Description

`poivregress` fits a lasso instrumental-variables linear regression model and reports coefficients along with standard errors, test statistics, and confidence intervals for specified covariates of interest. The covariates of interest may be endogenous or exogenous. The partialing-out method is used to estimate effects for these variables and to select from potential control variables and instruments to be included in the model.

Quick start

Estimate a coefficient for endogenous `d1` in a linear regression of `y` on `d1`, and include `x1`–`x100` as potential control variables and `z1`–`z100` as potential instruments to be selected by lassos

```
poivregress y (d1 = z1-z100), controls(x1-x100)
```

As above, and estimate the coefficient for the exogenous `d2`

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100)
```

Use cross-validation (CV) instead of a plugin iterative formula to select the optimal $\lambda^*$ in each lasso

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100) selection(cv)
```

As above, and set a random-number seed for reproducibility

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100) selection(cv) rseed(28)
```

Specify CV for the lasso for `y` only, with the stopping rule criterion turned off

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100) ///
lasso(y, selection(cv), stop(0))
```

As above, but apply the option to the lassos for `y`, `d2`, and `d1`

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100) ///
lasso(*, selection(cv), stop(0))
```

Compute lassos beyond the CV minimum to get full coefficient paths, knots, etc.

```
poivregress y d2 (d1 = z1-z100), controls(x1-x100) ///
lasso(*, selection(cv, alllambdas))
```

Menu

Statistics  >  Lasso  >  Lasso inferential models  >  Continuous outcomes  >  Partialing-out IV model
Syntax

