Bivariate Ordered Probit

Ordered Probability Models

- Unobserved variable is typically specified as a linear function for each observation (*n* subscripting omitted), such that

$$z = \boldsymbol{\beta}\mathbf{X} + \varepsilon,$$

- where $\boldsymbol{X}$ is a vector of explanatory variables determining the discrete ordering for observation *n*, $\boldsymbol{\beta}$ is a vector of estimable parameters, and ε is a random disturbance.

Using this equation, observed ordinal data, y, for each observation are defined as,

$$
\begin{aligned}
y &= 1 && \text{if } z \leq \mu_0 \\
y &= 2 && \text{if } \mu_0 < z \leq \mu_1 \\
y &= 3 && \text{if } \mu_1 < z \leq \mu_2 \\
y &= \ldots && \\
y &= I && \text{if } z \geq \mu_{I-1} \text{ ,}
\end{aligned}
$$

where μ are estimable parameters (referred to as thresholds) that define y, which corresponds to integer ordering, and I is the highest integer ordered response.

For the Bivariate case we have:

$$z_{i1} = \boldsymbol{\beta}_1 \mathbf{X}_{i1} + \varepsilon_{i1},$$

$$z_{i2} = \boldsymbol{\beta}_2 \mathbf{X}_{i2} + \varepsilon_{i2},$$

And we now take into account the facts that these equations are linked by:

$$\rho = \mathrm{Cor}(\varepsilon_{i1}, \varepsilon_{i2})$$

This is equivalent to a SURE model for non-continuous data.

Limdep commands are more involved:

1. Estimate two single equation models and store estimation results

2. Use single equation results to estimate a joint model and ρ

Assignment 4 (based on Example 14.1)

- A survey of 279 commuters conducted in the Seattle metropolitan area.
- The survey's intent was to gather information on commuters' opinions of high-occupancy vehicle (HOV) lanes (lanes that are restricted for use by vehicles with 2 or more occupants).
- Opinion questions have ordered opinion responses:

  strongly disagree, disagree, neutral, agree, agree strongly

Questions we will address:

1. Existing HOV lanes are being adequately used:
   0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

2. HOV lanes should be open to all traffic:
   0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

With these questions we expect:

$$\rho = \text{Cor}(\varepsilon_{i1}, \varepsilon_{i2}) \text{ will be } \textbf{negative}$$

Limdep estimation procedure:

1. Existing HOV lanes are being adequately used (x28):

```
oprobit;lhs=x28;rhs=one,….$
matrix;b1=b;mu1=mu$
```

2. HOV lanes should be open to all traffic (x29):

```
oprobit;lhs=x29;rhs=one,….$
matrix;b2=b;mu2=mu$
```

3. Estimate the bivariate model:

```
oprobit;lhs=x28,x29
;rh1=one,dalone,x8,oldmen,college,x37
;rh2=one,dalone,x8,oldmen,college,x37
;start=b1,mu1,b2,mu2,0$
```

Here the “start” command has beta’s and mu’s from univariate models, and the “0” is the initial correaltion coefficient, ρ

Assignment #4:

- Says to model X28 and X29

- **BUT:** You can experiment with any dual combination of:

X27; X28; X29; X30; X31

- Also can consider recoding X27; X28; X28; X30; X31 **from 5 responses:** 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly
- **To 3:** 0 if strongly disagree or if disagree, 1 if neutral, 3 if agree or agree strongly

X27 HOV lanes save all commuters time: 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

X28 Existing HOV lanes are being adequately used: 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

X29 HOV lanes should be open to all traffic: 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

X30 Converting some regular lanes to HOV lanes is a good idea: 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly

X31 Converting some regular lanes to HOV lanes is a good idea only if it is done before traffic congestion becomes serious: 0 if strongly disagree, 1 if disagree, 2 if neutral, 3 if agree, 4 if agree strongly