Title  Instrumental-Variables Regression by ‘2SLS’, ‘2SM’, or ‘2SMM’, with Diagnostics

Description  Instrumental variable estimation for linear models by two-stage least-squares (2SLS) regression or by robust-regression via M-estimation (2SM) or MM-estimation (2SMM). The main ivreg() model-fitting function is designed to provide a workflow as similar as possible to standard lm() regression. A wide range of methods is provided for fitted ivreg model objects, including extensive functionality for computing and graphing regression diagnostics in addition to other standard model tools.

License  GPL (>= 2)

Depends  R (>= 3.6.0)

Imports  car (>= 3.0-9), Formula, lmtest, MASS, stats

Suggests  AER, effects (>= 4.2.0), knitr, insight, parallel, rmarkdown, sandwich, testthat, modelsummary, ggplot2

Encoding  UTF-8

LazyData  true

VignetteBuilder  knitr

BugReports  https://github.com/zeileis/ivreg/issues/

URL  https://zeileis.github.io/ivreg/

RoxygenNote  7.2.3

NeedsCompilation  no

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**R topics documented:**

CigaretteDemand ............................................. 2  
coef.ivreg .................................................... 4  
influence.ivreg ............................................. 7  
ivreg .......................................................... 11  
ivreg.fit ....................................................... 15  
Kmenta .......................................................... 17  
SchoolingReturns .......................................... 18

Index ......................................................... 21

**CigaretteDemand**  
*U.S. Cigarette Demand Data*

**Description**


**Usage**

```r
data("CigaretteDemand", package = "ivreg")
```

**Format**

A data frame with 48 rows and 10 columns.

- **packs** Number of cigarette packs per capita sold in 1995.
- **rprice** Real price in 1995 (including sales tax).
- **rincome** Real per capita income in 1995.
- **salestax** Sales tax in 1995.
- **cigtax** Cigarette-specific taxes (federal and average local excise taxes) in 1995.
- **packs diff** Difference in \( \log(packs) \) (between 1995 and 1985).
- **pricediff** Difference in \( \log(rprice) \) (between 1995 and 1985).
- **incomediff** Difference in \( \log(rincome) \) (between 1995 and 1985).
- **salestaxdiff** Difference in salestax (between 1995 and 1985).
- **cigtaxdiff** Difference in cigtax (between 1995 and 1985).

**Details**

The data are taken from the online complements to Stock and Watson (2007) and had been prepared as panel data (in long form) in `CigarettesSW` from the AER package (Kleiber and Zeileis 2008). Here, the data are provided by state (in wide form), readily preprocessed to contain all variables needed for illustrations of OLS and IV regressions. More related examples from Stock and Watson (2007) are provided in the AER package in `StockWatson2007`. A detailed discussion of the various cigarette demand examples with R code is provided by Hanck et al. (2020, Chapter 12).
Source

Online complements to Stock and Watson (2007).

References


See Also

*CigarettesSW*.

Examples

```r
## load data
data(“CigaretteDemand”, package = “ivreg”)  

## basic price elasticity: OLS vs. IV
cig_ols <- lm(log(packs) ~ log(rprice), data = CigaretteDemand)
cig_iv <- ivreg(log(packs) ~ log(rprice) | salestax, data = CigaretteDemand)
cbind(OLS = coef(cig_ols), IV = coef(cig_iv))

## adjusting for income differences (exogenous)
cig_iv2 <- ivreg(log(packs) ~ log(rprice) + log(rincome) | salestax + log(rincome),
                  data = CigaretteDemand)
cbind(OLS = coef(cig_ols), IV = coef(cig_iv))

## adding a second instrument for log(rprice)
cig_iv3 <- update(cig_iv2, . ~ . | . + cigtax)

## comparison using heteroscedasticity-consistent standard errors
library(“lmtest”)
library(“sandwich”)
coeftest(cig_iv2, vcov = vcovHC, type = “HC1”)
coeftest(cig_iv3, vcov = vcovHC, type = “HC1”)

## long-run price elasticity using differences between 1995 and 1985
cig_ivdiff1 <- ivreg(packsdiff ~ pricediff + incomediff + salestaxdiff,
                    data = CigaretteDemand)
cig_ivdiff2 <- update(cig_ivdiff1, . ~ . | . ~ salestaxdiff + cigtaxdiff)
cig_ivdiff3 <- update(cig_ivdiff1, . ~ . | . + cigtaxdiff)
coeftest(cig_ivdiff1, vcov = vcovHC, type = “HC1”)
coeftest(cig_ivdiff2, vcov = vcovHC, type = “HC1”)
coeftest(cig_ivdiff3, vcov = vcovHC, type = “HC1”)
```
Description

Various methods for processing "ivreg" objects; for diagnostic methods, see ivregDiagnostics.

