

**heckoprobit postestimation** — Postestimation tools for heckoprobit

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## Postestimation commands

The following postestimation commands are available after `heckoprobit`:

| Command                      | Description   |
|------------------------------|---|
| <code>contrast</code>        | contrasts and ANOVA-style joint tests of estimates  |
| <code>estat ic</code>        | Akaike's, consistent Akaike's, corrected Akaike's, and Schwarz's Bayesian information criteria (AIC, CAIC, AICc, and BIC) |
| <code>estat summarize</code> | summary statistics for the estimation sample  |
| <code>estat vce</code>       | variance–covariance matrix of the estimators (VCE)  |
| <code>estat (svy)</code>     | postestimation statistics for survey data   |
| <code>estimates</code>       | cataloging estimation results   |
| <code>etable</code>          | table of estimation results   |
| * <code>hausman</code>       | Hausman's specification test  |
| <code>lincom</code>          | point estimates, standard errors, testing, and inference for linear combinations of coefficients                          |
| * <code>lrtest</code>        | likelihood-ratio test   |
| <code>margins</code>         | marginal means, predictive margins, marginal effects, and average marginal effects  |
| <code>marginsplot</code>     | graph the results from margins (profile plots, interaction plots, etc.)   |
| <code>nlcom</code>           | point estimates, standard errors, testing, and inference for nonlinear combinations of coefficients                       |
| <code>predict</code>         | probabilities, linear predictions and their SEs, etc.   |
| <code>predictnl</code>       | point estimates, standard errors, testing, and inference for generalized predictions                                      |
| <code>pwcompare</code>       | pairwise comparisons of estimates   |
| <code>suest</code>           | seemingly unrelated estimation  |
| <code>test</code>            | Wald tests of simple and composite linear hypotheses  |
| <code>testnl</code>          | Wald tests of nonlinear hypotheses  |

\*`hausman` and `lrtest` are not appropriate with `svy` estimation results.

# predict

## Description for predict

`predict` creates a new variable containing predictions such as probabilities, linear predictions, and standard errors.

## Menu for predict

Statistics > Postestimation

## Syntax for predict

```
predict [type] { stub* | newvar | newvarlist } [if] [in] [, statistic
    outcome(outcome) nooffset ]
```

```
predict [type] stub* [if] [in], scores
```

| <i>statistic</i> | Description |
|------------------|-------------|
|------------------|-------------|

|                   |  |
|-------------------|--|
| Main              |  |
| <u>pmargin</u>    | marginal probabilities; the default                            |
| <u>p1</u>         | bivariate probabilities of levels with selection               |
| <u>p0</u>         | bivariate probabilities of levels with no selection            |
| <u>pcond1</u>     | probabilities of levels conditional on selection               |
| <u>pcond0</u>     | probabilities of levels conditional on no selection            |
| <u>pselect</u>    | selection probability  |
| <u>xb</u>         | linear prediction  |
| <u>stdp</u>       | standard error of the linear prediction                        |
| <u>xbselect</u>   | linear prediction for selection equation                       |
| <u>stdpselect</u> | standard error of the linear prediction for selection equation |

If you do not specify `outcome()`, `pmargin` (with one new variable specified) assumes `outcome(#1)`.

You specify one or  $k$  new variables with `pmargin`, where  $k$  is the number of outcomes.

You specify one new variable with `pselect`, `xb`, `stdp`, `xbselect`, and `stdpselect`.

These statistics are available both in and out of sample; type `predict ... if e(sample) ...` if wanted only for the estimation sample.

## Options for predict

Main

`pmargin`, the default, calculates the predicted marginal probabilities.

You specify one or  $k$  new variables, where  $k$  is the number of categories of the outcome variable  $y_j$ . If you specify the `outcome()` option, you must specify one new variable. If you specify one new variable and do not specify `outcome()`, `outcome(#1)` is assumed.

