Lecture # 16 – Valuing Environmental Benefits: Stated Preference Approaches

I. Revealed Preference Approaches (continued)

C. Hedonic Pricing Techniques: Housing

- Hedonic pricing techniques look at the value that people place on the *attributes* of a good.
  - That is, it assumes that people don't value a house itself, but rather the *features* of a house (e.g. number of rooms, location, is there a fireplace)
  - One such feature is environmental quality.
- Using regression analysis, we can find the correlation between housing prices and environmental quality in an area.
- Most studies find an elasticity of housing prices with respect to pollution that is around 0.1.
  - That is, a 1% decrease in pollution leads to a 0.1% increase in housing prices.
- Example
  - Data are median house prices and community characteristics
  - Includes data on NOx concentrations in each neighborhood
  - Consider first a regression of just prices and NOX.
    - Both are in logs so can interpret as elasticities.

```
. reg lprice lnox

      Source |       SS           df       MS      Number of obs   =       506
-------------+----------------------------------   F(1, 504)       =    180.36
       Model |  22.2916457         1  22.2916457   Prob > F        =    0.0000
    Residual |  62.2906252       504   .12359251   R-squared       =    0.2635
-------------+----------------------------------   Adj R-squared   =    0.2621
       Total |  84.5822709       505  .167489645   Root MSE        =    .35156

------------------------------------------------------------------------------
      lprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnox |  -1.043143   .0776728   -13.43   0.000    -1.195746    -.890541
       _cons |   11.70719   .1324326    88.40   0.000     11.44701    11.96738
------------------------------------------------------------------------------
```

- The elasticity is -1.04. A 10% increase in NOx concentrations reduces prices by 10.4%.

- But, this model ignores controls. Add the following variables:
  - rooms: average # of rooms per house
  - ldist: log of weighted distance to 5 employment centers
  - lproptax: log of property tax rate per $1000
  - stration: average student-teacher ratio
  - crime: crimes committed per capita

```
. reg lprice lnox ldist rooms stratio lproptax crime

      Source |       SS           df       MS      Number of obs   =       506
-------------+----------------------------------   F(6, 499)       =    161.15
       Model |  55.7902689         6  9.29837815   Prob > F        =    0.0000
    Residual |   28.792002       499  .057699403   R-squared       =    0.6596
-------------+----------------------------------   Adj R-squared   =    0.6555
       Total |  84.5822709       505  .167489645   Root MSE        =    .24021

------------------------------------------------------------------------------
      lprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnox |  -.8075904   .1143758    -7.06   0.000    -1.032308   -.5828729
       ldist |  -.2123361   .0398586    -5.33   0.000    -.2906474   -.1340248
       rooms |    .246118   .0168155    14.64   0.000     .2130801    .2791558
     stratio |  -.0384403   .0057099    -6.73   0.000    -.0496586   -.0272219
    lproptax |  -.0898723   .0415893    -2.16   0.031    -.1715839   -.0081607
       crime |  -.0137003   .0015339    -8.93   0.000    -.0167141   -.0106866
       _cons |   11.3062   .3203163    35.30   0.000     10.67686    11.93553
------------------------------------------------------------------------------
```

  - The elasticity falls to -0.8.
    - A 10% increase in NOx concentrations reduces prices by 8%.
- To get a value for reducing pollution, we need to know current home values and the number of homes affected.
  - The median home value in this data set is about $22,500.
  - Suppose there are 1 million homes in this region.
  - A 10% reduction in NOX concentrations would increase the median home value by $2,250.
  - Multiplying by 1,000,000 gives us a total value of $2,250,000,000 ($2.25 billion)

D. Hedonic Pricing Techniques: Wages

- Another application of hedonics is with wages.
- Examples:
  1. People will choose to live in cities with positive characteristics.
     - Differences in wages can be seen as the value of these characteristics.
     - E.g.: Kahn (2017) studied public sector compensation
       - California workers are paid just 9% more than workers in Alabama
       - Adjusting for the cost of living, these workers are paid less
       - Implies they value the other amenities of living in California
  2. People need to be compensated to be willing to take riskier jobs.
     - Differences in wages represent the value of a human life.

