

**meta galbraithplot** — Galbraith plots

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## Description

`meta galbraithplot` produces Galbraith plots for a meta-analysis. These plots are useful for assessing heterogeneity of the studies and for detecting potential outliers. They may also be an alternative to forest plots for summarizing meta-analysis results when there are many studies.

## Quick start

Produce a Galbraith plot after data are declared by using either `meta set` or `meta esize`

```
meta galbraithplot
```

Same as above, but request that the slope of the regression line, the standardized effect-sizes, and the study precisions be computed using a random-effects REML method instead of the default common-effect inverse-variance method

```
meta galbraithplot, random(reml)
```

Same as above, but suppress the CI bands

```
meta galbraithplot, random(reml) noci
```

Modify the default styles of the reference and regression lines

```
meta galbraithplot, rlopts(lcolor(red)) lineopts(lpattern(dash))
```

## Menu

Statistics > Meta-analysis

## Syntax

```
meta galbraithplot [if] [in] [, options]
```

<i>options</i>	Description
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## Main

<code>random</code> [ <i>remethod</i> ]	random-effects meta-analysis
<code>common</code>	common-effect meta-analysis; implies inverse-variance method; the default
<code>fixed</code>	fixed-effects meta-analysis; implies inverse-variance method
[ <code>no</code> ] <code>regline</code>	display or suppress the regression line
[ <code>no</code> ] <code>ci</code>	display or suppress the confidence intervals
<code>level</code> (#)	set confidence level; default is as declared for meta-analysis
[ <code>no</code> ] <code>metashow</code>	display or suppress meta settings in the output
<i>graph_options</i>	affect rendition of overall Galbraith plot
[ <code>no</code> ] <code>lowercase</code>	lowercase (default) or display as is the first word of the effect-size label used in the <i>y</i> -axis title

`collect` is allowed; see [U] 11.1.10 Prefix commands.

`lowercase` and `nolowercase` do not appear in the dialog box.

<i>remethod</i>	Description
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<code>reml</code>	restricted maximum likelihood; the default
<code>mle</code>	maximum likelihood
<code>ebayes</code>	empirical Bayes
<code>dlaird</code>	DerSimonian–Laird
<code>sjonkman</code>	Sidik–Jonkman
<code>hedges</code>	Hedges
<code>hschmidt</code>	Hunter–Schmidt

<i>graph_options</i>	Description
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## RL options

<code>rlopts</code> ( <i>line_options</i> )	affect rendition of the plotted reference line indicating no effect
---	---

## Fitted line

<code>lineopts</code> ( <i>line_options</i> )	affect rendition of the plotted regression line
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## CI plot

<code>ciopts</code> ( <i>ciopts</i> )	affect rendition of the plotted CI band
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## Add plots

<code>addplot</code> ( <i>plot</i> )	add other plots to the Galbraith plot
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## Y axis, X axis, Titles, Legend, Overall

<i>twoway_options</i>	any options other than <code>by()</code> documented in [G-3] <i>twoway_options</i>
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## Options

### Main

`random()`, `common`, and `fixed` specify a meta-analysis model to use when estimating the slope of the regression line in the Galbraith plot. These options also affect the standard error computation used in the standardization of the effect sizes. For historical reasons, the default is `common` based on the inverse-variance method, regardless of the global model declared by `meta set` or `meta esize`. Specify one of these options with `meta galbraithplot` to override this default.

`random` and `random(remethod)` specify that a random-effects model be assumed for the construction of the Galbraith plot; see *Random-effects model* in [META] **Intro**.

*remethod* specifies the type of estimator for the between-study variance  $\tau^2$ . *remethod* is one of `reml`, `mle`, `ebayes`, `dlaird`, `sjonkman`, `hedges`, or `hschmidt`. `random` is a synonym for `random(reml)`. See *Options* in [META] **meta esize** for more information.

`common` specifies that a common-effect model be assumed for the construction of the Galbraith plot; see *Common-effect (“fixed-effect”) model* in [META] **Intro**. It uses the inverse-variance estimation method; see *Meta-analysis estimation methods* in [META] **Intro**. Also see the *discussion* in [META] **meta data** about common-effect versus fixed-effects models.

`fixed` specifies that a fixed-effects model be assumed for the construction of the Galbraith plot; see *Fixed-effects model* in [META] **Intro**. It uses the inverse-variance estimation method; see *Meta-analysis estimation methods* in [META] **Intro**. Also see the *discussion* in [META] **meta data** about fixed-effects versus common-effect models. Galbraith plots for the common-effect and fixed-effects models are identical.

`regline` and `noregline` display or suppress the rendition of the regression line. The default, `regline`, is to display the regression line. Option `noregline` implies option `noci`.