When `outcome()` is specified, the marginal probability that  $y_j$  is equal to the level `outcome()` is calculated. When `outcome()` is not specified, the marginal probabilities for each outcome level are calculated.

`p1` calculates the predicted bivariate probabilities of outcome levels with selection.

You specify one or  $k$  new variables, where  $k$  is the number of categories of the outcome variable  $y_j$ . If you specify the `outcome()` option, you must specify one new variable. If you specify one new variable and do not specify `outcome()`, `outcome(#1)` is assumed.

When `outcome()` is specified, the bivariate probability that  $y_j$  is equal to the level `outcome()` and that  $y_j$  is observed is calculated. When `outcome()` is not specified, the bivariate probabilities for each outcome level and selection are calculated.

`p0` calculates the predicted bivariate probabilities of outcome levels with no selection.

You specify one or  $k$  new variables, where  $k$  is the number of categories of the outcome variable  $y_j$ . If you specify the `outcome()` option, you must specify one new variable. If you specify one new variable and do not specify `outcome()`, `outcome(#1)` is assumed.

When `outcome()` is specified, the bivariate probability that  $y_j$  is equal to the level `outcome()` and that  $y_j$  is not observed is calculated. When `outcome()` is not specified, the bivariate probabilities for each outcome level and no selection are calculated.

`pcond1` calculates the predicted probabilities of outcome levels conditional on selection.

You specify one or  $k$  new variables, where  $k$  is the number of categories of the outcome variable  $y_j$ . If you specify the `outcome()` option, you must specify one new variable. If you specify one new variable and do not specify `outcome()`, `outcome(#1)` is assumed.

When `outcome()` is specified, the probability that  $y_j$  is equal to the level `outcome()` given that  $y_j$  is observed is calculated. When `outcome()` is not specified, the probabilities for each outcome level conditional on selection are calculated.

`pcond0` calculates the predicted probabilities of outcome levels conditional on no selection.

You specify one or  $k$  new variables, where  $k$  is the number of categories of the outcome variable  $y_j$ . If you specify the `outcome()` option, you must specify one new variable. If you specify one new variable and do not specify `outcome()`, `outcome(#1)` is assumed.

When `outcome()` is specified, the probability that  $y_j$  is equal to the level `outcome()` given that  $y_j$  is not observed is calculated. When `outcome()` is not specified, the probabilities for each outcome level conditional on no selection are calculated.

`pse1` calculates the predicted univariate (marginal) probability of selection.

`xb` calculates the linear prediction for the outcome variable, which is  $\mathbf{x}_j\boldsymbol{\beta}$  if `offset()` was not specified and  $\mathbf{x}_j\boldsymbol{\beta} + \text{offset}_j^\beta$  if `offset()` was specified.

`stdp` calculates the standard error of the prediction, which can be thought of as the standard error of the predicted expected value or mean for the observation's covariate pattern. The standard error of the prediction is also referred to as the standard error of the fitted value.

`xbse1` calculates the linear prediction for the selection equation, which is  $\mathbf{z}_j\boldsymbol{\gamma}$  if `offset()` was not specified in `select()` and  $\mathbf{z}_j\boldsymbol{\gamma} + \text{offset}_j^\gamma$  if `offset()` was specified in `select()`.

`stdpse1` calculates the standard error of the linear prediction for the selection equation.

`outcome(outcome)` specifies for which outcome the predicted probabilities are to be calculated. `outcome()` should contain either one value of the dependent variable or one of #1, #2, ..., with #1 meaning the first category of the dependent variable, #2 meaning the second category, etc.

`nooffset` is relevant only if you specified `offset(`*varname*`)` for `heckoprobit`. It modifies the calculations made by `predict` so that they ignore the offset variable; the linear prediction is treated as  $\mathbf{x}_j\mathbf{b}$  rather than as  $\mathbf{x}_j\mathbf{b} + \text{offset}_j$ .

`scores` calculates equation-level score variables.

The first new variable will contain  $\partial \ln L / \partial (\mathbf{x}_j\boldsymbol{\beta})$ .

