AGRODEP Training Session

Poverty Dynamics -Models

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- Most common approach is to use a hazard regression model of poverty (re)exit and re-entry rate using data on poverty spells
- Second most uses approaches are variance-component models of income.
- The drawbacks of these methods are that they are very data intensive and usually not applicable with short panel data. We will focus on the models derived from the Jalan and Ravaillion's component approach and the Markovian transition models.

Component approach

Censored variables =>Tobit models

- Chronic Poverty

$$C_i = (\frac{\overline{y_i} - z}{z})^2 \text{ if } \overline{y_i} \lessdot z$$
$$C_i = 0 \text{ if } \overline{y_i} \lessdot z$$

- Transient Poverty

$$T_i = P_i - C_i$$

Component approach

Censored variables =>Tobit models

$$\begin{aligned} T_i &= T_i^* \text{ if } T_i > 0 \\ T_i &= 0 \text{ otherwise} \end{aligned}$$

$$T_i^* = x\prime_i \beta^T + u_i^T$$

$$\begin{aligned} C_i &= C_i^* \text{ if } C_i > 0 \\ C_i &= 0 \text{ otherwise} \end{aligned}$$

$$C_i^* = x\prime_i \beta^c + u_i^C$$

Markovian transition approach

- What are the determinans of poverty persistence and poverty entry rates?
- Assumptions about the nature of the dynamic process
  - We assume that poverty follows a first order Markov process

$=>$ It implies that transition probabilities are independent of the poverty status previous to $t-1$ and namely of the duration spent in each poverty state.

  - Initial conditions (initial poverty status) matter, as well as,
  - Household characteristics, as well
  - Unobserved individual time invariant heterogeneity

Markovian transition approach

	Poverty status, year t	
Poverty status, year t-1	Not poor	Poor
(a) Complete Panel: Sample size=43626 observations, 16126 households		
Not poor	55,67	44,33
Poor	17,84	82,16
All	27,46	72,54
(b) Balanced Panel: Sample size=18545 observations, 6139 households		
Not poor	56,51	43,49
Poor	18,04	81,96
All	27,81	72,19

The poverty line is evaluated at 988600 Fmg in 2001 (INSTAT, 2002) and is deflated by the national IPC for the other years.

Table 1: Poverty transition matrix, ROR surveys 1999-2006, pooled data

Markovian transition approach

Impact of past poverty

- The impact of past poverty on current poverty can be treated in different ways. The appropriate model depends on how one believes past poverty affects current poverty propensity.
- If one believes that past poverty status has a slope effect => endogenous switching model b/w the poor and the non-poor "regime"
- If one believes that previous poverty status has merely an intercept effect on current poverty status, then the appropriate model includes initial poverty status as a right-hand-side variable and pools the entire sample of previously poor and previously non-poor households.=> dynamic random effect probit model.

Markovian transition approach

Random effect probit model

$$P(p_{it} = 1) = P(\theta_1 p_{it-1} + \delta' g_{it} + e_i + \varepsilon_{it} > 0)$$

where p_{it} is the poverty status of household $i, i = 1...N$ in period $t, t = 1...T$ and p_{it-1} is the poverty status in the previous period $t-1$. The vector g_{it} is a vector of exogenous explanatory variables. The scalar e_i is an (unobserved) household time invariant effect. It contains all household specific time invariant unobserved determinants of poverty like intelligence or motivation for instance. The residual ε_{it} is an error term assuming to follow a standard normal distribution.

Markovian transition approach

Random effect probit model: Treatment of unobserved heterogeneity

- Probit + unobserved time invariant heterogeneity => incidental parameter problem
- To consistently estimate your coefficients, you need that the error term is uncorrelated with explanatory variables
- We need to decide how to treat the initial poverty status (initial condition)
- Wooldrige's (2005) method

Modelling the household fixed effect

(Wooldrige, 2005)

$$e_i = \Psi + \bar{x}_i\xi + \tau p_{i0} + a_i$$

with $\bar{x}_i = \frac{1}{T}\sum_{i=1,\ldots,T} x_{it}$ and $a_i / (\bar{x}_i, p_{i0}) \hookrightarrow Normal(0, \sigma_a^2)$. The model can be rewritten :

$$p_{it} = P(\delta' x_{it} + \theta p_{it-1} + \Psi + \bar{x}_i\xi + \tau p_{i0} + a_i + u_{1it} > 0)$$

with $a_i / (\bar{x}_i, n_{i0}, ln(d_{i0}))\tilde{}Normal(0, \sigma_a^2)$

$\Rightarrow$ By construction, a_i is uncorrelated with the explanatory variables.

