bmagraph pmp — Model-probability plots after BMA regression

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Description

`bmagraph pmp` provides graphical summary information for the models visited by the `bmaregress` command, including their posterior model probabilities (PMPs) and cumulative PMPs (CPMPs). This command is useful for checking Markov chain Monte Carlo (MCMC) convergence of a Bayesian model averaging (BMA) model.

Quick start

Plot PMPs for the default top 100 models with highest PMPs

```
bmagraph pmp
```

Same as above, but request CPMPs

```
bmagraph pmp, cumulative
```

Same as above, but suppress frequency PMPs, and show only the top 20 models with highest PMPs

```
bmagraph pmp, cumulative nofreqline top(20)
```

Menu

Statistics > Bayesian model averaging > Model-probability plots

Syntax

`bmagraph pmp` [, *options*]

options	Description
Main	
`top(#)`	show top # models with highest PMPs; default is `top(100)`
`cumulative`	display CPMPs instead of PMPs for plotted models
`pmpcutoff(#)`	do not show models with PMP less than #; default is # = 0
`maxmodels(#)`	plot results for the first # models; default is `maxmodels(1000)`
`anlineopts(`*cline_options*`)`	affect rendition of analytical-PMP or harmonic-PMP line
[`no`]`freqline`	show or suppress frequency-PMP line
`freqlineopts(`*cline_options*`)`	affect rendition of frequency-PMP line
Line options	
cline_options	affect rendition of all plotted lines
Y axis, X axis, Titles, Legend, Overall	
twoway_options	any options other than `by()` documented in [G-3] ***twoway_options***
`all`	plot all models

`all` does not appear in the dialog box.

Options

Main

`top(#)` specifies that the top # models with highest PMPs be shown. By default, the top 100 are shown. The maximum number of models plotted is controlled by option `maxmodels()`. Use `top()` in combination with `maxmodels()`, if you need to plot more than 1,000 models.

`cumulative` specifies that CPMPs be reported for the models instead of the default PMPs.

`pmpcutoff(#)` specifies that models with PMPs less than # should not be shown. The default is `pmpcutoff(0)`. This option is useful when there are many models with small PMPs.

`maxmodels(#)` specifies the maximum number of models to be plotted. The default is `maxmodels(1000)`. When this option is specified together with option `top(`$\#_1$`)`, the number of plotted models is the minimum between # and $\#_1$.

`anlineopts(`*cline_options*`)` affects the rendition of the analytical-PMP line; see [G-3] ***cline_options***. With a random g, this option affects the harmonic-PMP line, where the harmonic-mean estimator is used to approximate the analytical PMPs.

`freqline` and `nofreqline` show or suppress the frequency-PMP line. By default, the frequency-PMP line is shown when it is available. Frequency-PMP line is not available with model enumeration, so `nofreqline` is implied and `freqline` is ignored, if specified, in that case.

`freqlineopts(`*cline_options*`)` affects the rendition of the frequency-PMP line when it is available; see [G-3] ***cline_options***. With model enumeration, this option is ignored if specified.

Line options

cline_options affects the rendition of all plotted lines; see [G-3] ***cline_options***.

Y axis, X axis, Titles, Legend, Overall

twoway_options are any of the options documented in [G-3] ***twoway_options***, excluding `by()`. These include options for titling the graph (see [G-3] ***title_options***) and for saving the graph to disk (see [G-3] ***saving_option***).

The following option is available with `bmagraph pmp` but is not shown in the dialog box:

`all` specifies that all models, up to `maxmodels()`, be shown on the plot. This option may be useful when the number of visited models is small. This option may not be specified together with `top()`.

Remarks and examples

The `bmagraph pmp` command is used to visualize the posterior distribution of the explored model space and to check for sampling convergence when the model space is explored using the MC3 algorithm. The analytical and MCMC frequency-based or simply frequency posterior probability distributions should be close when the model space is sufficiently explored.