Usage

```r
## S3 method for class 'ivreg'
coef(object, component = c("stage2", "stage1"), complete = TRUE, ...)

## S3 method for class 'ivreg'
vcov(object, component = c("stage2", "stage1"), complete = TRUE, ...)

## S3 method for class 'ivreg'
confint(
  object,
  parm,
  level = 0.95,
  component = c("stage2", "stage1"),
  complete = TRUE,
  vcov. = NULL,
  df = NULL,
  ...
)

## S3 method for class 'ivreg'
bread(x, ...)

## S3 method for class 'ivreg'
estfun(x, ...)

## S3 method for class 'ivreg'
vcovHC(x, ...)

## S3 method for class 'ivreg'
terms(x, component = c("regressors", "instruments", "full"), ...)

## S3 method for class 'ivreg'
model.matrix(
  object,
  component = c("regressors", "projected", "instruments"),
  ...
)
```
coef.ivreg

model.matrix(object, ...)

## S3 method for class 'ivreg'
predict(
  object,
  newdata,
  type = c("response", "terms"),
  na.action = na.pass,
  ...)

## S3 method for class 'ivreg'
print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'ivreg'
summary(object, vcov. = NULL, df = NULL, diagnostics = NULL, ...)

## S3 method for class 'summary.ivreg'
print(x, digits = max(3, getOption("digits") - 3),
  signif.stars = getOption("show.signif.stars"),
  ...)

## S3 method for class 'ivreg'
anova(object, object2, test = "F", vcov. = NULL, ...)

## S3 method for class 'ivreg'
update(object, formula., ..., evaluate = TRUE)

## S3 method for class 'ivreg'
residuals(
  object,
  type = c("response", "projected", "regressors", "working", "deviance", "pearson",
            "partial", "stage1"),
  ...)

## S3 method for class 'ivreg'
Effect(focal.predictors, mod, ...)

## S3 method for class 'ivreg'
formula(x, component = c("complete", "regressors", "instruments"), ...)

## S3 method for class 'ivreg'
find_formula(x, ...)
## S3 method for class 'ivreg'
Anova(mod, test.statistic = c("F", "Chisq"), ...)

## S3 method for class 'ivreg'
linearHypothesis(
  model, 
  hypothesis.matrix, 
  rhs = NULL, 
  test = c("F", "Chisq"), 
  ... 
)

## S3 method for class 'ivreg'
alias(object, ...)

## S3 method for class 'ivreg'
qr(x, ...)

## S3 method for class 'ivreg'
weights(object, type = c("variance", "robustness"), ...)

Arguments

object, object2, model, mod
  An object of class "ivreg".
component
  For terms, "regressors", "instruments", or "full"; for model.matrix, "projected", "regressors", or "instruments"; for formula, "regressors", "instruments", or "complete"; for coef and vcov, "stage2" or "stage1".
complete
  If TRUE, the default, the returned coefficient vector (for coef()) or coefficient-covariance matrix (for vcov) includes elements for aliased regressors.
...  arguments to pass down.
parm
  parameters for which confidence intervals are to be computed; a vector or numbers or names; the default is all parameters.
level
  confidence level; the default is 0.95.
vcov.
  Optional coefficient covariance matrix, or a function to compute the covariance matrix, to use in computing the model summary.
df
  Optional residual degrees of freedom to use in computing model summary.
x
  An object of class "ivreg" or "summary.ivreg".
newdata
  Values of predictors for which to obtain predicted values.
type
  For predict, one of "response" (the default) or "terms"; for residuals, one of "response" (the default), "projected", "regressors", "working", "deviance", "pearson", or "partial"; type = "working" and "response" are equivalent, as are type = "deviance" and "pearson"; for weights, "variance" (the default) for invariance-variance weights (which is NULL for an unweighted fit) or "robustness" for robustness weights (available for M or MM estimation).
influence.ivreg

