little free time because they work all the time for a high wage. Because they work all the time, and earn a high wage, they are rich. For such individuals, the opportunity cost of their time in terms of money is high but their opportunity cost of money in terms of time is low. That is, time is scarce relative to money.

Type 2: Consider individuals who are paid a low wage and who have chosen to work only a little. For such individuals, the opportunity cost of their time in terms of money is low. They don't give up much money when they pay for something in terms of time. However, if they pay for something in terms of money it costs them a lot of time. Money is scarce relative to money.

Type 3: Consider individuals who are paid a low wage and who have decided to work a lot, e.g., an uneducated, single mother who is trying to put her teenage son through college. Such people have neither time nor money.

Type 4: Consider rich individuals who don't have to work and choose not to work. These people have both lots of time and lots of money. For such individuals, it might be the case that

neither time nor money is scarce relative to the other.

Type 5: Consider individual who have no money wealth, could earn a high wage if they chose to work but choose to not work. E.g., Boulder brain surgeons who decide to become Buddhist Monks. These individuals have chosen to give up worldly goods to have more time.

Consider WTP for an environmental improvement that all individuals **favor highly**

Individual type	Wtp in terms of money	Wtp in terms of time
1 Guys who are rich because they work all the time	High	Low
2 Bums in a nonnegative sense of the word	Low	High
3 Uneducated single mothers	Low	Low
4 Trust-funders	High	High
5 Brain surgeons turned monks	? My guess it their wtp is higher in terms of money than in terms of time.	?

Ceteris paribus, measuring CS in terms of money means that the preferences of those for whom money is relatively un-scarce will get more weight if decisions are made on the basis of benefits and costs (measured in money) in social decision making than those for whom

money is relatively scarce.

If CS is measured in units of time, those with the most free-time will have more say in social decision making based on CS estimation.

Neither unit of account is inherently better on positive criteria. Which would be better is a normative issue. We typically measure CS surplus in terms of money because we allocate market goods (for better or worse) on the basis of monetary wealth.

General questions about non-market valuation:

1. Nonmarket valuation uses *stated preference techniques* and *revealed preference techniques* to value environmental amenities. Explain to the reader the difference between *stated preferences* and *revealed preferences*. List two *stated preference techniques* for nonmarket valuation, and two *revealed preference techniques* of nonmarket valuation.

Answer: An individual's preferences are an individual's rankings over states of the world. For example, if you rank bundle A over bundle B, you "prefer" A over B, and this is part of your preferences. *Revealed preferences* are those preferences that can be inferred by observing an individual's behavior. E.g. if I buy Coke rather than Pepsi, I am revealing that I prefer Coke. In contrast, *stated preferences* are statements of one's preferences. For example, the comment "I prefer Coke" is a stated preference, which might or might not correspond with my behavior. The alcoholic might state that he will quit drinking. Maybe he will and maybe he won't.

Travel-cost studies and Hedonic wage and price studies are examples of revealed preference techniques for nonmarket valuation.

CVM and Choice Experiments are examples of stated preference techniques.

Questions that are primarily travel-cost questions:

1. What is the travel-cost method for valuing site-specific recreational activities? Briefly explain what it is and how it can be used to value recreational sites.

Answer: The travel-cost method is a technique that uses revealed-preference (RP) data to estimate the consumer's surplus associated with the existence of a recreational site or a change in one or more of its characteristics (cost and attributes)

Valuation proceeds in three steps:

1. Data collection

2. Estimation of the demand function for a recreation site or sites

3. Calculating the areas under these demand functions above costs (or the changes in these areas) to get an estimate of the consumer's surplus associated with site or a change its characteristics.

In more detail:

(1) One collects, for a representative sample of the population of interest, RP data on how many trips each individual takes to each site in his choice set and one estimates the travel cost to each site for each individual in the sample, using travel distances, vehicle operating costs, wage rates, etc. To identify the effect of cost on demand, one needs variation in costs both across individuals for a given site and across sites for a given individual. In addition, one collects data on the significant characteristics of each site in the choice set. To estimate the effect of the site characteristics on demand one will need variation in the characteristics levels across sites.