II. Value of a Statistical Life

- The most controversial aspect of cost-benefit analysis is placing a value on human life.
    - What is the value?
        - Is it merely the opportunity cost (e.g. foregone wages)?
        - Are there other values (perhaps non-market values) that need to be considered?
    - Concepts of the value of a life
        - The most commonly used value is the value of a statistical life.
            - We don't know who will die, but we expect someone will.
            - The value of environmental protection is lessening the risk of someone dying.
                - Note that specific deaths capture the attention of individuals. However, that is not what a statistical life focuses on.
            - We are valuing changes in the probability that a random individual will die, by asking what is the willingness to pay for changes in risk.
                - It is the ratio of marginal utility of a small risk reduction over marginal utility of income: VSL = $MU_{\text{Risk reduction}}/MU_{\text{Income}}$.
                - That is, the as the marginal rate of substitution between mortality risk and money
            - Because of diminishing marginal returns, when dealing with large changes in risk, willingness to pay and willingness to accept will differ
            - For policy, this is the most appropriate measure, because policy does not prevent death, but rather changes the probability that death will occur.
            - Can also be put into annual figures: value of a statistical life year (VSLY)
                - Found by dividing VSL by the discounted expected years of life remaining for the average individual studied.
        - Contrast this with the optimal insurance and compensation of accident victims.
            - Colmer notes that other principles apply when lives are identifiable
            - Here, things such as the opportunity cost of foregone wages and medical expenses are often used, since now we are focusing on a specific loss.

- How to measure the value of a life:
  - Revealed preference approaches
    - Expenditures to reduce risk
      - For example, how much more will people spend for a car with airbags, or for bottled drinking water?
      - Challenge: separating value assigned to changing risk to other characteristics (e.g. other features of the car, or better taste for bottled water)
    - Hedonic wage approach
      - People need to be compensated to be willing to take riskier jobs.
        - Differences in wages represent the value of a human life.
      - To calculate, we regress wages on job characteristics, worker characteristics, and risk
      - Key is to compare risk of jobs and compensation required for each.
        - Occupation 1: 1 in 10,000 risk of death per year
          - As a result, 1 worker dies every 10,000 years.
          - If 10,000 workers in this occupation, expect 1 to die each year.
        - Occupation 2: 3 in 10,000 risk of death per year
          - As a result, 3 worker dies every 10,000 years.
          - If 10,000 workers in this occupation, expect 3 to die each year.
      - Comparison
        - Difference in risk is 2 in 10,000
        - Suppose wages in occupation 2 are $1,000 higher. What is the value of a statistical life?
          - The value is the willingness to pay to avoid a risk that results in one more death in the population.
          - This is the wage differential divided by the additional risk
            - = $1,000/0.00002 (or 1,000/(2/10,000)
            - = $5,000,000
      - Note that this assumes people's preferences are linear.
        - Does $1,000 for 1/1000 => $100 for 1/10,000?
    - Issues:
      - Requires people to have perfect information about risks, and to be able to evaluate this information properly.
      - Do people take risks knowingly and willingly?
      - True locally (that is for marginal changes), but for large changes in risks might not be appropriate.
  - Ask people: stated preference methods
    - We will discuss these next

- Estimates of the value of a life in the United States vary by agency. These values were in effect in 2011:
  - E.P.A. $9.1 million
  - F.D.A. $7.9 million
  - DOT: $6 million
- Issues for valuing life
  - WTP depends on:
    - Type of risk
    - Amount reduced for each individual
    - Income
    - Substitutes: other ways to mitigate or avoid the risk
    - Preferences: each individual's subjective disutility from the risk, their risk aversion, and discount rate
  - How do we deal with different groups?
    - Reducing risk extends one's life expectancy.
    - Given this, should we place different weights on the lives of children?
    - Should we place less value on protecting the elderly?
      - EPA explored this idea in 2003
      - In some cases (e.g. air pollution), it is these high risk groups who are most affected by a policy.
      - OMB guidelines advise against adjusting VSL for age.
  - Extrapolating results across groups can be a problem.
    - Many VSL studies look at job risk in middle-aged men. However, the young and old tend to be most vulnerable to pollution.
    - Estimating VSL for children particularly difficult.
      - Cannot ask them directly
      - Parents often willing to pay more to reduce risk to children than to themselves.

III. Stated Preference Valuation

- So far, we have studied revealed preference approaches to valuing environmental amenities. Those approaches look at actual market transactions to infer value.
- Unfortunately, there aren't always market transactions that can serve this purpose. For example, how do we value protection of endangered species?
- In these cases, economists simply ask people for their valuation. These are known as stated preference techniques
- Types of stated preference approaches
    - Contingent valuation
        - Uses surveys to assess WTP
        - Typically a yes/no response to a posted price
        - "Contingent" because asking people what they would do if faced with a market for environmental amenities, since the actual markets do not exist.
            - Uses textual description of scenarios
            - Will respondents identify key features in the text?
    - Choice experiments: conjoint analysis
        - Respondent asked to consider an environmental commodity defined by several attributes
        - Choose among three or more options during each task
        - Reveal information on value of individual attributes, which are not emphasized in CV
            - But short descriptions of attributes may oversimplify
- Contingent valuation versus choice experiments
    - Decision of which to use depends on how respondents tend to perceive the good. Suggest three considerations:
        - Will the change being valued affect specific characteristics of the item or the item as a whole
            - CV works well if estimating fixed set of changes as a whole (e.g. oil spill damages)
            - CE useful if some attributes affected but not others
        - Do respondents think of the change in terms of individual attributes or as a whole?
            - E.g. do they think of an ecosystem holistically?
            - If they think of individual attributes, can the attributes be thought of separately?
                - If so, CE appropriate.
        - How does information presentation affect respondents understanding of item to be valued?
            - If complex, listing individual attributes (CE) may be confusing