```
poivregress depvar [exovars] (endovars = instrumvars) [if] [in],
  controls([(alwaysvars) othervars]) [options]
```

Coefficients and standard errors are estimated for the exogenous variables, `exovars`, and the endogenous variables, `endovars`. The set of instrumental variables, `instrumvars`, may be high dimensional.

<table>
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<th>options</th>
<th>Description</th>
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<tr>
<td>Model</td>
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<tr>
<td>*<code>controls([(alwaysvars) othervars])</code> alwaysvars and othervars are control variables for depvar, exovars, and endovars; instrumvars are an additional set of control variables that apply only to the endovars; alwaysvars are always included; lassos choose whether to include or exclude othervars</td>
<td></td>
</tr>
<tr>
<td><code>selection(plugin)</code></td>
<td>use a plugin iterative formula to select an optimal value of the lasso penalty parameter $\lambda^*$ for each lasso; the default</td>
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<tr>
<td><code>selection(cv)</code></td>
<td>use CV to select an optimal value of the lasso penalty parameter $\lambda^*$ for each lasso</td>
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<tr>
<td><code>selection(adaptive)</code></td>
<td>use adaptive lasso to select an optimal value of the lasso penalty parameter $\lambda^*$ for each lasso</td>
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<tr>
<td><code>sqrtlasso</code></td>
<td>use square-root lassos</td>
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<tr>
<td><code>missingok</code></td>
<td>after fitting lassos, ignore missing values in any instrumvars or othervars not selected, and include these observations in the final model</td>
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<td>Reporting</td>
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<td>control columns and column formats, row spacing, line width, display of omitted variables and base and empty cells, and factor-variable labeling</td>
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<td>Optimization</td>
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<td><code>[no]log</code></td>
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<td><code>lasso(varlist, lasso_options)</code></td>
<td>specify options for the lassos for variables in varlist; may be repeated</td>
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<tr>
<td><code>sqrtlasso(varlist, lasso_options)</code></td>
<td>specify options for square-root lassos for variables in varlist; may be repeated</td>
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<tr>
<td><code>vce(robust)</code></td>
<td>robust VCE is the only VCE available</td>
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<tr>
<td><code>reestimate</code></td>
<td>refit the model after using lassoselect to select a different $\lambda^*$</td>
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<tr>
<td><code>noheader</code></td>
<td>do not display the header on the coefficient table</td>
</tr>
<tr>
<td><code>coeflegend</code></td>
<td>display legend instead of statistics</td>
</tr>
</tbody>
</table>
controls() is required.  
exovars, endovars, instrumvars, alwaysvars, and othervars may contain factor variables. Base levels of factor variables cannot be set for instrumvars, alwaysvars, and othervars. See [U] 11.4.3 Factor variables.

vce(robust), reestimate, noheader, and coeflegend do not appear in the dialog box.

See [U] 20 Estimation and postestimation commands for more capabilities of estimation commands.

Options

controls((alwaysvars)) othervars) specifies the set of control variables, which control for omitted variables. Control variables are also known as confounding variables. alwaysvars are variables that are always to be included in lassos. alwaysvars are optional. othervars are variables that lassos will choose to include or exclude. The instrumental variables, instrumvars, are an additional set of control variables, but they apply only to the endovars. controls() is required.

poivregress fits lassos for depvar and each one of the exovars and endovars. The control variables for the lassos for depvar and exovars are alwaysvars (always included) and othervars (lasso will include or exclude). The control variables for lassos for endovars are exovars (always included), alwaysvars (always included), instrumvars (lasso will include or exclude), and othervars (lasso will include or exclude).

selection(plugin cv adaptive) specifies the selection method for choosing an optimal value of the lasso penalty parameter \(\lambda^*\) for each lasso or square-root lasso estimation. Separate lassos are estimated for depvar and each variable in varsofinterest. Specifying selection() changes the selection method for all of these lassos. You can specify different selection methods for different lassos using the option lasso() or sqrtlasso(). When lasso() or sqrtlasso() is used to specify a different selection method for the lassos of some variables, they override the global setting made using selection() for the specified variables.

selection(plugin) is the default. It selects \(\lambda^*\) based on a “plugin” iterative formula dependent on the data. See [LASSO] lasso options.

selection(cv) selects the \(\lambda^*\) that gives the minimum of the CV function. See [LASSO] lasso options.

selection(adaptive) selects \(\lambda^*\) using the adaptive lasso selection method. It cannot be specified when sqrtlasso is specified. See [LASSO] lasso options.

sqrtlasso specifies that square-root lassos be done rather than regular lassos. The option lasso() can be used with sqrtlasso to specify that regular lasso be done for some variables, overriding the global sqrtlasso setting for these variables. See [LASSO] lasso options.

missingok specifies that, after fitting lassos, the estimation sample be redefined based on only the nonmissing observations of variables in the final model. In all cases, any observation with missing values for depvar, exovars, endovars, instrumvars, alwaysvars, and othervars is omitted from the estimation sample for the lassos. By default, the same sample is used for calculation of the coefficients of the exovars and endovars and their standard errors.