na.action  
na method to apply to predictor values for predictions; default is na.pass.
digits    
For printing.
diagnostics 
Report 2SLS "diagnostic" tests in model summary (default is TRUE). These tests are not to be confused with the regression diagnostics provided elsewhere in the ivreg package: see ivregDiagnostics.
signif.stars  
Show "significance stars" in summary output.
test, test.statistic  
Test statistics for ANOVA table computed by anova(), Anova(), or linearHypothesis(). Only test = "F" is supported by anova(); this is also the default for Anova() and linearHypothesis(), which also allow test = "Chisq" for asymptotic tests.
formula.  
To update model.
evaluate  
If TRUE, the default, the updated model is evaluated; if FALSE the updated call is returned.
focal.predictors  
Focal predictors for effect plot, see Effect.
hypothesis.matrix, rhs  
For formulating a linear hypothesis; see the documentation for linearHypothesis for details.

See Also

ivreg, ivreg.fit, ivregDiagnostics

Deletion and Other Diagnostic Methods for "ivreg" Objects

Description

Methods for computing deletion and other regression diagnostics for 2SLS regression. It’s generally more efficient to compute the deletion diagnostics via the influence method and then to extract the various specific diagnostics with the methods for "influence.ivreg" objects. Other diagnostics for linear models, such as added-variable plots (avPlots) and component-plus-residual plots (crPlots), also work, as do effect plots (e.g., predictorEffects) with residuals (see the examples below). The pointwise confidence envelope for the qqPlot method assumes an independent random sample from the t distribution with degrees of freedom equal to the residual degrees of freedom for the model and so are approximate, because the studentized residuals aren’t independent.

For additional information, see the vignette Diagnostics for 2SLS Regression.

Usage

## S3 method for class 'ivreg'
influence(
  model,  
sigma. = n <= 1000,  
)
type = c("stage2", "both", "maximum"),
applyfun = NULL,
ncores = NULL,
... )

## S3 method for class 'ivreg'

rstudent(model, ...)

## S3 method for class 'ivreg'
cooks.distance(model, ...)

## S3 method for class 'influence.ivreg'
dfbeta(model, ...)

## S3 method for class 'ivreg'
dfbeta(model, ...)

## S3 method for class 'ivreg'
hatvalues(model, type = c("stage2", "both", "maximum", "stage1"), ...)

## S3 method for class 'influence.ivreg'
rstudent(model, ...)

## S3 method for class 'influence.ivreg'
hatvalues(model, ...)

## S3 method for class 'influence.ivreg'
cooks.distance(model, ...)

## S3 method for class 'influence.ivreg'
qqPlot(
  x,
  ylab = paste("Studentized Residuals("), deparse(substitute(x)), ")", sep = ""),
  distribution = c("t", "norm"),
  ...
)

## S3 method for class 'influence.ivreg'
influencePlot(model, ...)

## S3 method for class 'influence.ivreg'
influencePlot(model, ...)

## S3 method for class 'influence.ivreg'
influencePlot(model, ...)

## S3 method for class 'influence.ivreg'
influencePlot(model, ...)

## S3 method for class 'influence.ivreg'
influence.ivreg

infIndexPlot(model, ...)
## S3 method for class 'influence.ivreg'
model.matrix(object, ...)
## S3 method for class 'ivreg'
avPlots(model, terms, ...)
## S3 method for class 'ivreg'
avPlot(model, ...)
## S3 method for class 'ivreg'
mcPlots(model, terms, ...)
## S3 method for class 'ivreg'
mcPlot(model, ...)
## S3 method for class 'ivreg'
Boot(
  object,
  f = coef,
  labels = names(f(object)),
  R = 999,
  method = "case",
  ncores = 1,
  ...
)
## S3 method for class 'ivreg'
crPlots(model, terms, ...)
## S3 method for class 'ivreg'
crPlot(model, ...)
## S3 method for class 'ivreg'
ceresPlots(model, terms, ...)
## S3 method for class 'ivreg'
ceresPlot(model, ...)
## S3 method for class 'ivreg'
plot(x, ...)
## S3 method for class 'ivreg'
qqPlot(x, distribution = c("t", "norm"), ...)
## S3 method for class 'ivreg'
outlierTest(model, ...)
## S3 method for class 'ivreg'
spreadLevelPlot(x, main = "Spread-Level Plot", ...)