- Policy background
    - The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) gave government the right to sue for damages to natural resources for which they are trustees.
        - In 1986, the Department of Interior said nonuse (largely existence) values were recoverable if use values were not measurable.
            - Sanctioned the use of CV
    - In 1989, a federal court of appeals directed the Department of the Interior to redraft its regulations with equal weight on use and nonuse values.
    - After the Exxon Valdez crash in March of 1989, DOI regulations meant that Exxon would have to pay for non-use damages.
        - CV estimate of damages: $3 billion. Other studies cited in Kling *et al*. range from $3.8 *million* (recreation demand study) to $4.9 *billion*
        - Difference is almost entirely that the larger study includes non-use values, rather than just the loss of actual visits to the spill area
            - Thus, CV became a focus of court cases.
        - Settled through a U.S. District Court consent decree in 1991.
            - Paid out $1 billion in damages and over $2 billion in immediate responses and restoration efforts
    - In response to the Exxon Valdez, Congress passed the Oil Pollution Act of 1990.
        - In addition to reducing the likelihood of future spills, the act provided for damage recovery.
        - The Department of Commerce was to draw up regulations on damage assessment.
            - The Dept., through the National Oceanic and Atmospheric Administration (NOAA), assembled a blue ribbon panel to evaluate CV.
                - Question to panel: Is the CV method capable of providing estimates of lost nonuse or existence values that are reliable enough to be used in natural resource damage assessments?
    - BP accident in 2010 raised the issue again

- How contingent valuation works:
    1. Ask people their willingness to pay (WTP) to bring about a specific environmental improvement (e.g. improved visibility from air pollution, protection of an endangered species).
    2. A payment mechanism is specified.
        - The respondent must believe that the money paid could lead to the desired effect.
            - E.g.: increase sewer fees to improve water quality.
        - It should not be controversial (e.g. property taxes).
            - Because the survey shouldn't serve as a referendum on the type of payment mechanism chosen.
            - Other alternatives include surcharges on utility bills or generally assessed fees
    3. Information about the respondent is usually gathered.
        - E.g. income, age, education...
        - Allows verification of results, estimation of income elasticities, etc.
- Survey development and implementation – how to describe the scenario
    - Goal of good survey design is to maximize validity and reliability of results
    - Scenario description
        - Both the baseline (status quo) and proposed change must be described in a way that is understood and viewed as credible
            - Description should be specific
                - Want to capture the value of a specific amenity (e.g. cleaning a local lakes) not a general class (e.g. preferences for lakes in general)
                - People may react to news (e.g. oil spills)
                    - Do people care about the resource (e.g. Alaskan coast) or preventing the action (e.g. clean up oil spills)?
        - Provide information on the mechanisms that will lead to the change
            - Payment mechanism must be clear and credible (e.g. on tax bill or utility bill)
    - Surveys should be pretested
        - Both qualitative (e.g. focus groups) and quantitative (pilot studies)
        - Do respondents understand the baseline and proposed treatment?
        - <u>Verbal protocol analysis</u> looks at why people answer as they do.
            - Have respondents think out loud.
                - When they do this, they often say irrelevant things: “If we all do our part it won’t cost much.”
                - Pretesting of surveys can avoid these problems.

- Data collection
  - Survey method
    - E.g. mail vs. electronic
      - Do Internet surveys reach all desired respondents?
    - Choice is often context specific
      - Phone generally worst, as difficult to convey complex information
  - Sample
    - Market studied should be the group of people whose welfare is affected by the change being valued
      - Harder to identify for non-use values
    - Draw sample from known frames consistent with the population
      - Check for non-response bias
  - Choice of sample relates to generalizability
    - To use WTP results to guide policy often requires aggregating results to a population
    - Knowledge of the sample frame is important for establishing generalizability
      - Socioeconomic characteristics of respondents should be documented
      - Test for non-response bias
        - Do the demographics of respondents compare to demographics of the population?
        - If there are differences, demographic data can be used to re-weight the responses
- Include auxiliary questions
  - Can help test validity
    - E.g. does willingness to pay increase with income?
  - Theory should motivate the use of auxiliary questions
    - Be careful to not include endogenous covariates
      - Responses to questions asked after valuation question may be influenced by the valuation
        - E.g. asking about a person's environmental beliefs or the certainty of their answer
  - Can identify demographic information
    - Demographics clearly exogenous