$\Rightarrow$ Classical assumptions needed to consistently estimate $(\delta, \theta, \Psi, \xi, \tau)$ with random effects by conditional maximum likelihood are verified (strict exogeneity of explanatory variables, orthogonality between explanatory variables and the unobserved time invariant heterogeneity).

Markovian transition approach

Random effect probit model: Interpreting the results

- Average partial effect (APE)
- Households permanent characteristics ($\bar{x}_i$) vs time varying variables (x_{it})
- State dependence is measured by the APE of p_{it-1}

Markovian transition approach

Random effect probit model: Limitations

- Coefficients of the explanatory variables are restricted to be the same for the poor and the non-poor households (average effect of explanatory variable on the poverty risk)
- Analysis that allows a differential impact of explanatory variables on the poverty risk depending on the poverty status could be appropriate. For instance, we know that the return on productive capital is lower for the poor because exclusion from insurance and credit markets maintain them in low risk-low return activities

Markovian transition approach

Endogenous switching model

- Cappellari and Jenkins, 2004
- Bivariate probit:

Basis poverty status:

$$P(p_{it-1} = 1) = \Phi(\alpha' z_{it-1})$$

Poverty transition:

$$P(p_{it} = 1 | p_{it-1}) = \Phi([p_{it-1}\beta_1' + (1 - p_{it-1})\beta_2']x_{it})$$

where p_{it-1} and p_{it} are poverty status at $t-1$ and t respectively. The z_{it} and x_{it} vectors are vectors of exogenous explanatory variables and Φ is the standard normal cumulative distribution function. The scalar i, $i = 1...N$, indexes individuals and the scalar t indexes time.

Markovian transition approach

Poverty propensity at $t-1$:

$$p^*_{it-1} = \alpha' z_{it-1} + u_{it-1}$$

Poverty propensity at t:

$$p^*_{it} = [p_{it-1}\beta'_1 + (1 - p_{it-1})\beta'_2]x_{it} + v_{it}$$

with

$$\rho = corr(u_{it-1}, v_{it})$$

Markovian transition approach

Endogenous switching model: Interpreting the results

- Average partial effect (APE)
- Determinants of poverty entry, poverty persitence and poverty dynamics in general
- State dependence can be tested by looking at the difference b/w β_1 and β_2

Markovian transition approach

Endogenous switching model: Interpreting the results

- Cappellari and Jenkins (2004) propose the following measures for agregate and genuine state dependence

$$ASD = \frac{\sum_{j \in \{p_{jt-1}=1\}} P(p_{jt} = 1 | p_{jt-1} = 1)}{\sum_{j} p_{jt-1}} - \frac{\sum_{j \in \{p_{jt-1}=0\}} P(p_{jt} = 1 | p_{jt-1} = 0)}{\sum_{j} (1 - p_{jt-1})}$$

Markovian transition approach

Endogenous switching model: Interpreting the results

- Cappellari and Jenkins (2004) propose the following measures for agregate and genuine state dependence

$$GSD = \frac{1}{N} \sum_{i=1\ldots N} [\widehat{P}(p_{it} = 1 | p_{it-1} = 1) - \widehat{P}(p_{it} = 1 | p_{it-1} = 0)]$$

$$= \frac{1}{N} \sum_{i=1\ldots N} [\frac{\Phi_{\mathbf{2}}(\widehat{\beta}_1' x_{it}, \widehat{\alpha}' z_{it}; \rho_1)}{\Phi(\widehat{\alpha}' z_{it})} - \frac{\Phi_{\mathbf{2}}(\widehat{\beta}_2' x_{it}, -\widehat{\alpha}' z_{it}; -\rho_2)}{\Phi(-\widehat{\alpha}' z_{it})}]$$

Markovian transition approach

Endogenous switching model: Interpreting the results

- The poverty persistence probability, i.e, the probability of being poor at t, conditional on being poor at $t-1$, is given by:

$$s_{it} = P(p_{it} = 1 | p_{it-1} = 1) = \frac{\Phi_{\mathbf{2}}(\beta_1' x_{it}, \alpha' z_{it}; \rho)}{\Phi(\alpha' z_{it})}$$