(2) One uses this data to estimate a representative individual's demand function(s) for the sites of interest. How is this done? One specifies some algebraic function for trips to a site as a function of the site's cost and characteristic levels, and the costs and characteristic levels of the other sites in the choice set. These algebraic demand functions will have parameters (alpha and betas) that explain the influence of each factor on demand. One uses the data to estimate the values of the parameters that best explain the participation and site choices of the individuals in the sample.

(3) Given these estimated demand functions for a representative individual, one then uses them to estimate each individual's consumer's surplus associated with either the existence of a site or a change in the characteristics of a site. How?

Consider first the value of a site (that is, what the individual would pay to have the site available at the cost they currently pay). If a site is eliminated the CS associated is approximated by the area under the demand function for the site above the individual's current cost of a trip to that site. However, we can improve on this approximation by taking account of the fact that with the elimination of the site the demand functions for trips to substitute sites will shift to the right increasing the areas (surplus) under those demand functions. One subtracts these increases in surplus from visits to substitute sites from the lost surplus under the demand function for the eliminated site.

Now consider a quality change at a site (e.g. increase in catch rates, more skiable terrain, etc.). This improvement will shift the demand function for the improved site to the right (at every price more trips will be taken), but since in relative terms the quality at other sites has decreased, the demand curves at other sites will shift to the left (decreased surplus from trips to other sites). A good estimate of the CS associated with the improvement is the increase in the area under the demand function for the site that was improved, minus the loss of the areas under the demand function for the other sites.

Did your answer include all of the above details?

Did you define the travel-cost **method**, or just define travel costs? The latter is only part of the answer.

Did you discuss data collection?

Did you explain how the demand functions are estimated?

Did you explain how to calculate the CS for a change given the estimated demand functions?

2. Define and explain the travel-cost method for valuing attribute(s) of a site-specific recreational amenity in three sentences or less. Marcel Proust once wrote a sentence that went on for ten pages; you should not mimic this practice. Your sentences should be appropriately punctuated. You will lose points if your answer has more than three sentences, or more than three semicolons, or more than three colons, or more than ten commas. Penalties are additive.

Answer: The travel-cost method is a technique to estimate the use value, measured in terms of aggregate consumer's surplus, associated with a change in the characteristic(s) of one or more recreation sites (e.g. beaches or fishing sites or ski areas). Using collected trip, cost, and characteristic data, one estimates the demand functions for the sites as a function of their travel costs, characteristic levels, and other explanatory variables. One then calculates for each individual in the population of interest how much their consumer's surplus from the sites increases or decreases due to a change in the

characteristic levels at one or more of the sites, and then one sums these across the individuals.

Comments: there are three steps: data collection, demand estimation, and using the estimated demand function to calculate consumer's surplus. A complete answer needs to note each of these steps.

Note the distinction between "travel costs" and the "travel-cost method" and between "value" and a method to measure value. Some answers simply defined travel costs and or value, but never described the method. Noting that "Site choice reveals something about one's preferences of site characteristics," while a correct statement, is not a description of the travel-cost **method**.

Extra credit: we will add two bonus points for the best description of Marcel Proust. We are the final arbitrator of "best." Depending on what other groups say, the best definition of Marcel might, for example, be a blank.

http://en.wikipedia.org/wiki/Marcel_Proust

3. You are at a party talking to Burt Backpacker, and he is arguing that backpacking trips are a costless activity. Argue in a way that Burt would comprehend that he is wrong and that you could use the costs he incurs to estimate how he values backpacking trips and different backpacking destinations.

4. Outline how a travel-cost model might be used to estimate the demand for and benefits from a site with historical and/or cultural significance. What are some of the difficulties?

5. Write a short introductory paper on how one might estimate the demands for a group of recreational sites. How about the demand for a proposed site? Discuss the theoretical foundations of your proposed method, data requirements, etc.

6. List a potential application of travel-cost modeling that was not discussed in class.

Questions that are primarily CVM questions:

1. Assume that the 100 individuals randomly selected from you target population answer most of the questions on your CVM survey, but 20 of the 100 individuals leave blank the WTP question. Would you expect the 80 completed surveys to provide unbiased estimates of WTP for the target population? Explain. What sorts of evidence might you gather that would help you gauge whether significant bias exists.