When missingok is specified, the initial estimation sample is the same as the default, but the sample used for the calculation of the coefficients of the exovars and endovars can be larger. Now observations with missing values for any instrumvars and othervars not selected will be added to the estimation sample (provided there are no missing values for any of the variables in the final model).
missing ok may produce more efficient estimates when data are missing completely at random. It does, however, have the consequence that estimation samples can change when selected variables differ in models fit using different selection methods. That is, when *instrumvars* and *othervars* contain missing values, the estimation sample for a model fit using the default *selection(plugin)* will likely differ from the estimation sample for a model fit using, for example, *selection(cv)*.

**Reporting**

*level(#); see [R] Estimation options.*

*display_options: noci, nopvalues, noomitted, vsquish, noemptycells, baselevels, allbaselevels, noflabel, fvwrap(#), fvwrapon(style), cformat(%fmt), pformat(%fmt), sformat(%fmt), and nolstretch; see [R] Estimation options.*

**Optimization**

*[no]log displays or suppresses a log showing the progress of the estimation. By default, one-line messages indicating when each lasso estimation begins are shown. Specify *verbose* to see a more detailed log.*

*verbose* displays a verbose log showing the iterations of each lasso estimation. This option is useful when doing *selection(cv)* or *selection(adaptive)*. It allows you to monitor the progress of the lasso estimations for these selection methods, which can be time consuming when there are many *othervars* specified in *controls()* or many *instrumvars*.

*rseed(#) sets the random-number seed. This option can be used to reproduce results for selection(cv) and selection(adaptive). The default selection method *selection(plugin)* does not use random numbers. *rseed(#) is equivalent to typing set seed # prior to running poivregress. See [R] set seed.*

**Advanced**

*lasso(varlist, lasso_options)* lets you set different options for different lassos, or advanced options for all lassos. You specify a *varlist* followed by the options you want to apply to the lassos for these variables, where *varlist* consists of one or more variables from *depvar, exovars, or endovars*. *all* or *all* may be used to specify *depvar* and all *exovars* and *endovars*. This option is repeatable as long as different variables are given in each specification. *lasso_options* are *selection(...), grid(...), stop(#), tolerance(#), dtolerance(#), and cvtolerance(#)*. When *lasso(varlist, selection(...))* is specified, it overrides any global *selection()* option for the variables in *varlist*. It also overrides the global *sqrtlasso* option for these variables. See [LASSO] lasso options.

*sqrtlasso(varlist, lasso_options)* works like the option *lasso()*, except square-root lassos for the variables in *varlist* are done rather than regular lassos. *varlist* consists of one or more variables from *depvar, exovars, or endovars*. This option is repeatable as long as different variables are given in each specification. *lasso_options* are *selection(...), grid(...), stop(#), tolerance(#), dtolerance(#), and cvtolerance(#)*. When *sqrtlasso(varlist, selection(...))* is specified, it overrides any global *selection()* option for the variables in *varlist*. See [LASSO] lasso options.

The following options are available with *poivregress* but are not shown in the dialog box:

*vce(robust)* is the only variance–covariance estimator available for these models. The large-sample variance of the method of moments estimator for the partialed-out model has the sandwich structure, the same structure that would be termed a “robust” variance estimator. Only under special assumptions, like a correctly specified parametric model, can the robust form be simplified.
No such assumptions are commonly used for partialed-out models, so only the robust VCE is available.

`reestimate` is an advanced option that refits the `poivregress` model based on changes made to the underlying lassos using `lassoselect`. After running `poivregress`, you can select a different $\lambda^*$ for one or more of the lassos estimated by `poivregress`. After selecting $\lambda^*$, you type `poivregress, reestimate` to refit the `poivregress` model based on the newly selected $\lambda$'s.

`reestimate` may be combined only with reporting options.

`noheader` prevents the coefficient table header from being displayed.

`coeflegend`; see `[R] Estimation options`.

Remarks and examples

`poivregress` performs partialing-out lasso instrumental-variables linear regression. This command estimates coefficients, standard errors, and confidence intervals and performs tests for variables of interest, both exogenous and endogenous, while using lassos to select from among potential control variables and instruments.

The instrumental-variables linear regression model is

$$ y = d\alpha_d' + f\alpha_f' + x\beta' + \epsilon $$

where $d$ are the endogenous variables, $f$ are the exogenous variables for which we wish to make inferences, and $x$ are the potential control variables from which the lassos select. In addition, lassos select from potential instrumental variables, $z$. `poivregress` reports estimated coefficients for $\alpha_d$ and $\alpha_f$. However, partialing-out does not provide estimates of the coefficients on the control variables or their standard errors. No estimation results can be reported for $\beta$.

For an introduction to the partialing-out lasso method for inference, as well as the double-selection and cross-fit partialing-out methods, see [LASSO] Lasso inference intro.