## S3 method for class 'ivreg'
ncvTest(model, ...)

## S3 method for class 'ivreg'
deviance(object, ...)

## S3 method for class 'rivreg'
influence(model, ...)

### Arguments

- `model, x, object`
  - A "ivreg" or "influence.ivreg" object.
- `sigma`
  - If TRUE (the default for 1000 or fewer cases), the deleted value of the residual standard deviation is computed for each case; if FALSE, the overall residual standard deviation is used to compute other deletion diagnostics.
- `type`
  - If "stage2" (the default), hatvalues are for the second stage regression; if "both", the hatvalues are the geometric mean of the casewise hatvalues for the two stages; if "maximum", the hatvalues are the larger of the casewise hatvalues for the two stages. In computing the geometric mean or casewise maximum hatvalues, the hatvalues for each stage are first divided by their average (number of coefficients in stage regression/number of cases); the geometric mean or casewise maximum values are then multiplied by the average hatvalue from the second stage.
- `applyfun`
  - Optional loop replacement function that should work like `lapply` with arguments `function(X, FUN, ...)`. The default is to use a loop unless the `ncores` argument is specified (see below).
- `ncores`
  - Numeric, number of cores to be used in parallel computations. If set to an integer the applyfun is set to use either `parLapply` (on Windows) or `mclapply` (otherwise) with the desired number of cores.
- `...`
  - arguments to be passed down.
- `ylab`
  - The vertical axis label.
- `distribution`
  - "t" (the default) or "norm".
- `terms`
  - Terms for which added-variable plots are to be constructed; the default, if the argument isn’t specified, is the "regressors" component of the model formula.
- `f, labels, R`
  - see `Boot`.
- `method`
  - only "case" (case resampling) is supported: see `Boot`.
- `main`
  - Main title for the graph.

### Value

In the case of `influence.ivreg`, an object of class "influence.ivreg" with the following components:
ivreg  

Instrumental-Variable Regression by 2SLS, 2SM, or 2SMM Estimation

Description

Fit instrumental-variable regression by two-stage least squares (2SLS). This is equivalent to direct instrumental-variables estimation when the number of instruments is equal to the number of regressors. Alternative robust-regression estimators are also provided, based on M-estimation (2SM) and MM-estimation (2SMM).
Usage

ivreg(
  formula,
  instruments,
  data,
  subset,
  na.action,
  weights,
  offset,
  contrasts = NULL,
  model = TRUE,
  y = TRUE,
  x = FALSE,
  method = c("OLS", "M", "MM"),
  ...
)

Arguments

formula, instruments
  formula specification(s) of the regression relationship and the instruments. Either instruments is missing and formula has three parts as in y ~ x1 + x2 | z1 + z2 + z3 (recommended) or formula is y ~ x1 + x2 and instruments is a one-sided formula ~ z1 + z2 + z3 (only for backward compatibility).

data
  an optional data frame containing the variables in the model. By default the variables are taken from the environment of the formula.

subset
  an optional vector specifying a subset of observations to be used in fitting the model.

na.action
  a function that indicates what should happen when the data contain NAs. The default is set by the na.action option.

weights
  an optional vector of weights to be used in the fitting process.

offset
  an optional offset that can be used to specify an a priori known component to be included during fitting.

contrasts
  an optional list. See the contrasts.arg of model.matrix.default.

model, x, y
  logicals. If TRUE the corresponding components of the fit (the model frame, the model matrices, the response) are returned. These components are necessary for computing regression diagnostics.

method
  the method used to fit the stage 1 and 2 regression: "OLS" for traditional 2SLS regression (the default), "M" for M-estimation, or "MM" for MM-estimation, with the latter two robust-regression methods implemented via the rlm function in the MASS package.

...
  further arguments passed to ivreg.fit.

Details

ivreg is the high-level interface to the work-horse function ivreg.fit. A set of standard methods (including print, summary, vcov, anova, predict, residuals, terms, model.matrix, bread,
estfun) is available and described in `ivregMethods`. For methods related to regression diagnostics, see `ivregDiagnostics`.

Regressors and instruments for `ivreg` are most easily specified in a formula with two parts on the right-hand side, e.g., `y ~ x1 + x2 | z1 + z2 + z3`, where `x1` and `x2` are the explanatory variables and `z1`, `z2`, and `z3` are the instrumental variables. Note that exogenous regressors have to be included as instruments for themselves.