- Value elicitation – a payment mechanism is specified
    - The respondent must believe that the money paid could lead to the desired effect.
        - E.g.: increase sewer fees to improve water quality.
        - Surveys should be designed so participants believe the study's results could affect their well-being (consequentiality)
    - It should not be controversial.
        - Because the survey shouldn't serve as a referendum on the type of payment mechanism chosen.
        - Other alternatives include surcharges on utility bills or generally assessed fees (although Kling *et al*. do consider property taxes an alternative)
    - Use incentive-compatible response formats
        - Incentive compatible means that respondents have incentives to reveal their true value
            - E.g. there aren't strategic reasons to give a higher or lower answer
            - Voluntary contributions to public goods are an example
                - If the respondent believes the survey will be used to decide on the ultimate provision of a public good, may have incentive to report *more* that the true WTP and to contribute less should it become a reality
                - So as to influence provision and have an opportunity to free ride
            - Binding payment vehicles are incentive compatible and avoid free riding
                - Some taxes (e.g. income or sales taxes) can be avoided by consumers, and are thus not good choices
                - The question should involve a firm sense of commitment.
                    - "If the program is approved, firms will raise prices by $X."
        - Must be credible
        - Timing
            - Is it a one-time or annual payment?

- Types of questions:
  - Open-ended – ask respondents for maximum WTP.
    - "What is the highest amount you would be willing to pay each year to …?"
    - Open-ended questions are not incentive compatible.
      - May think strategically (how much do I need to offer to get the project done), rather than full value of the project.
  - Close-ended – ask respondents whether they are WTP a certain amount. This amount is varied across respondents.
    - "Would you pay $X for…?"
    - Close-ended questions are more like the everyday decisions that consumers make every day, and are thus easier for respondents to understand.
    - Best practice is to describe the market as a referendum
  - Bidding games – ask respondents if they are WTP a certain amount. If they say yes, raise the bid until they say no.
    - "Would you pay $5 for…?" "Yes." "Would you pay $10?"…
  - While early studies used a range of methods, standard practice now is to use close-ended responses.
    - A single bid offer is best, as iterative bidding can be subject to anchoring (e.g. influenced by where bidding started)
- What value to elicit? Willingness to pay (WTP) or willingness to accept (WTA)?
  - Implied property rights can inform the decision
  - Most studies estimate WTP
    - Framing WTA is more difficult
- Use multiple questions
  - Allows for testing for consistency in answers
  - May help respondents generate a better understanding of the task at hand
  - But be careful that sequencing doesn't affect answers
    - Questions should be independent of one another
    - Later questions shouldn't depend on answers to previous questions
    - If that will be a problem, shouldn't use multiple questions

- Example: study of the damage from the BP oil spill
    - Part of an effort to determine the value of natural resource damage from the spill
    - Used a nationally representative stated-preference survey
        - Would respondents support investing at least $17.2 billion to prevent future oil spills of this type in the Gulf of Mexico?
        - Took three years to design and pre-test the survey
        - Surveyed 3656 people
            - Response rate of 48%
    - Tests whether responses are consistent with economic decisions
    - Survey
        - Describes:
            - the state of the Gulf before the accident
            - what caused the accident
            - injuries to the Gulf's natural resources
                - This was randomly varied, describing different sets of injuries, to test for sensitivity to scope of injury. Examples:
                    - Smaller set: # of miles of oiled marshes, dead birds, and lost recreation trips
                    - Larger set: also included injuries to dolphins, coral, snails, and young fish and sea turtles
            - a proposed program for preventing future accidents
                - Can be seen as insurance against another spill occurring in the next 15 years
                - Involves drilling a second pipe as the same time a well is drilled
                    - Because it takes at least three months to drill a pipe, waiting until a leak occurs will not prevent an accident
                    - Doubles the cost of drilling, so survey says companies will need government support to pay for it
            - how much extra the household would pay in taxes if the program were implemented
                - Randomly assigned one of five different tax amounts: $15, $65, $135, $265, or $435.
                - Votes are used to establish a lower bound for WTP

- *Question*: What did the researchers do to ensure respondents believed their answers were consequential?
    - Respondents received official letter from US Department of Commerce, on letterhead, emphasizing that the survey results would be used for policy-making.
    - Interviewers reviewed content of that letter before administering the survey
    - Questionnaire explained that a decision on the program hadn't been made yet, and if it did move forward, it would require new tax revenue.
- *Question*: How do they show the results are represent consistent decisions?
    - Proportion of people voting for a proposal shouldn't increase as the tax increases
    - For a given tax amount, a program avoiding more injuries should be preferred
    - Table in paper shows both conditions were met.
- Results:
    - WTP for smaller set of injuries: $136 (s.e. $6.34)
    - WTP for larger set of injuries: $153 (s.e. $6.87)
        - Implies an aggregate benefit of $17.2 billion
            - Equals $153 X 112,647, 215 households in the US