2. Why the adjective *contingent* in the term *contingent valuation*?

3. Distinguish between payment cards, yes or no to a particular price, bidding games and direct solicitation. What are the advantages and disadvantages of each of these methods of eliciting valuation? Suggest another constructed market method of elicitation and discuss its advantages and disadvantages.

4. Write a short essay that explains the contingent valuation method, CVM (one page or so for this part). Then write a scathing critique of CVM that demonstrates that it is worthless as a method of non-market valuation (one or two pages for this part). Now write a defense of the CVM method that convinces the reader that CVM does a good job of achieving its goal (one or two pages for this part).

   Use examples and points from the readings on non-market valuation in your critiques and description.

   Write as if you were writing for an economics major who has not taken environmental economics.

   I am imagining that your total answer will be about three pages. Grammar, exposition, clarity, etc., are all important parts of your answer.

Think of this as a short paper assignment.

5. Define the following terms and discuss their relevance to the Contingent Valuation Method: *embedding*, *free-rider bias*, and *starting point bias*. As part of your answer discuss how you might attempt to minimize the potential problems.

6. What is the contingent valuation method for valuing in situ natural resources?

7. Write a short essay (one to three pages) that explains the contingent valuation method and argues that it is a good and defensible method for estimating environmental benefits and/or costs. Then give your essay to one of your classmate and have him or her write a brief retort that argues that the contingent valuation method is not a defensible method for estimating environmental benefits and/or costs.

8. Write the retort to someone else's question to the last question

9. Critique the NYT's article, *Polls May Help Government Decide the Worth of Nature.*

10. Do you believe that the average of what Americans would pay to avoid to another oil spill in Prince William Sound of the magnitude of the Exxon Valdez spill is $30? Explain. If not, is the amount they would be willing-to-pay more or less? Why?

11. Write up a set of lecture notes for a micro principles class (one to three pages) that introduces the students to nonmarket valuation in environmental economics and explains to them the contingent valuation method.

    Assume a level of knowledge consistent with the student getting an A in principles micro.

    Before you begin writing you might want to spend a little time outlining what you will say. Clarity, exposition, and level are all important.

Questions that are primarily hedonic questions:

1. Discuss the potential for using a hedonic property value study to estimate the neighborhood's WTP for preservation of open space. What are its advantages, disadvantages and complementarities with CVM estimation?

2. Why is it possible to look at wages or housing/land prices and draw conclusions about the value of environmental amenities?

3. Should one expect cross-sectional variations in environmental amenities to be reflected in cross-sectional variations in rents and/or wage rates? If so, how might these relationships be utilized to evaluate environmental amenities?

4. Assume that Boulder, a featureless, square plain, is inhabited by only young people and cranky old men, that the number of young people is fixed, the number of cranky old men is fixed, the number apartments is fixed and equal to 1 plus the number of young people and cranky old men, and that everyone lives alone. The apartments are all identical, except for their location. There are many students and many cranky old men.

   The apartments are uniformly spread all over town and owned by the French.

   Being Boulder none of the young people work: they all have trust funds, but all trust funds are not equal. The cranky old men are all retired and live on pensions, some big, some small

   You can assume that for young people, ceteris paribus, they prefer to live next to other young people.

   The cranky old men do not like young people, or their behaviors (noise, dress, music, etc.)

   With the travel-cost models and hedonic models in mind, describe to the reader a likely equilibrium distribution of rents, young people and cranky old men, and why that distribution is likely to occur in the absence of any government

intervention. As part of your answer, define "equilibrium" in this context. Note that there are three questions asked in this paragraph.

Would you expect this equilibrium allocation to be efficient from the perspective of the young people, the old farts and the French landlords? Why or why not? Explain your answer, and as part of your answer define "efficient" in this context. If you conclude the allocation is not efficient, discuss a policy or policies that might make it more efficient. Note that there are two or three questions asked in this paragraph.

In your answer I want to see you thinking like an economist.