The second new variable will contain  $\partial \ln L / \partial (\mathbf{z}_j\boldsymbol{\gamma})$ .

When the dependent variable takes  $k$  different values, new variables three through  $k + 1$  will contain  $\partial \ln L / \partial (\kappa_{j-2})$ .

The last new variable will contain  $\partial \ln L / \partial (\text{atanh } \rho)$ .

## margins

### Description for margins

`margins` estimates margins of response for probabilities and linear predictions.

### Menu for margins

Statistics > Postestimation

### Syntax for margins

```
margins [marginlist] [, options]
```

```
margins [marginlist] , predict(statistic ...) [predict(statistic ...) ...] [options]
```

| <i>statistic</i>        | Description   |
|-------------------------|---|
| default                 | marginal probabilities for each outcome             |
| <u>p</u> margin         | marginal probabilities                              |
| p1                      | bivariate probabilities of levels with selection    |
| p0                      | bivariate probabilities of levels with no selection |
| pcond1                  | probabilities of levels conditional on selection    |
| pcond0                  | probabilities of levels conditional on no selection |
| <u>p</u> sel            | selection probability                               |
| xb                      | linear prediction                                   |
| <u>x</u> b <u>sel</u>   | linear prediction for selection equation            |
| stdp                    | not allowed with <code>margins</code>               |
| <u>std</u> p <u>sel</u> | not allowed with <code>margins</code>               |

`pmargin`, `p1`, `p0`, `pcond1`, and `pcond0` default to the first outcome.

Statistics not allowed with `margins` are functions of stochastic quantities other than  $\mathbf{e}(\mathbf{b})$ .

For the full syntax, see [R] [margins](#).

## Remarks and examples

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

### ► Example 1

In [example 1](#) of [\[R\] heckoprobit](#), we examined a simulated dataset of 5,000 women, 3,480 of whom work and can thus report job satisfaction. Using job satisfaction (`satisfaction`) as the outcome variable and employment (`work`) as the selection variable, we estimated the parameters of an ordered probit sample-selection model. Covariates `age` (age), years of education (`education`), number of children (`children`), and marital status (`married`) are expected to affect selection. The outcome, job satisfaction, is affected by `age` and `education`.

We first reestimate the parameters of the regression, but this time we request a robust variance estimator:

```
. use https://www.stata-press.com/data/r18/womensat
(Job satisfaction, female)
. heckoprobit satisfaction education age,
> select(work=education age i.married##c.children) vce(robust)
(output omitted)
```

We then use `margins` (see [\[R\] margins](#)) to estimate the average marginal effect of education on the probability of having low job satisfaction.

```
. margins, dydx(education) vce(unconditional)
Average marginal effects                                Number of obs = 5,000
dy/dx wrt: education
1._predict: Pr(satisfaction=1), predict(pmargi outcome(1))
2._predict: Pr(satisfaction=2), predict(pmargi outcome(2))
3._predict: Pr(satisfaction=3), predict(pmargi outcome(3))
4._predict: Pr(satisfaction=4), predict(pmargi outcome(4))
```

|           | Unconditional |           |        |       |                        |
|-----------|---------------|-----------|--------|-------|------------------------|
|           | dy/dx         | std. err. | z      | P> z  | [95% conf. interval]   |
| education |               |           |        |       |                        |
| _predict  |               |           |        |       |                        |
| 1         | -.0234776     | .0019176  | -12.24 | 0.000 | -.027236    -.0197192  |
| 2         | -.0230858     | .0015143  | -15.24 | 0.000 | -.0260538    -.0201178 |
| 3         | -.0020603     | .001142   | -1.80  | 0.071 | -.0042987    .000178   |
| 4         | .0486238      | .0018593  | 26.15  | 0.000 | .0449795    .052268    |

The estimated average marginal effect of education on the probability of having low job satisfaction is approximately  $-0.023$ .

