

**eivreg** — Errors-in-variables regression[Description](#)  
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## Description

`eivreg` fits errors-in-variables regression models when one or more of the independent variables are measured with error. To use `eivreg`, you must have an estimate of each independent variable's reliability or assume it is measured without error.

## Quick start

Regression of `y` on `x1`, `x2`, and `x3` adjusted for `x1` measured with 90% reliability

```
eivreg y x1 x2 x3, reliab(x1 .9)
```

As above, but also specify 80% reliability for `x2`

```
eivreg y x1 x2 x3, reliab(x1 .9 x2 .8)
```

## Menu

Statistics > Linear models and related > Errors-in-variables regression

## Syntax

```
eivreg depvar [indepvars] [if] [in] [weight] [, options]
```

<i>options</i>	Description
<b>Model</b>	
<code>reliab(<i>indepvar</i> # [<i>indepvar</i> # [...]])</code>	specify measurement reliability for each <i>indepvar</i> measured with error
<b>Reporting</b>	
<code>level(#)</code>	set confidence level; default is level(95)
<code>display_options</code>	control columns and column formats, row spacing, line width, display of omitted variables and base and empty cells, and factor-variable labeling
<code>coeflegend</code>	display legend instead of statistics

*indepvars* may contain factor variables; see [U] 11.4.3 Factor variables.

`bootstrap`, `by`, `jackknife`, `rolling`, and `statsby` are allowed; see [U] 11.1.10 Prefix commands.

Weights are not allowed with the `bootstrap` prefix; see [R] `bootstrap`.

`aweight`s are not allowed with the `jackknife` prefix; see [R] `jackknife`.

`aweight`s and `fweight`s are allowed; see [U] 11.1.6 `weight`.

`coeflegend` does not appear in the dialog box.

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

## Options

### Model

`reliab(indepvar # [indepvar # [...]])` specifies the measurement reliability for each independent variable measured with error. Reliabilities are specified as pairs consisting of an independent variable name (a name that appears in *indepvars*) and the corresponding reliability  $r$ ,  $0 < r \leq 1$ . Independent variables for which no reliability is specified are assumed to have reliability 1. If the option is not specified, all variables are assumed to have reliability 1, and the result is thus the same as that produced by `regress` (the ordinary least-squares results).

### Reporting

`level(#)`; see [R] estimation options.

`display_options`: `noci`, `noptions`, `noomitted`, `vsquish`, `noemptycells`, `baselevels`, `allbaselevels`, `nofvlabel`, `fvwrap(#)`, `fvwrapon(style)`, `cformat(%fmt)`, `pformat(%fmt)`, `sformat(%fmt)`, and `nolstretch`; see [R] estimation options.

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

`coeflegend`; see [R] estimation options.

## Remarks and examples

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

For an introduction to errors-in-variables regression, see Draper and Smith (1998, 89–91) or Kmenta (1997, 352–357). Treiman (2009, 258–261) compares the results of errors-in-variables regression with conventional regression.

Errors-in-variables regression models are useful when one or more of the independent variables are measured with additive noise. Standard regression (as performed by `regress`) would underestimate the effect of the variable, and the other coefficients in the model can be biased to the extent that they are correlated with the poorly measured variable. You can adjust for the biases if you know the reliability:

$$r = 1 - \frac{\text{noise variance}}{\text{total variance}}$$

That is, given the model  $\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u}$ , for some variable  $x_i$  in  $\mathbf{X}$ , the  $x_i$  is observed with error,  $x_i = x_i^* + e$ , and the noise variance is the variance of  $e$ . The total variance is the variance of  $x_i$ .

