6. *Other Models and Issues*

6.1 Tobit model (censored model)

The RE Tobit is very similar to the RE probit with the difference being in the observation rule.

$$y_{it}^{*} = \mathbf{x_{it}}\beta + c_i + u_{it} \qquad (1)$$

The observation rule: $y_{it} = y_{it}^{*}$ if $y_{it}^{*} > 0$

$y_{it} = 0$ otherwise

Also known as **censored** regression model.

Observations below 0 are censored at 0.

Note, we know who these people are.

Make the same assumptions as before and use MLE

St. exog of $\mathbf{x}$; $u_{it} \sim N(0,\sigma^2_u)$ etc.

The joint density for the ith observation is:

$$f(y_{i1},..,y_{iT}|\mathbf{x_{it}}, c_i) = \prod_t \left[\frac{1}{\sigma_u} \varphi\left(\frac{y_{it} - \mathbf{x_{it}}\boldsymbol{\beta} - c_i}{\sigma_u} \right) \right]^{d_{it}} \left[1 - \Phi\left(\frac{\mathbf{x_{it}}\boldsymbol{\beta} + c_i}{\sigma_u} \right) \right]^{1-d_{it}}$$

where $d_{it} = 1$ if $y_{it}^* > 0$ (i.e. y_{it} is observed and not **censored**)

Proceed as before by integrating out the c under a particular dist assumption or use a discrete approximation.

6.2 Incomplete panels and selection bias

- Reasons for incompleteness – attrition?
- Selection endog?

EG: Explaining performance of mutual funds – badly performing funds may not survive and therefore not appear in the sample.

- If observation missing, is it **missing at random?**

  Consider $y_{it} = \mathbf{x_{it}}\beta + c_i + u_{it}$

  Define $r_{it} = 1$ if $(y_{it}, \mathbf{x_{it}}\beta)$ is observed and $r_{it}=0$ if missing.

  Observations $(y_{it}, \mathbf{x_{it}}\beta)$ are **missing at random** if r_{it} is indep of c_i and u_{it}.

Simple tests (Verbeek and Nijmann, 1992)

(i) If you include some functions of the indicators r_{it}, it should not be significant.

- For example, can add r_{it} (observed in the last period); $\prod_{t=1}^{T} r_{it}$ (observed in all the periods); or $\sum_{t=1}^{T} r_{it}$ (total number of periods over i was observed).
- In the case of linear models, the model has to be a RE model.
- Rejection may not actually indicate no-selection bias – low power!

(ii) Comparison of the balanced vs unbalanced model estimates – use Hausman test.

Estimation in the presence of selection

Need to make extra assumptions.

Example: $r_{it}=1\{\mathbf{z_{it}\gamma} + \mu_i + e_{it}\}$

More complicated joint estimation.

- If selection is fully dependent on time-invariant characteristics, the problem becomes manageable!