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

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**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

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

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

```
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

```
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

```
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

```
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

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

Fit a logit model and display results as odds ratios

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

Display odds ratios on replay

```
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

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.

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

<table>
<thead>
<tr>
<th>re_options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>covariance(vartype)</td>
<td>variance–covariance structure of the random effects; only structures independent, identity, and unstructured supported</td>
</tr>
<tr>
<td>noconstant</td>
<td>suppress constant term from the random-effects equation</td>
</tr>
</tbody>
</table>
bayes: meglm — Bayesian multilevel generalized linear model

**options**

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

**Reporting**

| eform | report exponentiated coefficients |
| irr | report incidence-rate ratios |
| or | report odds ratios |
| notable | suppress coefficient table |
| noheader | suppress output header |
| nogroup | suppress table summarizing groups |
| `display_options` | control spacing, line width, and base and empty cells |

| level(#) | set credible level; default is `level(95)` |

**bayesopts**

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
</table>

**Priors**

| normalprior(#) | specify standard deviation of default normal priors for regression coefficients; default is `normalprior(100)` |
| igammapr(# #) | specify shape and scale of default inverse-gamma prior for variance components; default is `igammaprior(0.01 0.01)` |
| iwishartpr(# [...]) | specify degrees of freedom and, optionally, scale matrix of default inverse-Wishart prior for unstructured random-effects covariance |

| prior(priorspec) | prior for model parameters; this option may be repeated |

**Simulation**

| number of chains; default is to simulate one chain |
| mcmcsample size; default is `mcmcsample(10000)` |
| burn-in period; default is `burnin(2500)` |
| thinning interval; default is `thinning(1)` |
| random-number seed |
| specify model parameters to be excluded from the simulation results |
| specify stubs for random-effects parameters for all levels |

**Blocking**

| maximum block size; default is `blocksize(50)` |
| specify a block of model parameters; this option may be repeated |
| display block summary |
| do not block parameters by default |
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
`[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.

`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 `rename` 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>{lnalpha}</code> (mean disp.)</td>
<td>N(0,10000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><code>{lndelta}</code> (constant 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