`ci` and `noci` display or suppress confidence intervals. The default, `ci`, is to display them.

`level(#)` specifies the confidence level, as a percentage, for confidence intervals. The default is as declared for the meta-analysis session; see *Declaring a confidence level for meta-analysis* in [META] **meta data**. Also see option `level()` in [META] **meta set**.

`metashow` and `nometashow` display or suppress the meta setting information. By default, this information is displayed at the top of the output. You can also specify `nometashow` with `meta update` to suppress the meta setting output for the entire meta-analysis session.

### RL options

`rlopts(line_options)` affects the rendition of the plotted reference (diagonal) line that indicates no effect of the intervention or treatment; see [G-3] *line\_options*.

### Fitted line

`lineopts(line_options)` affects the rendition of the plotted regression line; see [G-3] *line\_options*.

### CI plot

`ciopts(ciopts)` affects the rendition of the CI band in the Galbraith plot. *ciopts* are any options as defined in [G-2] **graph twoway rline** and option `recast(rline)` as described in [G-3] *advanced\_options*.

## Add plots

`addplot(plot)` allows adding more graph twoway plots to the graph; see [G-3] [addplot\\_option](#).

## 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 options are available with `meta galbraithplot` but are not shown in the dialog box:

`lowercase` and `nolowercase` lowercase or leave as is the first word of the effect-size label shown on the  $y$ -axis title. The  $y$ -axis title is “Standardized *eslabel*”, where *eslabel* is the effect-size label defined by `meta set` or `meta esize` using the `eslabel()` option. By default, the command lowercases the first word of *eslabel* to follow Stata’s sentence capitalization style. If the first word is a proper name or if you want to use the title capitalization style, you can specify option `nolowercase` to display *eslabel* as is.

## Remarks and examples

[stata.com](http://stata.com)

The Galbraith plot (Galbraith 1988) is a scatterplot of the standardized effect size ( $z$  score) on the  $y$  axis against precision (inverse standard error) on the  $x$  axis for each study. It is mainly used to assess heterogeneity of the studies and detect potential outliers. It may also be an alternative to forest plots for summarizing meta-analysis results, especially when there are many studies (Anzures-Cabrera and Higgins 2010). The overall effect size is depicted as the slope of the regression line through the origin.

Heterogeneity (and potential outliers) may be investigated by looking at the variation of the studies around the regression line. To aid with that, the Galbraith plot additionally draws a  $100(1 - \alpha)\%$  confidence region represented by two lines drawn at the  $\pm z_{1-\alpha/2}$  intercept values parallel to the regression line. In the absence of heterogeneity,  $100(1 - \alpha)\%$  of the studies should fall within that region. The plot also contains a reference line at  $y = 0$ , which indicates “no effect”.

`meta galbraithplot` produces Galbraith plots. The plotted standardized effect size is determined automatically based on the declared effect size. Unlike other `meta` commands, for historical reasons, `meta galbraithplot` assumes a common-effect model with the inverse-variance method for the construction of the Galbraith plot.

Under the common-effect and fixed-effects models, the study precisions,  $x_j = 1/\hat{\sigma}_j$ , and the standardized effect sizes,  $y_j = \hat{\theta}_j/\hat{\sigma}_j$ , are used to estimate the slope,  $\hat{\theta}_{IV}$ , of the regression line through the origin

$$\hat{\theta}_{IV} = \frac{\sum_{j=1}^K x_j y_j}{\sum_{j=1}^K x_j^2}$$

If `random()` is specified, the expressions for  $x_j$  and  $y_j$  become  $x_j = 1/\sqrt{\hat{\sigma}_j^2 + \hat{\tau}^2}$  and  $y_j = \hat{\theta}_j/\sqrt{\hat{\sigma}_j^2 + \hat{\tau}^2}$ , and the slope of the regression line is now equal to the overall effect size from the random-effects model,  $\hat{\theta}^*$ .

Two  $100(1 - \alpha)\%$  CI lines  $y = \hat{\theta}x \pm z_{1-\alpha/2}$ , which are parallel to the regression line, are added to the plot, where  $\hat{\theta}$  is one of  $\hat{\theta}_{IV}$  or  $\hat{\theta}^*$  depending on the chosen model.