5. Assume that Boulder, a featureless circular plain, is inhabited by only students and cranky old men, that the number of students is fixed, the number of cranky old men is fixed, the number apartments is fixed and equal to 1 plus the number of students and cranky old men, and that everyone lives alone. The apartments are all identical, except for their location. There are many students and many cranky old men. The feature of interest is the University of Colorado. It is located in the center of the circle and all of the students attend it.

The apartments are spread all over town and owned by the French.

Being C.U., no students work: they all have trust funds, but all trust funds are not equal. The cranky old men are all retired and live on pensions, some big, some small

You can assume that for students, ceteris paribus, they prefer, ceteris paribus, living closer to other students than to cranky old men.

The cranky old men have no desire to visit the campus and do not like students, or their behaviors (noise, dress, music, etc.)

Assume students attend classes, so must travel to C.U. on a regular basis.

With the travel-cost models and hedonic models in mind, describe to the reader a likely equilibrium distribution of rents, students and cranky old men, and why that distribution is likely to occur in the absence of any government intervention. As part of your answer define "equilibrium" in this context. Note that there are three questions asked in this paragraph.

Would you expect this equilibrium allocation to be efficient from the perspective of the students, the old farts and the French landlords? Why or why not? Explain your answer, and as part of your answer define "efficient" in this context. If you conclude the allocation is not efficient, discuss a policy or policies that might make it more efficient. Note that there are two or three questions asked in this paragraph.

6. In your answer I want to see you thinking like an economist.

Some thoughts: Equilibrium is when is when everyone is doing the best they can given what everyone else is doing; that is, when no renter can make himself better off by moving and none of the French can make themselves better off by changing the rent. The landlords want to maximize their rental incomes and will be in equilibrium when they are doing so. The student will want to max their utility in terms of where they live and the rent they pay. They will be in equilibrium when they don't want to move, given their current location, rent, etc. The same is true of the cranky old men.

An important component of site choice for the students is distance to C.U. The closer they live to C.U. the lower the travel cost (in terms of time and money) to get to class.

In equilibrium, one would expect student rents to decrease as the distance from C.U. increases. Believe it or not, C.U. is a site-specific amenity (like open space) and in

equilibrium there will be a rent gradient as a function of distance from C.U. In a hedonic equilibrium, each student will be indifferent to where they live in terms of travel costs and rent. [I recently discovered that lots of students live in places like Louisville, the party Capitol of Colorado. I assume these students ……]

We also need to take account of the fact that students don't only care about how far it is to class. They also want to be close to other students. So, one would expect student ghettos, even if no one went to class. This should make the Hill, or somewhere dense with students.

Note that the student who never goes to class, or rarely goes to class, might get a surplus by living far from campus.

How about the old cranks? They will pay a premium to live far from students (which likely means far from C.U.) If there are places far from C.U. with more or less students, they will choose the places where there are the least number of student neighbors. Students who live farther away will prefer the apartments that are close to the other students who live far away. Note that in equilibrium old cranks will never live in the student ghetto around campus.

So, in equilibrium, will rents be higher close to C.U. or far from C.U.? It depends on the number of students and the number of cranks and their relative incomes.

If there are lots of students and lots of old farts, I might predict the following: Old farts will live in the outer rings; students will live in the inner rings near C.U. In the rings occupied by students, rents will decline the farther one lives from C.U. – be lowest in the outer-most ring occupied by the students. The students with the smallest trust funds will live in this ring, and those with the biggest trust funds will live right around C.U.

What the rents do in the outer rings where the old farts live will depend on how far student externalities travel. [What are the student externalities?] Rents in the inner old-

fart-ring – the one on the boundary with the students – will be the lowest. If what the old farts experience of the students persists but declines as one moves farther from them, rents will continuously rise as distance from the students increases. In all the old-fart rings where there is no student noise or sightings, rents will be the same. So, if the students affect only the boundary ring, rents will the same in all of the other old-fart rings.

The old farts with the biggest pensions will live in the rings where there is no student influence.

So, if the above is correct, the rent gradient will be U-shaped or ….

Either way, in equilibrium students and old farts will not live in the same neighborhood.

In equilibrium, the French will have no ability to increase rents. Supply and demand will determine the rents.

