Introduction to Contingent Valuation Using Stata

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  - Indirect (e.g., travel cost method, hedonic pricing, averting behavior)
  - Direct (e.g., contingent valuation, choice modelling)
- Contingent valuation implies asking to a sample of the population about their willingness to pay.

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- This changed after the State of Alaska requested a contingent valuation exercise to get an estimate of the non-use value loss associated with the Exxon Valdez oil spill (Carson *et al.*, 1992).
- Widely used and discussed in environmental economics literature.
- There is still debate about its validity:
  - Carson (2012). Contingent Valuation: A Practical Alternative when Prices Aren't Available. *Journal of Economic Perspectives*
  - Hausman (2012). Contingent Valuation: From Dubious to Hopeless. *Journal of Economic Perspectives*

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CV with dichotomous choice questions

- The objective of this presentation is to show how to econometrically analyse data obtained from a contingent valuation survey using Stata.
- One of the most common ways to elicit WTP using contingent valuation is to use a dichotomous choice question.
- In the simplest case the individual is asked: will you be willing to pay t for the program that I just described?
- The dichotomous answer ($y_i = 0$ if the individual answers no and $y_i = 1$ if the answer is yes), given a question about paying a previously determined amount (t_i, that varies randomly across individuals), allows us to to estimate the WTP.

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- where z_i is a vector of explanatory variables, β is a vector of parameters and u_i is an error term.
- It is expected that the individual will answer yes when his WTP is greater than the suggested amount, i.e., when $WTP_i > t_i$.

Estimating WTP (II)

- WTP from the previous model can be estimated using `probit` with some minor modifications or directly using the command `singleb` (see López-Feldman (2013a) or López-Feldman (2013b) for details).

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- Hanemman *et al.* (1991) suggest an alternative to improve efficiency of the estimation.
- The alternative is known as the double-bounded model or dichotomous question with follow-up.

Contingent valuation using double-bounded model (I)

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- Let's call the first bid amount t^1 and the second one t^2, then each individual will be in one of the following categories:
  1. The individual answers yes to the first question and no to the second, then $t^2 > t^1$. In this case we can infer that $t^1 \leq WTP < t^2$.
  2. The individual answers yes to the first question and yes to the second, then $t^2 \leq WTP < \infty$.
  3. The individual answers no to the first question and yes to the second, then $t^2 < t^1$. In this case we have that $t^2 \leq WTP < t^1$.
  4. The individual answers no to the first and second questions, then we have that $0 < WTP < t^2$.

Econometric estimation using the double-bounded model

- Let's define y_i^1 and y_i^2 as the dichotomous variables that capture the response to the first and second closed questions, then the probability that an individual answers yes to the first question and no to the second can be expressed as:

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- Let's define y_i^1 and y_i^2 as the dichotomous variables that capture the response to the first and second closed questions, then the probability that an individual answers yes to the first question and no to the second can be expressed as:
- $Pr(y_i^1 = 1, y_i^2 = 0|z_i) = Pr(s, n)$.
- Given this and under the assumption that $WTP_i(z_i, u_i) = z_i'\beta + u_i$ and $u_i \sim N(0, \sigma^2)$, we have that the probability of each one of the four cases is given by:

1. $y_i^1 = 1$ and $y_i^2 = 0$.

$$
\begin{aligned}
Pr(s,n) &= Pr(t^1 \leq WTP < t^2) \\
&= Pr(t^1 \leq z_i'\beta + u_i < t^2) \\
&= Pr\left(\frac{t^1 - z_i'\beta}{\sigma} \leq \frac{u_i}{\sigma} < \frac{t^2 - z_i'\beta}{\sigma}\right) \\
&= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right)
\end{aligned}
$$

- Therefore, using symmetry of the normal distribution we have that:

$$
Pr(s,n) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \qquad (2)
$$

2. $y_i^1 = 1$ and $y_i^2 = 1$.

$$\begin{aligned} Pr(s,s) &= Pr(WTP > t^1, WTP \geq t^2) \\ &= Pr(z_i'\beta + u_i > t^1, z_i'\beta + u_i \geq t^2) \end{aligned}$$

- Here by definition $t^2 > t^1$ and then $Pr(z_i'\beta + u_i > t^1 | z_i'\beta + u_i \geq t^2) = 1$ which implies:

$$\begin{aligned} Pr(s,s) &= Pr(u_i \geq t^2 - z_i'\beta) \\ &= 1 - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \end{aligned}$$

- so by symmetry we have:

$$Pr(s,s) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \quad (3)$$

3. $y_i^1 = 0$ and $y_i^2 = 1$.