◀

## Methods and formulas

The ordinal outcome equation is

$$y_j = \sum_{h=1}^H v_h 1(\kappa_{h-1} < \mathbf{x}_j \boldsymbol{\beta} + u_{1j} \leq \kappa_h)$$

where  $\mathbf{x}_j$  is the outcome covariates,  $\beta$  is the coefficients, and  $u_{1j}$  is a random-error term. The observed outcome values  $v_1, \dots, v_H$  are integers such that  $v_i < v_m$  for  $i < m$ .  $\kappa_1, \dots, \kappa_{H-1}$  are real numbers such that  $\kappa_i < \kappa_m$  for  $i < m$ .  $\kappa_0$  is taken as  $-\infty$  and  $\kappa_H$  is taken as  $+\infty$ .

The selection equation is

$$s_j = 1(\mathbf{z}_j\gamma + u_{2j} > 0)$$

where  $s_j = 1$  if we observed  $y_j$  and 0 otherwise,  $\mathbf{z}_j$  is the covariates used to model the selection process,  $\gamma$  is the coefficients for the selection process, and  $u_{2j}$  is a random-error term.

$(u_{1j}, u_{2j})$  have bivariate normal distribution with mean zero and variance matrix

$$\begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

The probability of selection is

$$\Pr(s_j = 1) = \Phi(\mathbf{z}_j\gamma + \text{offset}_j^\gamma)$$

$\Phi(\cdot)$  is the standard cumulative normal distribution function.

The probability of selection and the outcome  $y_j = v_h$  is

$$\begin{aligned} \Pr(y_j = v_h, s_j = 1) &= \Phi_2\left(\mathbf{z}_j\gamma + \text{offset}_j^\gamma, \kappa_h - x_j\beta - \text{offset}_j^\beta, -\rho\right) \\ &\quad - \Phi_2\left(\mathbf{z}_j\gamma + \text{offset}_j^\gamma, \kappa_{h-1} - \mathbf{x}_j\beta - \text{offset}_j^\beta, -\rho\right) \end{aligned}$$

$\Phi_2(\cdot)$  is the cumulative bivariate normal distribution function (with mean  $[0 \ 0]'$ ).

The probability of  $y_j$  not being selected and the outcome  $y_j = v_h$  is

$$\begin{aligned} \Pr(y_j = v_h, s_j = 0) &= \Phi_2\left(-\mathbf{z}_j\gamma - \text{offset}_j^\gamma, \kappa_h - x_j\beta - \text{offset}_j^\beta, \rho\right) \\ &\quad - \Phi_2\left(-\mathbf{z}_j\gamma - \text{offset}_j^\gamma, \kappa_{h-1} - \mathbf{x}_j\beta - \text{offset}_j^\beta, \rho\right) \end{aligned}$$

The probability of outcome  $y_j = v_h$  given selection is

$$\Pr(y_j = v_h | s_j = 1) = \frac{\Pr(y_j = v_h, s_j = 1)}{\Pr(s_j = 1)}$$

The probability of outcome  $y_j = v_h$  given  $y_j$  is not selected is

$$\Pr(y_j = v_h | s_j = 0) = \frac{\Pr(y_j = v_h, s_j = 0)}{\Pr(s_j = 0)}$$

The marginal probabilities of the outcome  $y_j$  are

$$\begin{aligned} \Pr(y_j = v_1) &= \Phi(\kappa_1 - x_j\beta - \text{offset}_j^\beta) \\ \Pr(y_j = v_H) &= 1 - \Phi(\kappa_{H-1} - x_j\beta - \text{offset}_j^\beta) \\ \Pr(y_j = v_h) &= \Phi(\kappa_h - x_j\beta - \text{offset}_j^\beta) - \Phi(\kappa_{h-1} - x_j\beta - \text{offset}_j^\beta) \end{aligned}$$

## Also see

[R] [heckoprobit](#) — Ordered probit model with sample selection

[U] [20 Estimation and postestimation commands](#)

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