2022 Essex Summer School
3K: Dynamics and Heterogeneity

Robert W. Walker, Ph. D.
Associate Professor of Quantitative Methods
Atkinson Graduate School of Management
Willamette University
Salem, Oregon USA
rwalker@willamette.edu

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To Panel GLM

A Brief Diversion to GEE

Semi-parametric regression that relies on specifying the first-two moments.

Random effects and variances are nuisance (this is the PA option)

Estimating equations, not likelihoods so no L-R tests.

Specifies the within-group structure.

Uses the sandwich for variance/covariance matrix

Back to the Story

- Is the effect that we want to identify a within or a between effect?
- A brief aside on the population issue
- BIG PICTURE ISSUE: Just because data are not continuous does not mean heterogeneity and dynamics don't matter.

Nuisance v. Substance

There are methods, like GEE, that treat dynamics and other issues as nuisance. Specify some correlation structure and then utilize a moment-based quasi-likelihood estimator to get parameter estimates because we don't care about the correlation. In many instances, this is probably fine. But many times, the precise time issues are essential.

Panel Data Count Models

Stata estimates two panel data count model classes – the Poisson and the Negative Binomial. In most cases, the fact that the Poisson is a single-parameter distribution leads to a default preference for the negative binomial (of which the Poisson is a special case).

- `xtpoisson` estimates fixed effects, random effects, and population averaged versions of the Poisson model for TSCS/CSTS. The population averaged version is simply a GEE with a correlation option.

- `xtnbreg` is similar with a negative binomial regression model. The options are the same.

Binary Models

Stata estimates three panel data binary estimators – the logit, probit, and cloglog. Fixed, random, and population averaged versions exist for logit and cloglog; the probit has no fixed effects version. The PA is, again, a GEE estimator.

Ordered Models

Stata estimates two classes of panel data ordinal regressions – the logit and probit. Both are random effects estimators, though population averaged versions exist. The PA is, again, a GEE estimator.

Mixed Effects Models

`xtmelogit` (logit) and `xtmepoisson` (Poisson) estimate mixed effects regression models for TSCS/CSTS data. The ideas and implementation are similar to the related command `xtmixed` that we have discussed.

`xtgee` **syntax**

`xtgee` operates off of the GLM family and link function ideas. For example, probits and logits are family (binomial) with a probit or logit link. The key issue becomes specifying a working correlation matrix (within-groups/units) from among the options of exchangeable, independent, unstructured, fixed (must be user specified), ar (of order), stationary (of order), and nonstationary (of order).

Binary Dynamics

There are four classes of discrete time series models that we might use for incorporating dynamics for binary observations varying across both time and space. These get some treatment in the paper by Beck, et. al.

- Latent dependence (Dynamic Linear Models)
- State dependence (Markov Processes)
- Autoregressive disturbances
- Duration (survival models and isomorphisms)

Latent Dependence

Carry on the setup from yesterday.

$$u^*_{i,t} = X\beta + \rho u^*_{i,t-1} + \epsilon_{it}$$

This is the analog of a lagged dependent variable regression fit in the latent space rather than the observed data. Such models are probably easiest to fit using Bayesian data augmentation.

Autoregressive Errors and Serial Correlation

$$u^*_{i,t} = X\beta + \epsilon_{it} \quad (1)$$

$$\epsilon_{i,t} = \rho\epsilon_{i,t-1} + \nu_t \quad (2)$$

where ν are i.i.d. The model is odd in the sense that a shock to X dies immediately but a shock to an omitted thing has dynamic impacts. There are some suggested tests for serial correlation. We will implement one of them that employs the generalized residual. The idea is similar to what we have seen before. Here, we have two outcome values and two possible generalized residuals. We either have the density over the CDF or the negative of the density over one minus the CDF. Then we want the covariance in time of the generalized residuals

and need to calculate a variance given as

$$V(s) = \sum_{t=2}^{T} \frac{\phi_t^2 \phi_{t-1}^2}{\Phi_t(1-\Phi_t)\Phi_{t-1}(1-\Phi_{t-1})}$$

We could apply this individually or collectively to the whole set with N summations added to the mix. One can show that the covariance over the square root of $V(s)$ has an asymptotic normal distribution.

BKT 1998

Beck, Katz, and Tucker (1998) point out that BTSCS are grouped duration data. Indeed, a cloglog discrete choice model is a Cox proportional hazards model. They are not similar, like each other, whatever. They are isomorphic. One can leverage this to do something about the temporal evolution of binary processes. Let's get to the details.

Carter and Signorino

One can use a Taylor series approximation to maximize degrees of freedom while maintaining significant flexibility in the baseline hazard with their approach. A cloglog regression with time, time-squared, and time-cubed.

Markov Processes

Markov processes extend to a general class of discrete events observed through time and across units. While the reading discusses the binary case, extensions for ordered and multinomial events are straightforward. I will show two examples.

$$\mathbf{P} = \begin{pmatrix} \pi_{11} & \pi_{12} & \dots & \pi_{1J} \\ \pi_{21} & \ddots & \dots & \vdots \\ \vdots & \ddots & \dots & \vdots \\ \pi_{J1} & \pi_{J2} & \dots & \pi_{JJ} \end{pmatrix}$$

- Rows represent s^t: the state up to time t
- Columns represent y^t
- Rows sum to unity

The idea is that the current outcome depends on covariates and the prior state. We can do a lot with that.

Some General Comments on Panel GLM

- One has to be careful with these extensions of standard linear models. Ex. Random effects probit and fixed effects logit.
- The orthogonality of the random effects and the regressors is maintained.
- In most cases, the real trouble is incidental parameters. That may not be as harsh as it initially seems. William Greene has an interesting argument about this in his paper, "Estimating Econometric Models with Fixed Effects".