If in equilibrium, a ring is occupied by both students and farts, old farts will likely live next to old farts, except for the two old farts forced to live next to a student on one side. That is, all of the old farts will be in the same segment of a ring with both students and cranks.

So, would such a free-market allocation be efficient? The answer depends on the extent of externalities. Students produce externalities for farts (noise, parties, couches in the yard, accumulating newspapers, etc.). Old fart are bad for students for two reasons: they are not students, and they complain about parties, etc. Since we assuming students like to live near other students, they must like parties, noise etc. If the equilibrium is the one described above, it will be efficient or close to efficient because the two groups are segregated; there might be some externality-type market failures on the student/fart border. So, efficiency might require influencing the behaviors of only the students who live on the border (party, noise and couch taxes). Note that such policies would not be

required for the students living in the inner rings because their behaviors don't influence the farts.[3]

An aside, if having a party makes your neighbors better off, does the government need to subsidize parties to achieve efficiency?

So, is the city of Boulder in equilibrium with respect to where everyone lives? This is a complicated question. Not everyone is either a party student or a student-hating old fart. Some old farts actually like being around students and some students like peace and quiet, so live in Louisville.

In equilibrium few families will likely live on the hill in Boulder – we are not quite yet to equilibrium. Should the government subsidize old farts and families to move off the hill? For many years the hill has been changing? The family sells out to a landlord for big bucks and moves elsewhere. This is what I did. This is what my friend Don did when his wife got worried the kids would get hit by a student driver, and what my friend Phil has done. We all lived on the Hill when we were wild and crazy singles, and wanted to be close to work, but not now. I go to sleep at 9 p.m. and can do a lot of my work with email. I must be an old crank.

A few more things to note: There are no wages because not one works, so we don't need to worry about what happens to wages.

Since students go to class, they all take the same number of trips to campus each week, and this number does not depend on the cost of the commute.

7. Imagine the featureless suburb of Pleasantville: no site-specific amenities, little business, and all of the houses are identical. Everyone is on a fixed income (not necessarily the same) of social security, trust fund payments, or both. Age in the

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[3] So, for example universal tax on noise would not achieve efficiency because a lot of the noise produced affects no one negatively and some positively.

population varies from newborns to old farts, the number of households and the number of homes are fixed and equal, and all of the homes are owner occupied. No one moves to Pleasantville and no one leaves town. Reproduction and death proceed at rates that keep the number of households constant. Every house is owner-occupied.

Things have been static for quite a while, so the housing market is in equilibrium: prices are stable and no one wants to move. Then, the F.B.I. accompanied by John Ashcroft (former Attorney General of the U.S.), raids a home in the center of town of town. It turns out that terrorists living there were making dirty bombs in the basement for eventual detonation in France. They were doing it carefully, so there was no risk to the neighbors. However, during the raid John stumbles over a canister and contaminants the place with low-level radiation. The terrorists go the jail, decreasing the number of households by one.

Assume that except for the FBI there is no government. There wasn't a need.

Unfortunately, the contaminated property can't be cleaned up. The risk associated with the contamination is a long-term risk: a cancer risk and this risk increases the closer one lives to the property. That is, the probability of getting cancer in the long run goes up, but the amount it goes up is less the farther one lives from the contaminated property. The contamination does not increase the probability of getting cancer in the short-run.

Five additional assumption: (1) All old farts are dead in the long-run and in the short-run old farts care nothing about their children and grandchildren. (2) House can't be moved, new houses can't be built and every household has to live in a separate house. (3) No one cares about other households. (4) Moving costs are negligible. And (5), ceteris paribus, utility decreases when their risk of cancer increases, but the amount is not necessarily the same for all of these households.

Explaining all of these assumptions, economists have trouble solving complicated problems so often make many simplifying assumptions

Consider and discuss the equilibrium in the housing market after the creation of the radioactive disamenity. Consider and discuss how where each household resides might or might not change, and the distributional implications of the contamination. Will everyone be worse off?

Pleasantville is considering hiring you, at $5K a day, to determine how much the community has been damaged, in $, by the contamination. They are planning on suing John Ashcroft for the damages. Explain, as if you were making a presentation to the newly-formed city council, how you would estimate those damages, or, at least, a lower-bound/minimum on those damages.

