

bayes: xtnbreg — Bayesian random-effects negative binomial model

[Description](#)

[Quick start](#)

[Menu](#)

[Syntax](#)

[Remarks and examples](#)

[Stored results](#)

[Methods and formulas](#)

[Reference](#)

[Also see](#)

Description

`bayes: xtnbreg` fits a Bayesian panel-data random-effects negative binomial model to a nonnegative count outcome; see [\[BAYES\] bayes](#) and [\[XT\] xtnbreg](#) for details.

Quick start

Bayesian random-effects negative binomial model of `y` on `x1` and `x2` with random intercepts by `id` (after `xtset`ing on panel variable `id`), using default normal priors for regression coefficients and beta prior for the random effects, and Pareto prior for the shape parameters of the beta prior

```
bayes: xtnbreg y x1 x2
```

Use a standard deviation of 10 instead of 100 for the default normal priors

```
bayes, normalprior(10): xtnbreg y x1 x2
```

Use uniform priors for the slopes and a normal prior for the intercept

```
bayes, prior({y: x1 x2}, uniform(-10,10)) ///
prior({y: _cons}, normal(0,10)): xtnbreg y x1 x2
```

Save simulation results to `simdata.dta`, and use a random-number seed for reproducibility

```
bayes, saving(simdata) rseed(123): xtnbreg y x1 x2
```

Specify 20,000 Markov chain Monte Carlo (MCMC) samples, set length of the burn-in period to 5,000, and request that a dot be displayed every 500 simulations

```
bayes, mcmcs(20000) burnin(5000) dots(500): xtnbreg y x1 x2
```

In the above, request that the 90% highest posterior density (HPD) credible interval be displayed instead of the default 95% equal-tailed credible interval

```
bayes, clevel(90) hpd
```

Display incidence-rate ratios instead of coefficients

```
bayes: xtnbreg y x1 x2, irr
```

Display incidence-rate ratios on replay

```
bayes, irr
```

Random-effects model with exposure variable `evar`

```
bayes: xtnbreg y x1 x2, exposure(evar)
```

Also see [Quick start](#) in [\[BAYES\] bayes](#) and [Quick start](#) in [\[XT\] xtnbreg](#).

Menu

Statistics > Longitudinal/panel data > Bayesian regression > Negative binomial regression

Syntax

```
bayes [ , bayesopts ] : xtnbreg depvar [indepvars] [if] [in] [ , options ]
```

<i>options</i>	Description
Model	
<u>noconstant</u>	suppress constant term
<u>exposure</u> (<i>varname_e</i>)	include $\ln(\text{varname}_e)$ in model with coefficient constrained to 1
<u>offset</u> (<i>varname_o</i>)	include <i>varname_o</i> in model with coefficient constrained to 1

Reporting

<u>irr</u>	report incidence-rate ratios
<u>display_options</u>	control spacing, line width, and base and empty cells
<u>level</u> (#)	set credible level; default is <code>level(95)</code>

A panel variable must be specified; see [XT] [xtset](#).

indepvars may contain factor variables; see [U] [11.4.3 Factor variables](#).

depvar, *indepvars*, *varname_e*, and *varname_o* may contain time-series operators; see [U] [11.4.4 Time-series varlists](#).

`bayes: xtnbreg, level()` is equivalent to `bayes, clevel(): xtnbreg`.

For a detailed description of options, see [Options for RE/FE models](#) in [XT] [xtnbreg](#).

<i>bayesopts</i>	Description
Priors	
* <u>normalprior</u> (#)	specify standard deviation of default normal priors for regression coefficients; default is <code>normalprior(100)</code>
<u>prior</u> (<i>priorspec</i>)	prior for model parameters; this option may be repeated
<u>dryrun</u>	show model summary without estimation
Simulation	
<u>nchains</u> (#)	number of chains; default is to simulate one chain
<u>mcmcsize</u> (#)	MCMC sample size; default is <code>mcmcsize(10000)</code>
<u>burnin</u> (#)	burn-in period; default is <code>burnin(2500)</code>
<u>thinning</u> (#)	thinning interval; default is <code>thinning(1)</code>
<u>rseed</u> (#)	random-number seed
<u>exclude</u> (<i>paramref</i>)	specify model parameters to be excluded from the simulation results
Blocking	
<u>block</u> (<i>paramref</i> [, <i>blockopts</i>])	specify a block of model parameters; this option may be repeated
<u>blocksummary</u>	display block summary

Initialization

<code><u>initial</u>(<i>initspec</i>)</code>	specify initial values for model parameters with a single chain
<code>init#(<i>initspec</i>)</code>	specify initial values for #th chain; requires <code>nchains()</code>
<code>initall(<i>initspec</i>)</code>	specify initial values for all chains; requires <code>nchains()</code>
<code>nomleinitial</code>	suppress the use of maximum likelihood estimates as starting values
<code>initrandom</code>	specify random initial values
<code>initsummary</code>	display initial values used for simulation
* <code>noisily</code>	display output from the estimation command during initialization

Adaptation

<code>adaptation(<i>adaptopts</i>)</code>	control the adaptive MCMC procedure
<code>scale(#)</code>	initial multiplier for scale factor; default is <code>scale(2.38)</code>
<code>covariance(<i>cov</i>)</code>	initial proposal covariance; default is the identity matrix