For example, if there is one exogenous regressor `ex` and one endogenous regressor `en` with instrument `in`, the appropriate formula would be `y ~ en + ex | in + ex`. Alternatively, a formula with three parts on the right-hand side can also be used: `y ~ ex | en | in`. The latter is typically more convenient, if there is a large number of exogenous regressors.

Moreover, two further equivalent specification strategies are possible that are typically less convenient compared to the strategies above. One option is to use an update formula with a `.` in the second part of the formula is used: `y ~ en + ex | . ~ en + in`. Another option is to use a separate formula for the instruments (only for backward compatibility with earlier versions): `formula = y ~ en + ex, instruments = ~ in + ex`.

Internally, all specifications are converted to the version with two parts on the right-hand side.

**Value**

`ivreg` returns an object of class "`ivreg" that inherits from class "lm", with the following components:

- `coefficients`: parameter estimates, from the stage-2 regression.
- `residuals`: vector of model residuals.
- `residuals1`: matrix of residuals from the stage-1 regression.
- `residuals2`: vector of residuals from the stage-2 regression.
- `fitted.values`: vector of predicted means for the response.
- `weights`: either the vector of weights used (if any) or NULL (if none).
- `offset`: either the offset used (if any) or NULL (if none).
- `estfun`: a matrix containing the empirical estimating functions.
- `n`: number of observations.
- `nobs`: number of observations with non-zero weights.
- `p`: number of columns in the model matrix `x` of regressors.
- `q`: number of columns in the instrumental variables model matrix `z`.
- `rank`: numeric rank of the model matrix for the stage-2 regression.
- `df.residual`: residual degrees of freedom for fitted model.
- `cov.unscaled`: unscaled covariance matrix for the coefficients.
- `sigma`: residual standard deviation.
- `qr`: QR decomposition for the stage-2 regression.
- `qr1`: QR decomposition for the stage-1 regression.
- `rank1`: numeric rank of the model matrix for the stage-1 regression.
- `coefficients1`: matrix of coefficients from the stage-1 regression.
df.residual1 residual degrees of freedom for the stage-1 regression.
exogenous columns of the "regressors" matrix that are exogenous.
endogenous columns of the "regressors" matrix that are endogenous.
instruments columns of the "instruments" matrix that are instruments for the endogenous variables.
method the method used for the stage 1 and 2 regressions, one of "OLS", "M", or "MM".
rweights a matrix of robustness weights with columns for each of the stage-1 regressions and for the stage-2 regression (in the last column) if the fitting method is "M" or "MM", NULL if the fitting method is "OLS".
hatvalues a matrix of hatvalues. For method = "OLS", the matrix consists of two columns, for each of the stage-1 and stage-2 regression; for method = "M" or "MM", there is one column for each stage=1 regression and for the stage-2 regression.
df.residual residual degrees of freedom for fitted model.
call the original function call.
formula the model formula.
na.action function applied to missing values in the model fit.
terms a list with elements "regressors" and "instruments" containing the terms objects for the respective components.
levels levels of the categorical regressors.
contrasts the contrasts used for categorical regressors.
model the full model frame (if model = TRUE).
y the response vector (if y = TRUE).
x a list with elements "regressors", "instruments", "projected", containing the model matrices from the respective components (if x = TRUE). "projected" is the matrix of regressors projected on the image of the instruments.

References

See Also
ivreg.fit, ivregDiagnostics, ivregMethods, lm, lm.fit

Examples
```r
## data
data("CigaretteDemand", package = "ivreg")

## model
m <- ivreg(log(packs) ~ log(rprice) + log(rincome) | salestax + log(rincome),
  data = CigaretteDemand)
summary(m)
summary(m, vcov = sandwich::sandwich, df = Inf)
```
## ANOVA
m2 <- update(m, . ~ . - log(rincome) | . - log(rincome))
anova(m, m2)
car::Anova(m)

## same model specified by formula with three-part right-hand side
ivreg(log(packs) ~ log(rincome) | log(rprice) | saletax, data = CigaretteDemand)

# Robust 2SLS regression
data("Kmenta", package = "ivreg")
Kmental <- Kmenta
Kmental[20, "Q"] <- 95 # corrupted data
deq <- ivreg(Q ~ P + D | D + F + A, data = Kmental) # demand equation, uncorrupted data
deq1 <- ivreg(Q ~ P + D | D + F + A, data = Kmental) # standard 2SLS, uncorrupted data
deq2 <- ivreg(Q ~ P + D | D + F + A, data = Kmental, subset = -20) # standard 2SLS, removing bad case
deq3 <- ivreg(Q ~ P + D | D + F + A, data = Kmental, method = "MM") # 2SLS MM estimation
car::compareCoefs(deq, deq1, deq2, deq3)
round(deq3$weights, 2) # robustness weights

