**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 $x_1$ and $x_2$ 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)
**Syntax**

```bash
bayes [ , bayesopts ] : meglm depvar fe_equation
[ || re_equation ] [ || re_equation ... ] [ , options ]
```

where the syntax of `fe_equation` is

```bash
[ indepvars ] [ if ] [ in ] [ weight ] [ , fe_options ]
```

and the syntax of `re_equation` is one of the following:

- for random coefficients and intercepts
  ```bash
  levelvar: [ varlist ] [ , re_options ]
  ```
- for random effects among the values of a factor variable
  ```bash
  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><strong>noconstant</strong></td>
</tr>
<tr>
<td><strong>exposure(varname_e)</strong></td>
</tr>
<tr>
<td><strong>offset(varname_o)</strong></td>
</tr>
<tr>
<td><strong>asis</strong></td>
</tr>
</tbody>
</table>

### re_options

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>covariance(vartype)</strong></td>
</tr>
<tr>
<td><strong>noconstant</strong></td>
</tr>
</tbody>
</table>
## options

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

### Reporting

- report exponentiated coefficients | eform |
- report incidence-rate ratios | irr |
- report odds ratios | or |
- suppress coefficient table | notable |
- suppress output header | noheader |
- suppress table summarizing groups | nogroup |
- control spacing, line width, and base and empty cells | display_options |
- set credible level; default is level(95) | level(#) |

* depvar, indepvars, and varlist may contain time-series operators; see [U] 11.4.4 Time-series varlists.
* indepvars may contain factor variables; see [U] 11.4.3 Factor variables.

**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>Description</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</td>
<td>iwishartprior(# [...])</td>
</tr>
<tr>
<td>prior for model parameters; this option may be repeated</td>
<td>prior <em>(priorspec)</em></td>
</tr>
<tr>
<td>show model summary without estimation</td>
<td>dryrun</td>
</tr>
</tbody>
</table>

### Simulation

- number of chains; default is to simulate one chain | nchains(#) |
- MCMC sample size; default is mcmcsize(10000) | mcmcsize(#) |
- burn-in period; default is burnin(2500) | burnin(#) |
- thinning interval; default is thinning(1) | thinning(#) |
- random-number seed | rseed(#) |
- specify model parameters to be excluded from the simulation results | exclude *(paramref)* |
- specify stubs for random-effects parameters for all levels | restubs *(restub1 restub2 ...)* |

### Blocking

- maximum block size; default is blocksize(50) | blocksize(#) |
- specify a block of model parameters; this option may be repeated | block *(paramref[, blockopts]*) |
- display block summary | blocksummary |
- do not block parameters by default | noblocking |
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
- `initrandom` 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)`
- `saving(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
- `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)`
Bayesian multilevel generalized linear model

*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.
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(unstructured) 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>{e.depvar:sigma2}</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>{cut1}, {cut2}, ...</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>{lnalpha} (mean disp.)</td>
<td>N(0, 10000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>{lndelta} (constant disp.)</td>
<td>N(0, 10000)</td>
</tr>
<tr>
<td>Gamma</td>
<td>Log-scale</td>
<td>{lnscale}</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