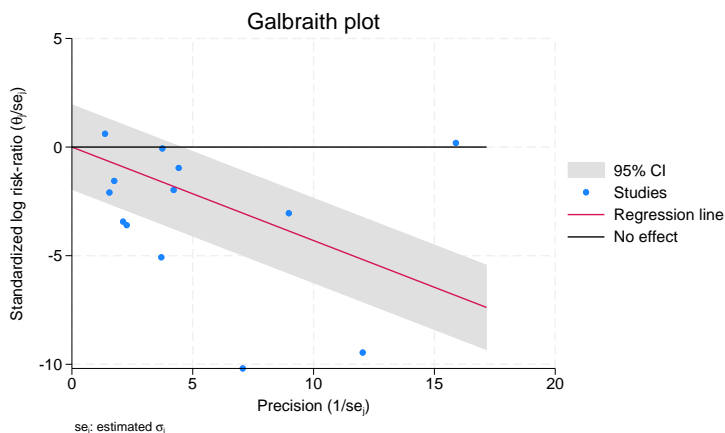
By default, the global CI level specified in `meta set` or `meta esize` is used to compute  $z_{1-\alpha/2}$  but a different level may be selected via the `level()` option. The regression line (and consequently its CI bands) may be suppressed via the `noregline` option.

If you wish to only suppress the CI bands, then you may specify the `noci` option. You can also control the look of the plotted reference line, the regression line, and the CI bands by specifying the `rlopts()`, `lineopts()`, and `ciopts()` options, respectively.

## ► Example 1: Basic Galbraith plot

Consider the declared version of the BCG dataset, `bcgset.dta`, which we used in, for instance, [example 1](#) of [\[META\] meta regress](#). Let's produce the Galbraith plot for these data.

```
. use https://www.stata-press.com/data/r18/bcgset
(Efficacy of BCG vaccine against tuberculosis; set with -meta esize-)
. meta galbraithplot
Effect-size label: Log risk-ratio
Effect size: _meta_es
Std. err.: _meta_se
Model: Common effect
Method: Inverse-variance
```



The blue circles form a scatterplot of the study-specific standardized log risk-ratios against study precisions. Studies that are close to the  $y$  axis have low precision. Precision of studies increases as you move toward the right on the  $x$  axis.

The reference black line ( $y = 0$ ) represents the “no-effect” line. That is, the log risks (or risks) in the treatment and control groups for the trials on the line are either the same or very similar. There are two trials that are on the line in our example: one is a large trial, and the other one is a small trial. The log risks for these trials are similar in the two groups, and the corresponding log risk-ratios are close to zero.

If a circle is above the reference line, the risk in the treatment group is higher than the risk in the control group for that study. Conversely, if a circle is below the line, the risk in the treatment group is lower than the risk in the control group. In our example, one trial is above the reference line, suggesting that the risk in the treatment group is higher, but this is an imprecise trial. The remaining trials are below the line, suggesting that the risk is lower in the treatment group.

The red line is the regression line through the origin. The slope of this line equals the estimate of the overall effect size, which is the overall log risk-ratio in our example. Also, the slope of an

imaginary line from the origin to an individual circle is equal to the effect size (log risk-ratio) estimate corresponding to that circle. This is because the slope is given by  $y_j/x_j = (\hat{\theta}_j/\hat{\sigma}_j)/(1/\hat{\sigma}_j) = \hat{\theta}_j$ . Thus, studies that fall above the regression line have effect-size estimates larger than the overall effect size, and those falling below the line have estimates that are smaller than the overall effect size.

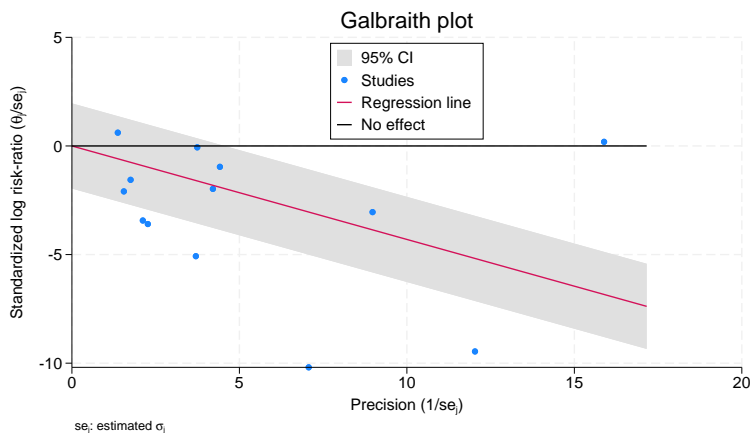
In the absence of substantial heterogeneity, we expect around 95% of the studies to lie within the 95% CI region (shaded area). In our example, there are 6 trials out of 13 that are outside of the CI region. We should suspect the presence of heterogeneity in these data. In fact, we did establish in [example 1](#) of [\[META\] meta regress](#) that there is at least one moderator, the distance from the equator, that explains some of the variation in the trial effect sizes.

