New in

Panel-data extended regression models (ERMs)

ERMs = Endogeneity  
+ Selection  
+ Treatment  
+ Panel data

We call them ERMs—extended regression models. They account for problems that arise in your data, even when those problems arise simultaneously.

**Models**
- Outcomes
  - Continuous
  - Interval-censored
  - Binary
  - Ordinal
  - Maximum likelihood estimation
  - Accounts for
    - Endogenous covariates
      - Unobserved confounding
      - Continuous, binary, and ordinal
      - Polynomials and interactions
    - Sample selection
      - MNAR outcomes
    - Nonrandom treatment assignment
      - Casual inference
      - Endogenous treatment
      - Exogenous treatment
  - Panel data
    - Random effects
    - Longitudinal data
    - Two-level data

**Advanced inferences**
- Inference statistics
  - Expected means
  - Expected probabilities
  - Contrasts/effects
  - Marginal effects
  - Average treatment effects (ATEs)
  - Potential-outcome means (POMs)
  - Average structural function (ASF) effects
  - Average structural probability (ASP) effects
  - Estimates of statistics are available for
    - Full population
    - Subpopulations
    - Means for specified covariate values
    - Censored and uncensored outcomes
  - Conditional analysis—specify values of all covariates
  - Population-averaged analysis—specify values of some covariates, or none, and average over the rest
  - Tests and confidence intervals for all statistics
  - Profile plots
Panel/longitudinal data
Say you want to fit a model of wages and have repeated data on individuals. You want to use random effects to account for within-panel correlation.

You type

```
xteregress wage c.age##c.age education
```

Panel data with endogenous covariates
But what if you worry education is endogenous—that unobserved variables that influence education also influence wage? You want to account for the endogenous covariate and within-panel correlation.

You type

```
xteregress wage c.age##c.age, endogenous(education = med fed)
```

Panel data with sample selection
What if wages are observed only for people who work and you worry that missing outcomes are missing not at random (MNAR)? You want to account for sample selection and within-panel correlation.

You type

```
xteregress wage c.age##c.age, select(working = age ed minwage)
```

Panel data with nonrandom treatment assignment
What if union membership affects wages and unobserved factors that influence membership also influence wage? You want to account for nonrandom treatment assignment and within-panel correlation.

You type

```
xteregress wage c.age##c.age, entreat(union = age i.urban i.occupation)
```

Panel data with multiple complications
What if endogenous covariates, sample selection, and nonrandom treatment assignment arise simultaneously in your panel data?

You type

```
xteregress wage c.age##c.age, endogenous(ed = med fed) select(working = age ed minwage) entreat(union = age i.urban i.occupation)
```

Binary, ordinal, or interval-censored outcomes
Panel-data ERM commands work in the same way with other types of outcomes.

If you have a binary outcome, you type

```
xteprobit highwage c.age##c.age, endogenous(ed = med fed) select(working = age ed minwage) entreat(union = age i.urban i.occupation)
```

If you have an ordinal outcome, you type

```
xteoprobit wagecat c.age##c.age, endogenous(ed = med fed) select(working = age ed minwage) entreat(union = age i.urban i.occupation)
```

If you have an interval-censored ordinal outcome, you type

```
xteintreg wagemin wagemax c.age##c.age, endogenous(ed = med fed) select(working = age ed minwage) entreat(union = age i.urban i.occupation)
```

Analyze model results
With any of these models, we can easily analyze the results.

For instance, we can explore wages for different counterfactual levels of age and union membership.

```
margins union, at(age = (18(5)65))
```

We can easily visualize the results using `marginsplot`.