Some thoughts and comments: (maybe flawed, maybe not):

Consider first **the initial equilibrium in the housing market**. Given that Pleasantville is a featureless plan and given that all the houses are identical, they would all sell for the same price.[4] Since there are no site-specific amenities, no one cares where they live, so no one will pay a premium for one house over another. (If the houses differ in size or quality, housing prices will not all be the same, but the price of land will be the same everywhere in town.)

The contamination will make the original equilibrium a disequilibrium. It will make the old better off and all, or most of the young worse off.

In explanation: After the contamination, some trades will occur: houses will be bought and sold. Each of these trades will be a Pareto Improvement (make both parties to the trade better off than were right after the contamination occurred– Alfred Pareto is an old, dead, Swiss economist) and each party to each trade is motivated by a desire to efficiently

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[4] No one wants to move so there are no actual sales.

adjust to the new contamination. While each party to each of these trades is better off after the trades than they were before the trade, many are worse off than they were before the contamination.

Consider Scooter: Scooter Harrington, father of six, and husband to the former Penny Lodge, hesitates half-way up the front steps of the home of Edith and Ralph Fartinski; the Fartinskis live on the edge of town and Scooter barely knows them – "how to begin?"

Scooter hasn't sleep since the radiation was discovered; Penny is worried sick that the kids are doomed if they remain at Lodge Hall and she wants to move to the edge of town – she has been hitting the scotch more than usual. Scooter's doctor recommends Prozac for them both.

Ralph watches from his hammock and, beer in hand, breaks the silence,

"Scooter isn't it? You wouldn't believe how many people have been asking us if we're considering selling. I suppose that is why you are here. The wife says we need to have a second-price auction: she went to the library and got Professor Zubrow's classic text on auction theory. The auction is next Saturday - hope you can make it. Edith says we will get more money if we do a second-price auction: the highest bidder doesn't pay what he or she bid, but rather what the next highest bidder bid. I know it sounds weird, but apparently it gets everyone to bid their maximum."

Scooter turns and leaves mumbling, "I got to sell the Beamer."

After the auction, Edith and Ralph get a good deal on one of the houses on Terrorist Row ($18 thousand). Scooter manages to buy a place a few blocks away from Terrorist Row: he couldn't afford to pay the million five that the Fartinski Estate went for. Ralph starts importing his beer from "Old Europe"; Edith gets Botox treatments.

The three-block move decreases the probability Penny and Scooter's kids will get cancer,

somewhat. Penny and Scooter switch from single-malt scotch to Cutty Sark, and start buying their clothes at Wal-Mart. Private school is no longer an option.

The new equilibrium will be quite different from the old one. Who will live where? Since the injury will only manifest itself in the long run and all the old people will be dead in the long run, the contamination is not a disamenity from their perspective. They don't care where they live except for cost, and housing prices will be lowest closest to the site.

Old people who move closer to the center because of the contamination are better off than they were before the contamination. Their gain is how much they clear by moving (selling price of their initial house minus the price of their new closer house).

In the new equilibrium, all of the old households will live closer to the site than any young household. (If a young household lives closer than an old household, they have an incentive to switch, even if it is only for a penny, so in the new equilibrium no young will live closer than an old).

All the houses in the old-fart ghetto circling the contaminated house will all sell for the same low price, but housing prices increase as their location from the ghetto increases.[5] Those houses far from the site, while contaminated, are, relatively speaking, much more attractive than they were in the pre-contamination equilibrium.

I will refer to the area outside of the old-fart ghetto as the Donut. How will the young configure themselves in the Donut? It will depend on each household's fixed income, where they lived before the incident, and their differing preferences for a long-term increase in cancer risk (their MRS between increased cancer risk and goods).

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[5] All the old people live together, around the contaminated site. I am calling this neighborhood the ghetto. All houses in this neighborhood sell for the same price because old farts are indifferent to where they live in the ghetto.

While there is a general desire to be farther out, some of the young will move closer to the old-fart ghetto.

If all of the young have the same preferences the richest young would live on the edge of town. If some of these homes were previously occupied by less-affluent young, these less-affluent young would move closer to the old-fart ghetto.