---

### ivreg.fit

**Fitting Instrumental-Variable Regressions by 2SLS, 2SM, or 2SMM Estimation**

**Description**

Fit instrumental-variable regression by two-stage least squares (2SLS). This is equivalent to direct instrumental-variables estimation when the number of instruments is equal to the number of predictors. Alternative robust-regression estimation is also supported, based on M-estimation (22M) or MM-estimation (2SMM).

**Usage**

```r
ivreg.fit(
  x, y, z, weights, offset, method = c("OLS", "M", "MM"),
  rlm.args = list(), ...
)
```

**Arguments**

- `x` regressor matrix.
- `y` vector for the response variable.
ivreg.fit

z instruments matrix.
weights an optional vector of weights to be used in the fitting process.
offset an optional offset that can be used to specify an a priori known component to be included during fitting.
method the method used to fit the stage 1 and 2 regression: "OLS" for traditional 2SLS regression (the default), "M" for M-estimation, or "MM" for MM-estimation, with the latter two robust-regression methods implemented via the rlm function in the MASS package.
rlm.args a list of optional arguments to be passed to the rlm function in the MASS package if robust regression is used for the stage 1 and 2 regressions.
... further arguments passed to lm.fit or lm.wfit, respectively.

Details

ivreg is the high-level interface to the work-horse function ivreg.fit. ivreg.fit is essentially a convenience interface to lm.fit (or lm.wfit) for first projecting x onto the image of z, then running a regression of y on the projected x, and computing the residual standard deviation.

Value

ivreg.fit returns an unclassed list with the following components:
coefficients parameter estimates, from the stage-2 regression.
residuals vector of model residuals.
residuals1 matrix of residuals from the stage-1 regression.
residuals2 vector of residuals from the stage-2 regression.
fitted.values vector of predicted means for the response.
weights either the vector of weights used (if any) or NULL (if none).
offset either the offset used (if any) or NULL (if none).
estfun a matrix containing the empirical estimating functions.
n number of observations.
nobs number of observations with non-zero weights.
p number of columns in the model matrix x of regressors.
q number of columns in the instrumental variables model matrix z
rank numeric rank of the model matrix for the stage-2 regression.
df.residual residual degrees of freedom for fitted model.
cov.unscaled unscaled covariance matrix for the coefficients.
sigma residual standard error; when method is "M" or "MM", this is based on the MAD of the residuals (around 0) — see mad.
x projection of x matrix onto span of z.
qr QR decomposition for the stage-2 regression.
qr1 QR decomposition for the stage-1 regression.
rank1 numeric rank of the model matrix for the stage-1 regression.
coefficients1 matrix of coefficients from the stage-1 regression.
df.residual1 residual degrees of freedom for the stage-1 regression.
exogenous columns of the "regressors" matrix that are exogenous.
endogenous columns of the "regressors" matrix that are endogenous.
instruments columns of the "instruments" matrix that are instruments for the endogenous variables.
method the method used for the stage 1 and 2 regressions, one of "OLS", "M", or "MM".
rweights a matrix of robustness weights with columns for each of the stage-1 regressions and for the stage-2 regression (in the last column) if the fitting method is "M" or "MM", NULL if the fitting method is "OLS".
hatvalues a matrix of hatvalues. For method = "OLS", the matrix consists of two columns, for each of the stage-1 and stage-2 regression; for method = "M" or "MM", there is one column for each stage-1 regression and for the stage-2 regression.

See Also
ivreg, lm.fit, lm.wfit, rlm, mad

Examples
## data
data("CigaretteDemand", package = "ivreg")

## high-level interface
m <- ivreg(log(packs) ~ log(rprice) + log(rincome) | salestax + log(rincome),
  data = CigaretteDemand)

## low-level interface
y <- m$y
x <- model.matrix(m, component = "regressors")
z <- model.matrix(m, component = "instruments")
ivreg.fit(x, y, z)$coefficients

---

### Description

These are partly contrived data from Kmenta (1986), constructed to illustrate estimation of a simultaneous-equation econometric model. The data are an annual time-series for the U.S. economy from 1922 to 1941. The values of the exogenous variables D, and F, and A are real, while those of the endogenous variables Q and P are simulated according to the linear simultaneous equation model fit in the examples.
Usage

data("Kmenta", package = "ivreg")

Format

A data frame with 20 rows and 5 columns.