$$\begin{aligned} Pr(s,n) &= Pr(t^2 \leq WTP < t^1) \\ &= Pr(t^2 \leq z_i'\beta + u_i < t^1) \\ &= Pr\left(\frac{t^2 - z_i'\beta}{\sigma} \leq \frac{u_i}{\sigma} < \frac{t^1 - z_i'\beta}{\sigma}\right) \\ &= \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \end{aligned}$$

$$Pr(s,n) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) \tag{4}$$

4. $y_i^1 = 0$ and $y_i^2 = 0$.

$$\begin{aligned} Pr(n,n) &= Pr(WTP < t^1, WTP < t^2) \\ &= Pr(z_i'\beta + u_i < t^1, z_i'\beta + u_i < t^2) \\ &= Pr(z_i'\beta + u_i < t^2) \\ &= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \end{aligned}$$

$$Pr(n,n) = 1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \tag{5}$$

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- Contrary to the single-bounded case, equations (2) to (5) do not correspond directly to a pre-existent model.
- In order to proceed with the estimation the following likelihood function is used to estimate β and σ

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- In order to proceed with the estimation the following likelihood function is used to estimate β and σ

$$\sum_{i=1}^{N} d_i^{sn} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)$$

$$+ d_i^{ss} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)$$

$$+ d_i^{ns} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right)\right)$$

$$+ d_i^{nn} \ln\left(1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)$$

doubleb

- The command `doubleb` described in López-Feldman (2013a) and López-Feldman (2013b) uses maximum likelihood estimation to get estimates for β and σ that can then be used to estimate *WTP*.

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- The basic syntax of the command is:
- **doubleb** *varlist* [*if*] [*in*] [*weight*] , [**level(#) noconstant**]
- The first and second variables in *varlist* should be the first and second bid variables, respectively.
- The third and fourth variables should be the dummies for the response to the first and second dichotomous choice questions, respectively. The remaining variables will be interpreted as covariates or control variables.
- Note that the second bid variable refers to the actual bid offered after the individual has answered to the first bid.

Example of the use of `doubleb` (I)

- A data set for a natural reserve in Portugal is used to illustrate the estimation
- The data set captures willingness to pay to avoid the development of commercial and tourist infrastructure inside the park.

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- A data set for a natural reserve in Portugal is used to illustrate the estimation
- The data set captures willingness to pay to avoid the development of commercial and tourist infrastructure inside the park.
- The following table presents the definition of some of the variables included in the data.

Table: 1

Name of the variable	Definition
bid1	initial amount (bid) in euros
bid2	second bid in euros
answer1	= 1 if the answer to the first WTP question was y
answer2	= 1 if the answer to the second WTP was yes

Example of the use of doubleb (II)

```
. * Model with explanatory variables
. doubleb bid1 bid2 answer1 answer2 age female
initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -940.87306
rescale:       log likelihood = -444.64525
rescale eq:    log likelihood = -409.27306
Iteration 0:   log likelihood = -409.27306
Iteration 1:   log likelihood = -396.34722
Iteration 2:   log likelihood = -394.56437
Iteration 3:   log likelihood =  -394.5571
Iteration 4:   log likelihood =  -394.5571
                                                  Number of obs   =        312
                                                  Wald chi2(2)    =      26.28
Log likelihood =  -394.5571                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
         age |  -8.047011   1.639399    -4.91   0.000    -11.26017   -4.833848
      female |  -6.237376    4.81779    -1.29   0.195    -15.68007    3.205319
       _cons |   46.35356    5.83763     7.94   0.000     34.91202    57.79511
-------------+----------------------------------------------------------------
Sigma        |
       _cons |   36.90406   2.776473    13.29   0.000     31.46227    42.34585
------------------------------------------------------------------------------

First-Bid Variable:             bid1
Second-Bid Variable:            bid2
First-Response Dummy Variable:  answer1
Second-Response Dummy Variable: answer2
```

Example of the use of `doubleb` (III)

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- The `doubleb` command directly estimates $\hat{\beta}$. Then, the WTP formula is simply $\tilde{z}'\hat{\beta}$.

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- The doubleb command directly estimates $\hat{\beta}$. Then, the WTP formula is simply $\tilde{z}'\hat{\beta}$.
- Therefore, for this example the estimate of the mean WTP is:

```
. * WTP for mean values
. nlcom (WTP:(_b[_cons]+age_m*_b[age]+female_m*_b[female])), noheader
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	18.52186	2.425411	7.64	0.000	13.76814	23.27558

References

- López-Feldman (2013a). *Introducción a la valoración contingente utilizando Stata*. Chapter 4 in Mendoza(2013), *Aplicaciones en Economía y Ciencias Sociales con Stata*, Stata Press.
- López-Feldman (2013b). *Introduction to contingent valuation using Stata*. MPRA paper 41018. Available here.