- The poverty entry probability, i.e., the probability of being poor at t, conditional on being non-poor at $t-1$, is given by:

$$e_{it} = P(p_{it} = 1 | p_{it-1} = 0) = \frac{\Phi_{\mathbf{2}}(\beta_2' x_{it}, -\alpha' z_{it}; -\rho)}{\Phi(-\alpha' z_{it})}$$

Household type	Description	Poverty persitence rate *(ESPM)*	Poverty entry rate	Poverty risk *(REDP model)*
(1)	**Male household head** Couple with 2 children, living with one elder. No shocks on crops Net seller of rice	**0,75**	**0,62**	**0,82**
(2)	As (1) except change to female household head and monoparental family	0,75	0,80	0,84
(3)	As (1) + 2 children	0,83	0,75	0,89
(4)	As (1) except net net buyer of rice	84,00	0,62	0,87
(5)	As (1) except no education	0,82	0,67	0,89
(6)	As (1) except 4 children	0,78	0,63	0,83
(7)	As (1) except rice harvest reduced detroyed	0,75	0,62	0,86
(8)	**Female household head,** monoparental family other characteristics like (1)	**0,75**	**0,55**	**0,82**
(9)	As (8) + 2 children	0,83	0,65	0,89
(10)	As (8) except net buyer of rice	0,79	0,58	0,87
(11)	As (8) except no education	0,82	0,65	0,89

Table 2: Predicted persistence and poverty entry rates and predicted poverty risk, ROR surveys 1999-2006, Madagascar

Markovian transition approach

Endogenous switching model: Accounting for attrition

- Allows to treat attrition in an heckman-style procedure
- Retention propensity

$$r_{it}^{*} = \psi' w_{it-1} + w_{it} \tag{1}$$

Poverty propensity at $t-1$:

$$p_{it-1}^{*} = \alpha' z_{it-1} + u_{it-1}$$

- Poverty propensity at t:

$$p_{it}^{*} = [p_{it-1}\beta_1' + (1 - p_{it-1})\beta_2']x_{it} + v_{it}$$

Markovian transition approach

Endogenous switching model: Accounting for attrition

with

$$\begin{aligned} \rho &= corr\left(u_{it-1}, v_{it}\right) \\ \rho &= corr\left(u_{it-1}, w_{it}\right) \quad (2) \\ \rho &= corr\left(w_{it}, v_{it}\right) \quad (3) \end{aligned}$$

▲: exclusion restriction !

Markovian transition approach

Endogenous switching model: Limitations

- The pooled estimator does not allow to estimate unobserved heterogeneity
- The impact of poverty in this model is measured only through the interaction with observed explanatory variables. All others transmission channels are ignored.

The spell approach

- Bane and Ellwood, 1986; Stevens, 1999
- Studies durations of poverty spells and probabilities that a poverty spell ends.
- The hazard, i.e. the instantaneous probability of leaving poverty at period t given that the household has not already left poverty, is specified as a function of the characteristics of households and the duration of past poverty.
- The latest versions of hazard models (also called duration models) take into account multiple episodes of poverty and unobserved heterogeneity.
- Hazard models are very well suited to study the impact of past poverty on current poverty (*state dependence* mechanisms).

The spell approach

Hazard model

Formal notation:

$$c \log\log(h_{id}) = \mathbf{f}(\mathbf{d}) + \beta \mathbf{x_{id}}$$

h :hazard rate
d: duration
x_{it} : individual characteristics

The spell approach

Limitations

- In practice, some problems arise though.
- Unobserved heterogeneity and initial conditions.

  Introduction of unobserved heterogeneity in hazard models leads to an issue regarding the treatment of (endogenous) initial conditions. If the model is true and that an individual time-invariant variable affects poverty propensity, the first observed individual's poverty status is no longer random. Individuals with a high poverty propensity are more likely to be found in poverty at the start of the observation period. This issue requires very complex treatments that did not find a satisfactory answer until now . Practically, the household initial poverty status is always considered exogenous.
- Right and left censures

Multivariate Analyses: Small Number of Panel Waves

1. Discrete choice models: multinomial logit models
2. Modelling a continuous welfare measure (income or expenditure)