When the model space is explored fully by using enumeration, the frequency posterior probabilities coincide with the analytical ones, and there is no need to check for convergence. The frequency-PMP line is not plotted in this case. With a random g, analytical-PMP line is not available and a harmonic-PMP line is displayed instead. This line represents a harmonic-mean estimate of the analytical PMPs.

▷ Example 1: Analytical and frequency PMPs

Recall the `performance` dataset (Chatterjee and Hadi 2012, sec. 3.3) analyzed in example 1 of [BMA] **bmaregress**, where the employee satisfaction with their supervisors, `rating`, is modeled by six potential predictors.

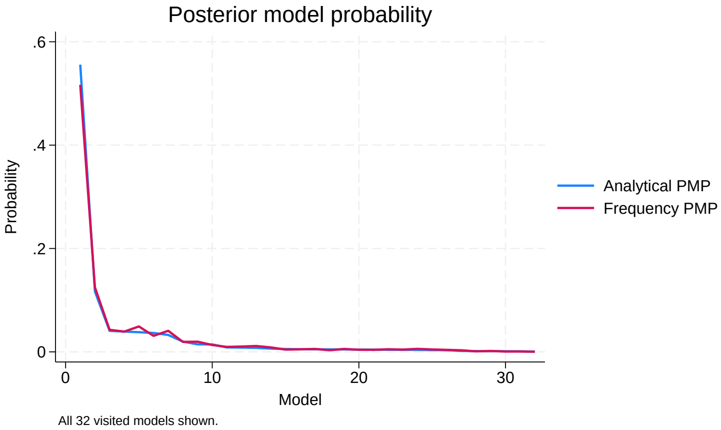
Let's fit a BMA linear regression to these data using `bmaregress` and explore PMPs using `bmagraph pmp`. With a few predictors, `bmaregress` explores a full space of all possible models. In this case, we do not need to check for sampling convergence because no sampling is performed. But we can still use `bmagraph pmp` to explore PMPs.

To demonstrate, let's use sampling instead of the default model enumeration in our example by specifying the `sampling` option with `bmaregress`. We use the `notable` option to suppress the output table because we are not interested in the regression coefficients but in the models explored by `bmaregress`.

```
. use https://www.stata-press.com/data/r19/performance
(Data on employee satisfaction with supervisor)

. bmaregress rating complaints-advance, sampling rseed(18) notable

Burn-in ...
Simulation ...
Computing model probabilities ...

Bayesian model averaging                  No. of obs         =     30
Linear regression                         No. of predictors  =      6
MC3 sampling                                          Groups =      6
                                                      Always =      0
                                          No. of models      =     32
                                              For CPMP >= .9 =     10
Priors:                                   Mean model size    =  1.699
  Models: Beta-binomial(1, 1)             Burn-in            =  2,500
   Cons.: Noninformative                  MCMC sample size   = 10,000
   Coef.: Zellner's g                     Acceptance rate    = 0.2417
       g: Benchmark, g = 36               Shrinkage, g/(1+g) = 0.9730
  sigma2: Noninformative                  Mean sigma2        = 52.292

Sampling correlation = 0.9990
```

We use `bmagraph pmp` to display both analytical and frequency PMPs of the 32 visited models.

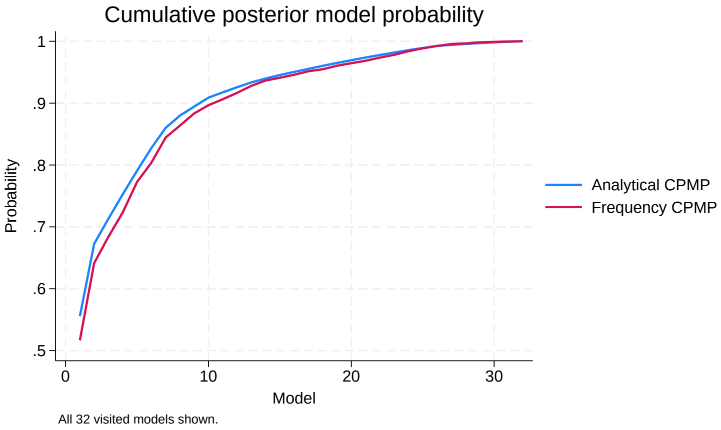
```
. bmagraph pmp
```



The two lines are nearly identical, which is a strong indication of convergence.

