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

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
```

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.

fe_options	Description
Model	
noconstant	suppress constant term from the fixed-effects equation
exposure(*varname*$_e$)	include $\ln(varname_e)$ in model with coefficient constrained to 1
offset(*varname*$_o$)	include *varname*$_o$ in model with coefficient constrained to 1
asis	retain perfect predictor variables

re_options	Description
Model	
covariance(*vartype*)	variance–covariance structure of the random effects; only structures independent, exchangeable, identity, and unstructured are supported
noconstant	suppress constant term from the random-effects equation

options	Description
Model	
`family(`*family*`)`	distribution of *depvar*; default is `family(gaussian)`
`link(`*link*`)`	link function; default varies per family
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)`

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**.

`fweight`s 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	Description
Priors	
* `normalprior(#)`	specify standard deviation of default normal priors for regression coefficients; default is `normalprior(100)`
* `igammaprior(# #)`	specify shape and scale of default inverse-gamma prior for variance components; default is `igammaprior(0.01 0.01)`
* `iwishartprior(#` [...]`)`	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
`dryrun`	show model summary without estimation
Simulation	
`nchains(#)`	number of chains; default is to simulate one chain
`mcmcsize(#)`	MCMC sample size; default is `mcmcsize(10000)`
`burnin(#)`	burn-in period; default is `burnin(2500)`
`thinning(#)`	thinning interval; default is `thinning(1)`
`rseed(#)`	random-number seed
`exclude(`*paramref*`)`	specify model parameters to be excluded from the simulation results
`restubs(`*restub1 restub2 ...*`)`	specify stubs for random-effects parameters for all levels
Blocking	
* `blocksize(#)`	maximum block size; default is `blocksize(50)`
`block(`*paramref* [, *blockopts*]`)`	specify a block of model parameters; this option may be repeated
`blocksummary`	display block summary
* `noblocking`	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
`showreffects`[`(`*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**.

`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 `{`*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*s 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`

Family	Parameter	Model parameter	Default prior
Gaussian	Error variance	`{e.`*depvar*`:sigma2}`	InvGamma$(0.01, 0.01)$
Bernoulli/Binomial	None	None	None
Ordinal	Cutpoints	`{cut1}`, `{cut2}`, ...	Flat
Poisson	None	None	None
Negative binomial	Log-overdispersion	`{lnalpha}` (mean disp.)	$N(0, 10000)$
		`{lndelta}` (constant disp.)	$N(0, 10000)$
Gamma	Log-scale	`{lnscale}`	$N(0, 10000)$

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 models

[BAYES] **Bayesian postestimation** — Postestimation tools after Bayesian estimation

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

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

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

[BAYES] **Glossary**

For suggested citations, see the FAQ on citing Stata documentation.