Thing are more complicated if preferences differ among the young. In which case, ceteris paribus, those who are more concerned about the cancer risk will live farther out – they might outbid a richer household for further out because they are more worried about the cancer risk (have more young kids).

This raises Whitney's question, **"Can any of the young end up better off because of the contamination."** I first I thought no but now think it possible. My current thinking is that if all of the young have the same preferences, then all of them will be worse off because of the contamination. However if there are varying preferences, a household that cares little about the cancer risk, initially lives far, and is not rich, could end up better off if initially there are rich who live close in and care greatly about the cancer risk. The rich household will pay them so much for their far-out house that moving in will make them better off (the increased cancer risk of moving closer is more than offset by the extra stuff they can now buy). This potential depends on the relative sizes of these two groups.

Consider the benefits and costs of the contamination, their total amount, and how they are distributed. The old who lived initially outside of what becomes the old-fart ghetto will all gain, but only because of the money they made from moving, the gain, in $, to the old farts is what they collectively make by "selling down."

However, each dollar an old fart makes in real estate is a dollar loss to some young household. So, the change in the total value of the housing stock is not an estimate of the total damage from the contamination. **Damages to Pleasantville are not the net change in housing prices.**

As explained above **a few of the young will be better off**. For these households their gain will be less than the profit they made by moving closer: the profit is their dollar gain to buy more stuff, but it is partially offset by their increased risk of cancer (their WTP to reduce the cancer risk in their new house.

All of the young who either stay put or move farther out will be worse off. Their loss is the money they lost by moving farther out, plus their WTP to eliminate the remaining cancer risk at their new house. Rich families who initially lived close to the incident and care greatly about the cancer risk will loses the most in dollar terms – they can now afford a lot less stuff and remain highly worried about the cancer risk, which they have reduced, but not eliminated, by moving farther out.

The terrorists take a hit in the real-estate market and go to jail. How much they lost in the real-estate market (their house is now worth zero) is a lower-bound on their damages. One has to add their WTP to get out of jail.

 So, what are damages? The sum of the CV (WTP for the contamination by all the old farts minus WTA for the contamination by all the young farts) is less than zero – positive damages.

WTP for the old farts is easily determined, it is how much they collectively made by moving.

Ideally we would want to estimate WTP for the few young households that benefit from the contamination and WTA for all of the worse-off young households.

WTA for each of the worse-off young households is the amount of money that would have to be added to their income in the new equilibrium to make them indifferent between new equilibrium and the initial equilibrium. This amount is greater than the absolute value of what they lost in the real-estate market, which is how much less they

have to buy goods.

A CVM survey would likely be needed to estimate the WTP and WTA for the young households.

You would likely ask the young losers a CVM question to determine their WTP to eliminate the cancer risk, rather than a CVM question to determine their WTA the contamination: WTP is easier to ask.

Once you estimate the total loss to the young households that were made worse off by the contamination, you would have to subtract from it the gain to the old farts, and the gain to the few young households that gained.

Figuring all this out and doing the CVM study would take a long time so you would make a lot of money.

Justin pointed out that I asked for a lower-bound estimate of damages, not an estimate of damages.

Given my assumption that at least some of the young care about the long-term cancer risk, zero is a lower bound estimate of damages. But saying this is the best you can do, would not endear you to the city council.

Some additional thoughts:

The question assumed away non-use values.

If moving houses was sufficiently small, damages would be less if houses could be physically moved.

If the cost of moving the household was sufficiently small, and households were allowed

to leave town, damages would be less. If households were allowed to move both out or in, the town might end up one big old-fart ghetto.

Some of you argued that there were no damages because prices would adjust until no one is worse off. This is incorrect. Prices will adjust to minimize the extent of the damage (people will trade houses after the contamination) but this does not imply the damage is zero.

Note that if Pleasantville was only inhabited by old people, there would be no damage.

This exercise teaches an important lesson in economics. The answer to every economic question is "It depends on what you assume."

This was a hard question.