Instead of PMPs, we can use the `cumulative` option to plot CPMPs:

```
. bmagraph pmp, cumulative
```



The plot shows that the first 10 models account for about 90% of the total probability mass.

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▷ Example 2: Harmonic and frequency PMPs

The BMA model in example 1 assumed a fixed parameter g that controls the shrinkage of regression coefficients toward zero. We can instead specify a prior distribution, a hyperprior, for g. For instance, we use a robust hyperprior below.

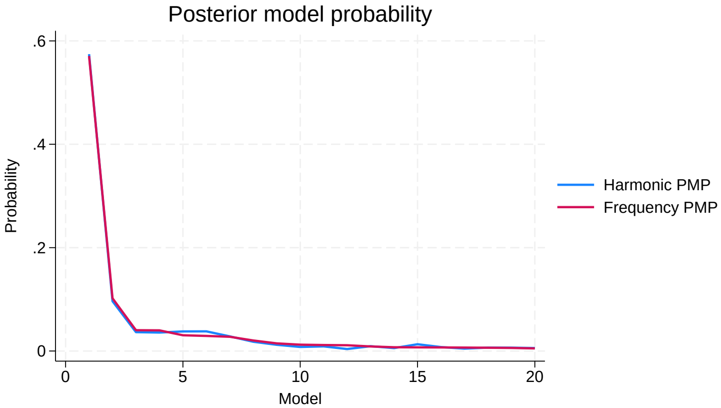
```
. bmaregress rating complaints-advance, gprior(robust) rseed(18) notable
Burn-in ...
Simulation ...
Computing model probabilities ...

Bayesian model averaging                    No. of obs         =     30
Linear regression                           No. of predictors  =      6
MC3 and adaptive MH sampling                             Groups =      6
                                                         Always =      0
                                            No. of models      =     34
                                               For CPMP >= .9  =     12
Priors:                                     Mean model size    =  1.734
  Models: Beta-binomial(1, 1)               Burn-in            =  2,500
   Cons.: Noninformative                    MCMC sample size   = 10,000
   Coef.: Zellner's g                       Acceptance rate    = 0.4232
       g: Robust
  sigma2: Noninformative                    Mean sigma2        = 53.095

Sampling correlation = 0.9994
```

With a random g, there is no analytical formula for computing PMPs. In this case, MCMC convergence is evaluated by comparing the frequency PMP to the harmonic-mean approximation of the analytical PMP. To demonstrate, let's also use the `top(20)` option to plot the top 20 models with the highest PMPs.

```
. bmagraph pmp, top(20)
```



Top 20 models shown out of 34 visited.

The above plot should be interpreted with extra caution because the assessment of the MCMC convergence here is subject to the accuracy of the harmonic-mean approximation of the analytical PMP, in addition to the inherent sampling variability. In our example, there is no concern for the accuracy of the approximation or nonconvergence.

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Methods and formulas

For methods and formulas of PMPs, see *Posterior model probability* in *Methods and formulas* of [BMA] **bmaregress**.

The CPMP for a model j is a cumulative sum of the first jth highest PMPs. The analytical CPMP is a cumulative sum of analytical PMPs, and the frequency CPMP is a cumulative sum of frequency PMPs.

Reference

Chatterjee, S., and A. S. Hadi. 2012. *Regression Analysis by Example*. 5th ed. New York: Wiley.

Also see

[BMA] **bmastats models** — Model and variable-inclusion summaries after BMA regression

[BMA] **bmagraph** — Graphical summary for models and predictors after BMA regression

[BMA] **bmaregress** — Bayesian model averaging for linear regression

[BMA] **BMA postestimation** — Postestimation tools for Bayesian model averaging

[BMA] **Glossary**