### ► Example 1

Say that in our automobile data, the weight of cars was measured with error, and the reliability of our measured weight is 0.85. The result of this would be to underestimate the effect of `weight` in a regression of, say, `price` on `weight` and `foreign`, and it would also bias the estimate of the coefficient on `foreign` (because being of foreign manufacture is correlated with the weight of cars). We would ignore all of this if we fit the model with `regress`:

```
. use http://www.stata-press.com/data/r15/auto
(1978 Automobile Data)
. regress price weight foreign
```

Source	SS	df	MS	Number of obs	=	74
Model	316859273	2	158429637	F(2, 71)	=	35.35
Residual	318206123	71	4481776.38	Prob > F	=	0.0000
				R-squared	=	0.4989
				Adj R-squared	=	0.4848
Total	635065396	73	8699525.97	Root MSE	=	2117

  

price	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
weight	3.320737	.3958784	8.39	0.000	2.531378 4.110096
foreign	3637.001	668.583	5.44	0.000	2303.885 4970.118
_cons	-4942.844	1345.591	-3.67	0.000	-7625.876 -2259.812

With `eivreg`, we can account for our measurement error:

```
. eivreg price weight foreign, r(weight .85)
```

variable	assumed reliability	Errors-in-variables regression				
weight	0.8500	Number of obs	=	74		
*	1.0000	F( 2, 71)	=	50.37		
		Prob > F	=	0.0000		
		R-squared	=	0.6483		
		Root MSE	=	1773.54		

  

price	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
weight	4.31985	.431431	10.01	0.000	3.459601 5.180099
foreign	4637.32	624.5362	7.43	0.000	3392.03 5882.609
_cons	-8257.017	1452.086	-5.69	0.000	-11152.39 -5361.639

The effect of `weight` is increased—as we knew it would be—and here the effect of foreign manufacture is also increased. A priori, we knew only that the estimate of `foreign` might be biased; we did not know the direction.

## □ Technical note

Swept under the rug in our example is how we would determine the reliability,  $r$ . We can easily see that a variable is measured with error, but we may not know the reliability because the ingredients for calculating  $r$  depend on the unobserved noise.

For our example, we made up a value for  $r$ , and in fact we do not believe that weight is measured with error at all, so the reported `eivreg` results have no validity. The `regress` results were the statistically correct results here.

But let's say that we do suspect that weight is measured with error and that we do not know  $r$ . We could then experiment with various values of  $r$  to describe the sensitivity of our estimates to possible error levels. We may not know  $r$ , but  $r$  does have a simple interpretation, and we could probably produce a sensible range for  $r$  by thinking about how the data were collected.

If the reliability,  $r$ , is less than the  $R^2$  from a regression of the poorly measured variable on all the other variables, including the dependent variable, the information might as well not have been collected; no adjustment to the final results is possible. For our automobile data, running a regression of `weight` on `foreign` and `price` would result in an  $R^2$  of 0.6743. Thus the reliability must be at least 0.6743 here. If we specify a reliability that is too small, `eivreg` will inform us and refuse to fit the model:

```
. eivreg price weight foreign, r(weight .6742)
reliability r() too small
r(399);
```

Returning to our problem of how to estimate  $r$ , too small or not, if the measurements are summaries of scaled items, the reliability may be estimated using the `alpha` command; see [\[MV\] alpha](#). If the score is computed from factor analysis and the data are scored using `predict`'s default options (see [\[MV\] factor postestimation](#)), the square of the standard deviation of the score is an estimate of the reliability.

□

## □ Technical note

Consider a model with more than one variable measured with error. For instance, say that our model is that `price` is a function of `weight`, `foreign`, and `mpg` and that both `weight` and `mpg` are measured with error.

```
. eivreg price weight foreign mpg, r(weight .85 mpg .9)
```

variable	assumed reliability	Errors-in-variables regression				
weight	0.8500	Number of obs	=		74	
mpg	0.9000	F( 3, 70)	=		429.14	
*	1.0000	Prob > F	=		0.0000	
		R-squared	=		0.9728	
		Root MSE	=		496.41	

  

	price	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
	weight	12.88302	.6820532	18.89	0.000	11.52271 14.24333
	foreign	8268.951	352.8719	23.43	0.000	7565.17 8972.732
	mpg	999.2043	73.60037	13.58	0.000	852.413 1145.996
	_cons	-56473.19	3710.015	-15.22	0.000	-63872.58 -49073.8

□

## Stored results

eivreg stores the following in `e()`:

### Scalars

<code>e(N)</code>	number of observations
<code>e(df_m)</code>	model degrees of freedom
<code>e(df_r)</code>	residual degrees of freedom
<code>e(r2)</code>	<i>R</i> -squared
<code>e(F)</code>	<i>F</i> statistic
<code>e(rmse)</code>	root mean squared error
<code>e(rank)</code>	rank of <code>e(V)</code>

### Macros

<code>e(cmd)</code>	eivreg
<code>e(cmdline)</code>	command as typed
<code>e(depvar)</code>	name of dependent variable
<code>e(rellist)</code>	<i>indepvars</i> and associated reliabilities
<code>e(wtype)</code>	weight type
<code>e(wexp)</code>	weight expression
<code>e(properties)</code>	b V
<code>e(predict)</code>	program used to implement <code>predict</code>
<code>e(marginsok)</code>	predictions allowed by <code>margins</code>
<code>e(asbalanced)</code>	factor variables <code>fvset</code> as <code>asbalanced</code>
<code>e(asobserved)</code>	factor variables <code>fvset</code> as <code>asobserved</code>

### Matrices

<code>e(b)</code>	coefficient vector
<code>e(V)</code>	variance–covariance matrix of the estimators

### Functions

<code>e(sample)</code>	marks estimation sample
------------------------	-------------------------

## Methods and formulas

Let the model to be fit be

$$\begin{aligned} \mathbf{y} &= \mathbf{X}^* \boldsymbol{\beta} + \mathbf{e} \\ \mathbf{X} &= \mathbf{X}^* + \mathbf{U} \end{aligned}$$

where  $\mathbf{X}^*$  are the true values and  $\mathbf{X}$  are the observed values. Let  $\mathbf{W}$  be the user-specified weights. If no weights are specified,  $\mathbf{W} = \mathbf{I}$ . If weights are specified, let  $\mathbf{v}$  be the specified weights. If `fweight` frequency weights are specified, then  $\mathbf{W} = \text{diag}(\mathbf{v})$ . If `aweight` analytic weights are specified, then  $\mathbf{W} = \text{diag}\{\mathbf{v}/(\mathbf{1}'\mathbf{v})(\mathbf{1}'\mathbf{1})\}$ , meaning that the weights are normalized to sum to the number of observations.

The estimates  $\mathbf{b}$  of  $\boldsymbol{\beta}$  are obtained as  $\mathbf{A}^{-1}\mathbf{X}'\mathbf{W}\mathbf{y}$ , where  $\mathbf{A} = \mathbf{X}'\mathbf{W}\mathbf{X} - \mathbf{S}$ .  $\mathbf{S}$  is a diagonal matrix with elements  $N(1 - r_i)s_i^2$ .  $N$  is the number of observations,  $r_i$  is the user-specified reliability coefficient for the  $i$ th explanatory variable or 1 if not specified, and  $s_i^2$  is the (appropriately weighted) variance of the variable.

The variance–covariance matrix of the estimators is obtained as  $s^2\mathbf{A}^{-1}\mathbf{X}'\mathbf{W}\mathbf{X}\mathbf{A}^{-1}$ , where the root mean squared error  $s^2 = (\mathbf{y}'\mathbf{W}\mathbf{y} - \mathbf{b}\mathbf{A}\mathbf{b}')/(N - p)$ , where  $p$  is the number of estimated parameters.

## References

- Draper, N., and H. Smith. 1998. *Applied Regression Analysis*. 3rd ed. New York: Wiley.
- Erickson, T., R. Parham, and T. M. Whited. 2017. [Fitting the errors-in-variables model using high-order cumulants and moments](#). *Stata Journal* 17: 116–129.
- Kmenta, J. 1997. *Elements of Econometrics*. 2nd ed. Ann Arbor: University of Michigan Press.
- Treiman, D. J. 2009. *Quantitative Data Analysis: Doing Social Research to Test Ideas*. San Francisco: Jossey-Bass.

## Also see

- [R] [eivreg postestimation](#) — Postestimation tools for eivreg
- [R] [regress](#) — Linear regression
- [SEM] [example 24](#) — Reliability
- [U] [20 Estimation and postestimation commands](#)