Questions about choice experiments:

1. What are choice experiments, and how are they used to value environmental commodities? As part of your answer, provide some examples. Why do environmental economists use choice experiments to help them estimate the preferences for environmental commodities? Note that this question has 4 parts.

Answer:

- In choice experiments, individuals are asked to choose between some number of hypothetical alternatives. For example, one is presented with a number of alternatives and asked to "choose" the most preferred alternative from the set of alternatives presented. This is also the situation that individuals are presented with in the real world. In the real world, one is presented with options, and chooses the option he or she "likes" best. What distinguishes choice experiments from real world choices is that, in choice experiments the alternatives in the choice set are defined by the researcher and the individual does not have to live with their choice.

- The purpose of choice experiments is to learn about people's preferences, including their preferences over different environmental programs. Put simply, individuals are assumed to have preferences; that is, individuals can rank bundles of commodities. We learn about those rankings by observing the bundles individuals choose from those available to them in the real world. In addition, we can learn about there ranking over bundles that are not in their real world choice sets, by conducting choice experiments.

- We conduct choice experiments because we are often trying to value environmental commodities that are not bought and sold in the market place and/or need to value a commodity at a level that does not currently exist. That is, we use choice experiments when commodities cannot be valued using only revealed-preference market data. For example, if a car company wanted to value a new feature that was not currently available on cars in the market place, there would be not market data on the feature that could be used to determine WTP for the feature. But, one could use choice experiments to see how potential car buyers would trade money for this feature or this feature for other features.

2. We have looked at a number of examples of choice experiment studies in

this class: choice of mountain bike sites as a function of the characteristics of the sites, and choice over monument preservation programs.

Other questions that I have either not yet filed into a category, or that would be difficult to put in one of the above categories.

1. Can human life be valued? Why is this an important question for environmental and health economists

2. What valuation technique would you use to measure the value of improving water quality in a local lake or river? Why?

3. What valuation technique would you use to measure the value to us of preserving a tropical rain forest? Why?

Answer: A critical issue in answering this question is value to whom, only the local population? All people? Etc?

If it were only the locals, much of the value would likely be use value, and it might be negative. If we are estimating a value to someone distant, most of the value would be nonuse value. So, maybe multiple techniques are appropriate. The problem of valuing the preservation of the rain forest is much like the problem of valuing wolf reintroduction programs in the western U.S. There is significant positive nonuse value by non-locals, feeling of the locals are more mixed.

For rain forests I would consider two studies: one for locals, one for others. For non-locals where total value is largely nonuse, I would advocate an SP technique such as contingent valuation or choices questions. A RP technique such as travel-cost would only pick up the use values of the small proportion of non-locals who visit the rain forest.

I personally prefer choice questions but a good study is possible with either choice questions or referendum cvm. Issues include what preservation means, one would have to be specific, and the choice of payment vehicle (increased taxes, prices, payments to conservation organizations, etc.).

Estimating the values for the locals will be difficult. The value is predominately use and often negative. That is, locals are made better off, at least in the short run, by the destruction of the rainforest. Much rainforest is lost to logging and agriculture which is undertaken by poor peasants who have no where else to farm. The question for them is what they would have to be paid to voluntary not exploit the rain forest.

One could observe how much the peasants pay to exploit the rainforest in terms of moving expenses, etc. These are likely low. One could offer peasants actual money not to be there and see how much it takes. One would have to structure the payments so the individual could not cheat (take the money then move to the rainforest). Maybe a monthly payment for staying where you are. Imagine donating $20/month to a family if they did not move to the rainforest. Of course there would be problems. Everyone would claim they would move to the rainforest just to get the money.

Hedonics probably won't get us far. One of the problems with the rainforest is that property rights are not well defined, so "land prices" to the extent they exist don't probably contain much information.

As an aside, if property rights were well defined and one could buy and sell rainforest, it would be less used for subsistence agriculture and international conservation organizations and governments could buy land for the purpose of preservation.

4. Why do you think that the management arm of the conservation movement (a current proponent of this philosophy is the U.S. Forest Service, etc.) has concentrated more on the production of produced goods and services from natural resources rather than the potential flow in services from in situ natural resources? Historically, was this a good policy for the Forest Service to adopt? Does it remain a good policy?