**bayes: meglm — Bayesian multilevel generalized linear model**

### Description

bayes: meglm fits a Bayesian multilevel generalized linear model to outcomes of different types such as continuous, binary, count, and so on; see [BAYES] bayes and [ME] meglm for details.

### Quick start

Bayesian two-level generalized linear model of $y$ on $x1$ and $x2$ with random intercepts by $id$, using the Gaussian family and log link, and using default normal priors for regression coefficients and default inverse-gamma prior for the variance of random intercepts

```stata
bayes: meglm y x1 x2 || id:, family(gaussian) link(log)
```

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

```stata
bayes, normalprior(10): meglm y x1 x2 || id:, family(gaussian) link(log)
```

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

```stata
bayes, prior({y: x1 x2}, uniform(-10,10)) ///
prior({y:_cons}, normal(0,10)): ///
meglm y x1 x2 || id:, family(gaussian) link(log)
```

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

```stata
bayes, saving(simdata) rseed(123): ///
meglm y x1 x2 || id:, family(gaussian) link(log)
```

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

```stata
bayes, mcmcsize(20000) burnin(5000) dots(500): ///
meglm y x1 x2 || id:, family(gaussian) link(log)
```

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

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

Fit a logit model and display results as odds ratios

```stata
bayes: meglm z x1 x2 || id:, family(binomial) eform
```

Display odds ratios on replay

```stata
bayes, eform
```

Also see **Quick start** in [BAYES] bayes and **Quick start** in [ME] meglm.

### Menu

Statistics > Multilevel mixed-effects models > Bayesian regression > Generalized linear model (GLM)
bayes [ , bayesopts ] : meglm depvar fe_equation
   [ || re_equation ] [ || re_equation ... ] [ , options ]

where the syntax of fe_equation is
   [ indepvars ] [ if ] [ in ] [ weight ] [ , fe_options ]

and the syntax of re_equation is one of the following:

for random coefficients and intercepts
   levelvar: [ varlist ] [ , re_options ]

for random effects among the values of a factor variable
   levelvar: R. varname

levelvar either is a variable identifying the group structure for the random effects at that level or is _all, representing one group comprising all observations.

### fe_options

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>suppress constant term from the fixed-effects equation</td>
</tr>
<tr>
<td>include ln(varname_e) in model with coefficient constrained to 1</td>
</tr>
<tr>
<td>include varname_o in model with coefficient constrained to 1</td>
</tr>
<tr>
<td>retain perfect predictor variables</td>
</tr>
</tbody>
</table>

### re_options

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>variance–covariance structure of the random effects; only structures independent, identity, and unstructured supported</td>
</tr>
<tr>
<td>suppress constant term from the random-effects equation</td>
</tr>
</tbody>
</table>

Model

- noconstant
- exposure(varname_e)
- offset(varname_o)
- asis

Model

- covariance(vartype)
- noconstant

Model

- covarianc(vartype)
- noconstant
Bayes: meglm — Bayesian multilevel generalized linear model

Options

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>distribution of depvar; default is family(gaussian)</td>
<td>family(family)</td>
</tr>
<tr>
<td>link function; default varies per family</td>
<td>link(link)</td>
</tr>
</tbody>
</table>

Reporting

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>report exponentiated coefficients</td>
<td>eform</td>
</tr>
<tr>
<td>report incidence-rate ratios</td>
<td>irr</td>
</tr>
<tr>
<td>report odds ratios</td>
<td>or</td>
</tr>
<tr>
<td>suppress coefficient table</td>
<td>notable</td>
</tr>
<tr>
<td>suppress output header</td>
<td>noheader</td>
</tr>
<tr>
<td>suppress table summarizing groups</td>
<td>nogroup</td>
</tr>
<tr>
<td>control spacing, line width, and base and empty cells</td>
<td>display_options</td>
</tr>
<tr>
<td>set credible level; default is level(95)</td>
<td>level(#)</td>
</tr>
</tbody>
</table>

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

**depvar**, **indepvars**, and **varlist** may contain time-series operators; see [U] 11.4.4 Time-series varlists.

**fweights** are allowed; see [U] 11.1.6 weight.

bayes: meglm, level() is equivalent to bayes, clevel(): meglm.

For a detailed description of options, see Options in [ME] meglm.

Bayesopts

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>specify standard deviation of default normal priors for regression coefficients; default is normalprior(100)</td>
<td>normalprior(#)</td>
</tr>
<tr>
<td>specify shape and scale of default inverse-gamma prior for variance components; default is igammaprior(0.01 0.01)</td>
<td>igammaprior(# #)</td>
</tr>
<tr>
<td>specify degrees of freedom and, optionally, scale matrix of default inverse-Wishart prior for unstructured random-effects covariance prior</td>
<td>iwishartprior(# [...])</td>
</tr>
<tr>
<td>prior for model parameters; this option may be repeated</td>
<td>prior(priorspec)</td>
</tr>
<tr>
<td>show model summary without estimation</td>
<td>dryrun</td>
</tr>
</tbody>
</table>