Q food consumption per capita.
P ratio of food prices to general consumer prices.
D disposable income in constant dollars.
F ratio of preceding year’s prices received by farmers to general consumer prices.
A time in years.

Source


See Also

*ivreg*.

Examples

data("Kmenta", package = "ivreg")
deq <- ivreg(Q ~ P + D | D + F + A, data = Kmenta) # demand equation
seq <- ivreg(Q ~ P + F + A | D + F + A, data = Kmenta) # supply equation
summary(deq, tests = TRUE)
summary(seq, tests = TRUE)
SchoolingReturns

Format

A data frame with 3010 rows and 22 columns.

- wage: Raw wages in 1976 (in cents per hour).
- education: Education in 1976 (in years).
- experience: Years of labor market experience, computed as age - education - 6.
- ethnicity: Factor indicating ethnicity. Is the individual African-American ("afam") or not ("other")?
- smsa: Factor. Does the individual reside in a SMSA (standard metropolitan statistical area) in 1976?
- south: Factor. Does the individual reside in the South in 1976?
- age: Age in 1976 (in years).
- nearcollege: Factor. Did the individual grow up near a 4-year college?
- nearcollege2: Factor. Did the individual grow up near a 2-year college?
- nearcollege4: Factor. Did the individual grow up near a 4-year public or private college?
- enrolled: Factor. Is the individual enrolled in college in 1976?
- married: Factor. Is the individual married in 1976?
- education66: Education in 1966 (in years).
- smsa66: Factor. Does the individual reside in a SMSA in 1966?
- south66: Factor. Does the individual reside in the South in 1966?
- feducation: Father’s educational attainment (in years). Imputed with average if missing.
- meducation: Mother’s educational attainment (in years). Imputed with average if missing.
- fameducation: Ordered factor coding family education class (from 1 to 9).
- kww: Knowledge world of work (KWW) score.
- iq: Normed intelligence quotient (IQ) score
- parents14: Factor coding living with parents at age 14: both parents, single mother, step parent, other
- library14: Factor. Was there a library card in home at age 14?

Details

Investigating the causal link of schooling on earnings in a classical model for wage determinants is problematic because it can be argued that schooling is endogenous. Hence, one possible strategy is to use an exogonous variable as an instrument for the years of education. In his well-known study, Card (1995) uses geographical proximity to a college when growing up as such an instrument, showing that this significantly increases both the years of education and the wage level obtained on the labor market. Using instrumental variables regression Card (1995) shows that the estimated returns to schooling are much higher than when simply using ordinary least squares.

The data are taken from the supplementary material for Verbeek (2004) and are based on the work of Card (1995). The U.S. National Longitudinal Survey of Young Men (NLSYM) began in 1966 and included 5525 men, then aged between 14 and 24. Card (1995) employs labor market information from the 1976 NLSYM interview which also included information about educational attainment. Out of the 3694 men still included in that wave of NLSYM, 3010 provided information on both wages and education yielding the subset of observations provided in SchoolingReturns.
The examples replicate the results from Verbeek (2004) who used the simplest specifications from Card (1995). Including further region or family background characteristics improves the model significantly but does not affect much the main coefficients of interest, namely that of years of education.

**Source**

Supplementary material for Verbeek (2004).

**References**


**Examples**

```r
## load data
data("SchoolingReturns", package = "ivreg")

## Table 5.1 in Verbeek (2004) / Table 2(1) in Card (1995)
## Returns to education: 7.4%
m_ols <- lm(log(wage) ~ education + poly(experience, 2, raw = TRUE) + ethnicity + smsa + south, data = SchoolingReturns)
summary(m_ols)

## Table 5.2 in Verbeek (2004) / similar to Table 3(1) in Card (1995)
m_red <- lm(education ~ poly(age, 2, raw = TRUE) + ethnicity + smsa + south + nearcollege, data = SchoolingReturns)
summary(m_red)

## Table 5.3 in Verbeek (2004) / similar to Table 3(5) in Card (1995)
## Returns to education: 13.3%
m_iv <- ivreg(log(wage) ~ education + poly(experience, 2, raw = TRUE) + ethnicity + smsa + south | nearcollege + poly(age, 2, raw = TRUE) + ethnicity + smsa + south, data = SchoolingReturns)
summary(m_iv)
```
## Index