◀

## ► Example 2: Custom legend

Continuing with [example 1](#), let's demonstrate how we can customize the look of the legend produced by default. We use `meta update` to suppress the meta setting information displayed by `meta galbraithplot`.

```
. quietly meta update, nometashow
. meta galbraithplot, legend(symxsize(*0.4) position(12) ring(0)
> region(lcolor(black)))
```



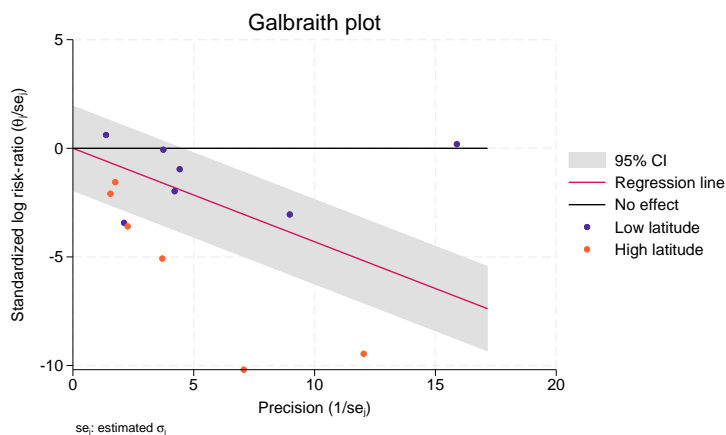
We customized the legend with a few suboptions specified in `legend()` (see [\[G-3\] legend\\_options](#)). We used `symxsize(*0.4)` to set the width of the key symbols to 40% of their default width. We used `position(12)` to position the label at 12 o'clock and `ring(0)` to place the legend inside the plot region. We used `region(lcolor(black))` to add a black border around the legend region.

◀

### ► Example 3: Labeling trials

Continuing with [example 1](#), we established that there is heterogeneity among the studies given the wide spread of the plotted circles around the regression line. We also know from [example 1](#) of [\[META\] meta regress](#) that there is at least one moderator, the distance from the equator, that explains some of the variation in the trial effect sizes. We would like to highlight this fact on the Galbraith plot by creating two study groups corresponding to low (`latitude_c < 0`) and high (`latitude_c ≥ 0`) absolute (mean-centered) latitudes and assigning a different color marker for each group on the plot. We will use the `addplot()` option.

```
. generate double precision = 1/_meta_se
. generate double zscore = _meta_es*precision
. local opts legend(order(1 3 4 5 "Low latitude" 6 "High latitude"))
. meta galbraithplot, msymbol(none)
> addplot(scatter zscore precision if latitude_c < 0, 'opts' ||
> scatter zscore precision if latitude_c >= 0, 'opts')
```



First, we generated two new variables, `precision` and `zscore`, that contain the precisions,  $1/\hat{\sigma}_j$ , and  $z$  scores,  $\hat{\theta}_j/\hat{\sigma}_j$ , of the studies. Then, we constructed a Galbraith plot without study markers (without the blue circles) using the `msymbol(none)` option. Finally, we used `addplot()` to overlay two scatterplots corresponding to low and high latitudes. The `order()` suboption within `legend()` displays informative legend keys for the added scatterplots in the legend box at the bottom of the plot (see [\[G-3\] legend\\_options](#)).

All circles in the “high latitude” group (colder climate) fall below the regression line. Thus, the reported risk ratios in colder climates are below the overall risk-ratio estimate, confirming our findings in [example 9](#) of [\[META\] meta](#) that the vaccine is more efficient in colder areas. In the “low latitude” group, only one study (study 7: Vandiviere et al., 1973) had a risk ratio below the overall risk-ratio estimate. Note that this study was also identified as an outlier in the bubble plot of [example 4](#) of [\[META\] estat bubbleplot](#).

## Stored results

`meta galbraithplot` stores the following in `r()`:

### Scalars

<code>r(theta)</code>	estimated overall effect size
<code>r(tau2)</code>	estimated between-study variance (when <code>random()</code> is specified)

### Macros

<code>r(model)</code>	meta-analysis model
<code>r(method)</code>	meta-analysis estimation method

## References

- Anzures-Cabrera, J., and J. P. T. Higgins. 2010. Graphical displays for meta-analysis: An overview with suggestions for practice. *Research Synthesis Methods* 1: 66–80. <https://doi.org/10.1002/jrsm.6>.
- Galbraith, R. F. 1988. A note on graphical representation of estimated odds ratios from several clinical trials. *Statistics in Medicine* 7: 889–894. <https://doi.org/10.1002/sim.4780070807>.

## Also see

[META] **meta data** — Declare meta-analysis data

[META] **meta forestplot** — Forest plots<sup>+</sup>

[META] **meta labbeplot** — L'Abbé plots

[META] **meta regress** — Meta-analysis regression

[META] **meta** — Introduction to meta

[META] **Glossary**

[META] **Intro** — Introduction to meta-analysis

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