Simulation

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of chains; default is to simulate one chain</td>
<td>nchains(#)</td>
</tr>
<tr>
<td>MCMC sample size; default is mcmcsize(10000)</td>
<td>mcmcsize(#)</td>
</tr>
<tr>
<td>burn-in period; default is burnin(2500)</td>
<td>burnin(#)</td>
</tr>
<tr>
<td>thinning interval; default is thinning(1)</td>
<td>thinning(#)</td>
</tr>
<tr>
<td>random-number seed</td>
<td>rseed(#)</td>
</tr>
<tr>
<td>specify model parameters to be excluded from the simulation results</td>
<td>exclude(paramref)</td>
</tr>
<tr>
<td>specify stubs for random-effects parameters for all levels</td>
<td>restubs(restub1 restub2 ...)</td>
</tr>
</tbody>
</table>

Blocking

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum block size; default is blocksize(50)</td>
<td>blocksize(#)</td>
</tr>
<tr>
<td>specify a block of model parameters; this option may be repeated</td>
<td>block(paramref[, blockopts])</td>
</tr>
<tr>
<td>display block summary</td>
<td>blocksummary</td>
</tr>
<tr>
<td>do not block parameters by default</td>
<td>noblocking</td>
</tr>
</tbody>
</table>
Initialization

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

Adaptation

- `adaptation(adaptopts)` control the adaptive MCMC procedure
- `scale(#)` initial multiplier for scale factor; default is `scale(2.38)`
- `covariance(cov)` initial proposal covariance; default is the identity matrix

Reporting

- `clevel(#)` set credible interval level; default is `clevel(95)`
- `hpd` display HPD credible intervals instead of the default equal-tailed credible intervals
- `*irr` report incidence-rate ratios
- `*or` report odds ratios
- `eform([string])` report exponentiated coefficients and, optionally, label as string
- `remargl` compute log marginal-likelihood
- `batch(#)` specify length of block for batch-means calculations; default is `batch(0)`
- `saying(filename[, replace])` save simulation results to `filename.dta`
- `nomodelsummary` suppress model summary
- `nomesummary` suppress multilevel-structure summary
- `chainsdetail` display detailed simulation summary for each chain
- `[no]dots` suppress dots or display dots every 100 iterations and iteration numbers every 1,000 iterations; default is `dots`
- `dots(#[, every(#)])` display dots as simulation is performed
- `[no]show(paramref)` specify model parameters to be excluded from or included in the output
- `showeffects([reref])` specify that all or a subset of random-effects parameters be included in the output
- `melabel` display estimation table using the same row labels as `meglm`
- `nogroup` suppress table summarizing groups
- `notable` suppress estimation table
- `noheader` suppress output header
- `title(string)` display string as title above the table of parameter estimates
- `display_options` control spacing, line width, and base and empty cells

Advanced

- `search(search_options)` control the search for feasible initial values
- `corrlag(#)` specify maximum autocorrelation lag; default varies
- `corrtol(#)` specify autocorrelation tolerance; default is `corrtol(0.01)`
Starred options are specific to the `bayes` prefix; other options are common between `bayes` and `bayesmh`. Options `prior()` and `block()` may be repeated.

`prior()` and `paramref` are defined in [BAYES] bayesmh.

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

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

Model parameters are regression coefficients `{depvar:indepvars}`, parameters as described in Additional model parameters, random effects `{rename}`, and either variance components `{rename:sigma2}` or, if option covariance(untstructured) is specified, matrix parameter `{restub:Sigma,matrix}`; see Likelihood model in [BAYES] bayes for how `renames` and `restub` are defined. 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

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 [ME] meglm.

For a simple example of the `bayes` prefix, see Introductory example in [BAYES] bayes. For multilevel examples, see Multilevel models in [BAYES] bayes. Also see Crossed-effects model in [BAYES] bayes.

Additional model parameters

In addition to regression coefficients `{depvar:indepvars}`, `bayes: meglm` defines extra parameters that depend on the chosen family; see table 1 below.

Table 1. Additional model parameters defined by `bayes: meglm`

<table>
<thead>
<tr>
<th>Family</th>
<th>Parameter</th>
<th>Model parameter</th>
<th>Default prior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaussian</td>
<td>Error variance</td>
<td><code>{e.depvar:sigma2}</code></td>
<td>InvGamma(0.01, 0.01)</td>
</tr>
<tr>
<td>Bernoulli/Binomial</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Ordinal</td>
<td>Cutpoints</td>
<td><code>{cut1}, {cut2}, ...</code></td>
<td>Flat</td>
</tr>
<tr>
<td>Poisson</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Negative binomial</td>
<td>Log-overdispersion</td>
<td><code>{l1alpha}</code> (mean disp.)</td>
<td>N(0, 10000)</td>
</tr>
<tr>
<td>Gamma</td>
<td>Log-scale</td>
<td><code>{lnscale}</code></td>
<td>N(0, 10000)</td>
</tr>
</tbody>
</table>

Use the `dryrun` option with the `bayes` prefix to see the definitions of model parameters prior to estimation.

Stored results

See Stored results in [BAYES] bayes.
Methods and formulas

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

Also see

[BAYES] bayes — Bayesian regression models using the bayes prefix
[ME] meglm — Multilevel mixed-effects generalized linear model
[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