* datasets
  CigaretteDemand, 2
  Kmenta, 17
  SchoolingReturns, 18
* regression
  ivreg, 11
  ivreg.fit, 15

alias.ivreg (coef.ivreg), 4
Anova.ivreg (coef.ivreg), 4
anova.ivreg (coef.ivreg), 4
avPlot.ivreg (influence.ivreg), 7
avPlots, 7, 11
avPlots.ivreg (influence.ivreg), 7
Boot, 10, 11
Boot.ivreg (influence.ivreg), 7
bread.ivreg (coef.ivreg), 4
ceresPlot.ivreg (influence.ivreg), 7
ceresPlots.ivreg (influence.ivreg), 7
CigaretteDemand, 2
CigarettesSW, 2, 3
coef, 6
coef.ivreg, 4
confint.ivreg (coef.ivreg), 4
cooks.distance.influence.ivreg (influence.ivreg), 7
cooks.distance.ivreg (influence.ivreg), 7
crPlot.ivreg (influence.ivreg), 7
crPlots, 7, 11
crPlots.ivreg (influence.ivreg), 7
deviance.ivreg (influence.ivreg), 7
dfbeta.influence.ivreg (influence.ivreg), 7
dfbeta.ivreg (influence.ivreg), 7
Effect, 7
Effect.ivreg (coef.ivreg), 4
estfun.ivreg (coef.ivreg), 4
find_formula.ivreg (coef.ivreg), 4
formula, 6
formula.ivreg (coef.ivreg), 4
hatvalues.influence.ivreg (influence.ivreg), 7
hatvalues.ivreg (influence.ivreg), 7
infIndexPlot, 11
infIndexPlot.ivreg (influence.ivreg), 7
infIndexPlot.ivreg (influence.ivreg), 7
influence.ivreg, 7
influence.rivreg (influence.ivreg), 7
influencePlot, 11
influencePlot.ivreg (influence.ivreg), 7
influencePlot (influence.ivreg), 7
influencePlot (influence.ivreg), 7
ivreg, 7, 11, 16-18
ivreg.fit, 7, 12, 14, 15
ivregDiagnostics, 4, 7, 13, 14
ivregDiagnostics (influence.ivreg), 7
ivregMethods, 13, 14
ivregMethods (coef.ivreg), 4
Kmenta, 17
lapply, 10
linearHypothesis, 7
linearHypothesis.ivreg (coef.ivreg), 4
lm, 14
lm.fit, 14, 16, 17
lm.wfit, 16, 17
mad, 16, 17
mclapply, 10
mcPlot.ivreg (influence.ivreg), 7
mcPlots.ivreg (influence.ivreg), 7
model.matrix, 6
model.matrix.default, 12
model.matrix.influence.ivreg (influence.ivreg), 7
model.matrix.ivreg(coef.ivreg), 4
model.matrix.ivreg_projected (coef.ivreg), 4

na.pass, 7
ncvTest, 11
ncvTest.ivreg(influence.ivreg), 7

outlierTest, 11
outlierTest.ivreg(influence.ivreg), 7

parLapply, 10
plot.ivreg(influence.ivreg), 7
predict.ivreg(coef.ivreg), 4
predictorEffects, 7, 11
print.ivreg(coef.ivreg), 4
print.summary.ivreg(coef.ivreg), 4

qqPlot, 7, 11
qqPlot.influence.ivreg
  (influence.ivreg), 7
qqPlot.ivreg(influence.ivreg), 7
qr.ivreg(coef.ivreg), 4

residuals.ivreg(coef.ivreg), 4
rlm, 12, 16, 17
rstudent.influence.ivreg
  (influence.ivreg), 7
rstudent.ivreg(influence.ivreg), 7

SchoolingReturns, 18
spreadLevelPlot, 11
spreadLevelPlot.ivreg (influence.ivreg), 7
StockWatson2007, 2
summary.ivreg(coef.ivreg), 4

terms, 6
terms.ivreg(coef.ivreg), 4

update.ivreg(coef.ivreg), 4

vcov, 6
vcov.ivreg(coef.ivreg), 4
vcovHC.ivreg(coef.ivreg), 4

weights.ivreg(coef.ivreg), 4