Reporting

<code>clevel(#)</code>	set credible interval level; default is <code>clevel(95)</code>
<code>hpd</code>	display HPD credible intervals instead of the default equal-tailed credible intervals
* <code>irr</code>	report incidence-rate ratios
<code>eform[(<i>string</i>)]</code>	report exponentiated coefficients and, optionally, label as <i>string</i>
<code>remargl</code>	compute log marginal-likelihood; suppressed by default
<code>batch(#)</code>	specify length of block for batch-means calculations; default is <code>batch(0)</code>
<code>saving(<i>filename</i>[, <i>replace</i>])</code>	save simulation results to <i>filename.dta</i>
<code>nomodelsummary</code>	suppress model summary
<code>chainsdetail</code>	display detailed simulation summary for each chain
<code>[no]dots</code>	suppress dots or display dots every 100 iterations and iteration numbers every 1,000 iterations; default is <code>nodots</code>
<code>dots(#[, <i>every</i>(#)])</code>	display dots as simulation is performed
<code>[no]show(<i>paramref</i>)</code>	specify model parameters to be excluded from or included in the output
<code>showreffects[(<i>refref</i>)]</code>	specify that all or a subset of random-effects parameters be included in the output
<code>notable</code>	suppress estimation table
<code>noheader</code>	suppress output header
<code>title(<i>string</i>)</code>	display <i>string</i> as title above the table of parameter estimates
<code>display_options</code>	control spacing, line width, and base and empty cells

Advanced

<code>search(<i>search_options</i>)</code>	control the search for feasible initial values
<code>corrlag(#)</code>	specify maximum autocorrelation lag; default varies
<code>corrtol(#)</code>	specify autocorrelation tolerance; default is <code>corrtol(0.01)</code>

*Starred options are specific to the `bayes` prefix; other options are common between `bayes` and `bayesmh`.
Options `prior()` and `block()` may be repeated.

priorspec and *paramref* are defined in [BAYES] `bayesmh`.

paramref may contain factor variables; see [U] 11.4.3 Factor variables.

`collect` is allowed; see [U] 11.1.10 Prefix commands.

See [U] 20 Estimation and postestimation commands for more capabilities of estimation commands.

Model parameters are regression coefficients $\{\text{devar: indepvars}\}$, random effects $\{U[\text{panelvar}]\}$ or simply $\{U\}$, and shape parameters $\{r\}$ and $\{s\}$ for the beta prior of $\{U\}$; also see *Methods and formulas*. Use the `dryrun` option to see the definitions of model parameters prior to estimation.

For a detailed description of *bayesopts*, see *Options* in [BAYES] **bayes**.

Remarks and examples

[stata.com](http://www.stata.com)

For a general introduction to Bayesian analysis, see [BAYES] **Intro**. For a general introduction to Bayesian estimation using an adaptive Metropolis–Hastings algorithm, see [BAYES] **bayesmh**. For remarks and examples specific to the `bayes` prefix, see [BAYES] **bayes**. For details about the estimation command, see [XT] **xtbnreg**.

For a simple example of the `bayes` prefix, see *Introductory example* in [BAYES] **bayes**. Also see *Panel-data models* in [BAYES] **bayes**.

Stored results

See *Stored results* in [BAYES] **bayes**. In addition, `bayes: xtbnreg` also stores the following results:

Macros	
<code>e(ivar)</code>	variable denoting groups
<code>e(redistrib)</code>	distribution of random effects

Methods and formulas

Bayesian random-effects negative binomial models are based on random-effects negative binomial models described in *Methods and formulas* of [XT] **xtbnreg**.

Let y_{it} be the count for the t th observation in the i th group. We assume $y_{it} \mid \gamma_{it} \sim \text{Poisson}(\gamma_{it})$, where $\gamma_{it} \mid u_i \sim \text{gamma}\{\lambda_{it}, (1 - u_i)/u_i\}$ with $\lambda_{it} = \exp(\mathbf{x}_{it}\boldsymbol{\beta} + \text{offset}_{it})$ and u_i is a dispersion-control parameter that varies randomly across groups. The likelihood of the model is thus

$$\Pr(Y_{it} = y_{it} \mid \mathbf{x}_{it}, u_i) = \frac{\Gamma(\lambda_{it} + y_{it})}{\Gamma(\lambda_{it})\Gamma(y_{it} + 1)} u_i^{\lambda_{it}} (1 - u_i)^{y_{it}}$$

We further assume that random-effects dispersion parameters u_i 's are a priori independent and follow beta distribution with shape parameters r and s , $u_i \sim \text{Beta}(r, s)$. The hyperprior for the shape parameters is chosen so that the joint distribution of the mean $r/(r + s)$ and inverse square-root of the sample size $(r + s)$ of the beta distribution is uniform, $\{r/(r + s), (r + s)^{-0.5}\} \sim 1$; see Gelman et al. (2014, sec. 5.3). This choice leads to a diffused distribution for (r, s) with a density proportional to $(r + s)^{-2.5}$, which is a Pareto-type distribution.

`bayes: xtbnreg` uses the default initial value of 0.5 for the random effects u_i 's.

See *Methods and formulas* in [BAYES] **bayesmh**.

Reference

Gelman, A., J. B. Carlin, H. S. Stern, D. B. Dunson, A. Vehtari, and D. B. Rubin. 2014. *Bayesian Data Analysis*. 3rd ed. Boca Raton, FL: Chapman & Hall/CRC.

Also see

[BAYES] **bayes** — Bayesian regression models using the bayes prefix

[XT] **xtnbreg** — Fixed-effects, random-effects, & population-averaged negative binomial models

[BAYES] **Bayesian postestimation** — Postestimation tools for bayesmh and the bayes prefix

[BAYES] **Bayesian estimation** — Bayesian estimation commands

[BAYES] **Bayesian commands** — Introduction to commands for Bayesian analysis

[BAYES] **Intro** — Introduction to Bayesian analysis

[BAYES] **Glossary**