Examples that demonstrate how to use `poivregress` and the other lasso inference commands are presented in [LASSO] Inference examples. In particular, we recommend reading 1 Overview for an introduction to the examples and to the vl command, which provides tools for working with the large lists of variables that are often included when using lasso methods. See 2 Fitting and interpreting inferential models for comparisons of the different methods of fitting inferential models that are available in Stata. See 6 Fitting an inferential model with endogenous covariates for examples and discussion specific to models that account for endogenous covariates.

If you are interested in digging deeper into the lassos that are used to select controls, see 5 Exploring inferential model lassos in [LASSO] Inference examples.
**Stored results**

`poivregress` stores the following in `e()`:

**Scalars**
- `e(N)` number of observations
- `e(k_varsofinterest)` number of variables of interest
- `e(k_controls)` number of potential control variables
- `e(k_controls_sel)` number of selected control variables
- `e(k_inst)` number of potential instruments
- `e(k_inst_sel)` number of selected instruments
- `e(df)` degrees of freedom for test of variables of interest
- `e(chi2)` \( \chi^2 \)
- `e(p)` \( p \)-value for test of variables of interest
- `e(rank)` rank of `e(V)`

**Macros**
- `e(cmd)` `poivregress`
- `e(cmdline)` command as typed
- `e(depvar)` name of dependent variable
- `e(lasso_depvars)` names of dependent variables for all lassos
- `e(varsofinterest)` variables of interest
- `e(controls)` potential control variables
- `e(controls_sel)` selected control variables
- `e(exog)` exogenous variables
- `e(endog)` endogenous variables
- `e(inst)` potential instruments
- `e(inst_sel)` selected instruments
- `e(model)` linear
- `e(title)` title in estimation output
- `e(chi2type)` Wald; type of \( \chi^2 \) test
- `e(vcetype)` `vcetype` specified in `vce()`
- `e(vce)` `vce()` title used to label Std. Err.
- `e(rngstate)` random-number state used
- `e(properties)` `b V`
- `e(predict)` program used to implement `predict`
- `e(select_cmd)` program used to implement `lassoselect`
- `e(marginsnotok)` predictions disallowed by `margins`
- `e(asbalanced)` factor variables `fvset` as `asbalanced`
- `e(asobserved)` factor variables `fvset` as `asobserved`

**Matrices**
- `e(b)` coefficient vector
- `e(V)` variance–covariance matrix of the estimators

**Functions**
- `e(sample)` marks estimation sample

**Methods and formulas**

`poivregress` implements partialing-out lasso instrumental-variables regression described in Chernozhukov, Hansen, and Spindler (2015). The model is

\[
y = d\alpha_d' + f\alpha_f' + x\beta' + \epsilon
\]

where \( d \) contains the \( J_d \) endogenous covariates of interest, \( f \) contains the \( J_f \) exogenous covariates of interest, and \( x \) contains the \( p_x \) controls. We also have \( p_z \) outside instrumental variables, denoted by \( z \), that are correlated with \( d \) but not with \( \epsilon \). The number of controls in \( x \) and the number of instruments in \( z \) can be large and, in theory, can grow with the sample size; however, the number of nonzero elements in \( \beta \) and nonzero coefficients of \( z \) must not be too large, which is to say that the model must be sparse. See `Stata commands for inference` in [LASSO] Lasso intro for a discussion on what it means for the model to be sparse.
In the following algorithm, each lasso can choose the lasso penalty parameter ($\lambda^\ast$) using the plugin estimator, adaptive lasso, or CV. The heteroskedastic plugin estimator for the linear lasso is the default.

**Partialing-out lasso instrumental-variables regression algorithm**

1. Perform a linear lasso of $y$ on $x$, and denote the selected controls by $\tilde{x}_y$.
   Fit a linear regression of $y$ on $\tilde{x}_y$, and denote the residual for the $i$th observation from this regression by $\tilde{\rho}_i$.

2. For $j = 1, \ldots, J_d$, perform a linear lasso of $d_j$ on $f$, $x$, and $z$, denote the selected controls by $\tilde{x}_{d,j}$, and denote the selected instruments by $\tilde{z}_j$.
   Fit a linear regression of $d_j$ on $f$, $\tilde{x}_{d,j}$, and $\tilde{z}_j$, and denote the linear prediction from this regression by $\hat{d}_j$.
   Perform a linear lasso of $\hat{d}_j$ on the controls $x$, and denote the selected controls by $\tilde{\beta}_{d,j}$.
   Fit a linear regression of $\hat{d}_j$ on $\tilde{x}_{d,j}$, let $\tilde{\beta}_{d,j}$ be the estimated coefficients, and denote the residuals from this regression by $\tilde{d}_j$, with its $i$th observation denoted by $\tilde{d}_{j,i}$.
   Also compute the “residuals” for the levels $\tilde{d}_j = d_j - \tilde{x}_j \tilde{\beta}_j$
   and denote its $i$th observation by $\tilde{d}_{j,i}$.

3. For $j = 1, \ldots, J_f$, perform a linear lasso of $f_j$ on the controls $x$, and denote the selected controls by $\tilde{x}_{f,j}$.
   Fit a linear regression of $f_j$ on $\tilde{x}_{f,j}$, and denote the residual for the $i$th observation by $\tilde{f}_{j,i}$.

4. Form the vector of instruments

   $$ w_i = (\tilde{d}_{1,i}, \ldots, \tilde{d}_{J_d,i}, \tilde{f}_{1,i}, \ldots, \tilde{f}_{J_f,i}) $$

5. Form the vector of partialed-out covariates

   $$ p_i = (\tilde{d}_{1,i}, \ldots, \tilde{d}_{J_d,i}, \tilde{f}_{1,i}, \ldots, \tilde{f}_{J_f,i}) $$

6. Compute $\hat{\alpha}$ by solving the following $J_d + J_f$ sample-moment equations.

   $$ \frac{1}{n} \sum_{i=1}^{n} w_i' (\tilde{\rho}_i - p_i \hat{\alpha}') = 0 $$

7. The variance for $\hat{\alpha}$ is estimated by

   $$ \text{Var}(\hat{\alpha}) = \frac{1}{n} \left( \hat{J}_0^{-1} \right) \hat{\Psi} \left( \hat{J}_0^{-1} \right)' $$

   where

   $$ \hat{J}_0 = \frac{1}{n} \sum_{i=1}^{n} w_i' p_i $$
\[ \hat{\Psi} = \frac{1}{n} \sum_{i=1}^{n} \hat{\psi}_i \hat{\psi}_i' \]
\[ \hat{\psi}_i = w_i'(\tilde{\rho}_i - p_i\hat{\alpha}') \]

See *Methods and formulas* in [LASSO lasso] for details on how the lassos in steps 1, 2, and 3 choose their penalty parameters (\(\lambda^*\)).

**Reference**


**Also see**

[LASSO lasso inference postestimation] — Postestimation tools for lasso inferential models
[LASSO xpoivregress] — Cross-fit partialing-out lasso instrumental-variables regression
[R] ivregress — Single-equation instrumental-variables regression
[U] 20 Estimation and postestimation commands