R OLS and Instrumental Variable Regression

Fan Wang

2020-04-01

Contents

Back to **Fan**'s R4Econ Homepage **Table of Content**

OLS and IV Regression

Go to the **RMD**, **R**, **PDF**, or **HTML** version of this file. Go back to fan's REconTools Package, R4Econ Repository (bookdown site), or Intro Stats with R Repository.

IV regression using AER package. Option to store all results in dataframe row for combining results from other estimations together. Produce Row Statistics.

```
# IV regression function
# The code below uses the AER library's regresison function
# All results are stored in a single row as data_frame
# This functoin could work with dplyr do
# var.y is single outcome, vars.x, vars.c and vars.z are vectors of endogenous variables, controls and
regf.iv <- function(var.y, vars.x, vars.c, vars.z, df, transpose=TRUE) {

#     print(length(vars.z))

    # A. Set-Up Equation
    str.vars.x <- paste(vars.x, collapse='+')
    str.vars.c <- paste(vars.c, collapse='+')

    df <- df %>% select(one_of(var.y, vars.x, vars.c, vars.z)) %>% drop_na() %>% filter_all(all_vars(!is

    if (length(vars.z) >= 1) {
        #     library(AER)
            str.vars.z <- paste(vars.z, collapse='+')
            equa.iv <- paste(var.y,
                             paste(paste(str.vars.x, str.vars.c, sep='+'),
                                   paste(str.vars.z, str.vars.c, sep='+'),
                                   sep='|'),
                             sep='~')
        #     print(equa.iv)

        # B. IV Regression
        ivreg.summ <- summary(ivreg(as.formula(equa.iv), data=df),
                              vcov = sandwich, df = Inf, diagnostics = TRUE)
```

```
    # C. Statistics from IV Regression
#     ivreg.summ$coef
#     ivreg.summ$diagnostics

    # D. Combine Regression Results into a Matrix
    df.results <- suppressMessages(as_tibble(ivreg.summ$coef, rownames='rownames') %>%
        full_join(as_tibble(ivreg.summ$diagnostics, rownames='rownames')) %>%
        full_join(tibble(rownames=c('vars'),
                         var.y=var.y,
                         vars.x=str.vars.x,
                         vars.z=str.vars.z,
                         vars.c=str.vars.c)))
} else {

    # OLS regression
    equa.ols <- paste(var.y,
                      paste(paste(vars.x, collapse='+'),
                            paste(vars.c, collapse='+'), sep='+'),
                      sep='~')

    lmreg.summ <- summary(lm(as.formula(equa.ols), data=df))

    lm.diagnostics <- as_tibble(list(df1=lmreg.summ$df[[1]],
                                     df2=lmreg.summ$df[[2]],
                                     df3=lmreg.summ$df[[3]],
                                     sigma=lmreg.summ$sigma,
                                     r.squared=lmreg.summ$r.squared,
                                     adj.r.squared=lmreg.summ$adj.r.squared)) %>%
                                     gather(variable, value) %>%
                                     rename(rownames = variable) %>%
                                     rename(v = value)

    df.results <- suppressMessages(as_tibble(lmreg.summ$coef, rownames='rownames') %>%
        full_join(lm.diagnostics) %>%
        full_join(tibble(rownames=c('vars'),
                         var.y=var.y,
                         vars.x=str.vars.x,
                         vars.c=str.vars.c)))
}

# E. Flatten Matrix, All IV results as a single tibble row to be combined with other IV results
df.row.results <- df.results %>%
    gather(variable, value, -rownames) %>%
    drop_na() %>%
    unite(esti.val, rownames, variable) %>%
    mutate(esti.val = gsub(' ', '', esti.val))

if (transpose) {
  df.row.results <- df.row.results %>% spread(esti.val, value)
}

# F. Return
return(data.frame(df.row.results))
```

```
}
```

Construct Program

Program Testing Load Data

```
# Library
library(tidyverse)
library(AER)

# Load Sample Data
setwd('C:/Users/fan/R4Econ/_data/')
df <- read_csv('height_weight.csv')
```

```
## Parsed with column specification:
## cols(
##   S.country = col_character(),
##   vil.id = col_double(),
##   indi.id = col_double(),
##   sex = col_character(),
##   svymthRound = col_double(),
##   momEdu = col_double(),
##   wealthIdx = col_double(),
##   hgt = col_double(),
##   wgt = col_double(),
##   hgt0 = col_double(),
##   wgt0 = col_double(),
##   prot = col_double(),
##   cal = col_double(),
##   p.A.prot = col_double(),
##   p.A.nProt = col_double()
## )
```

```
# Setting
options(repr.matrix.max.rows=50, repr.matrix.max.cols=50)
```

```
# One Instrucments
var.y <- c('hgt')
vars.x <- c('prot')
vars.z <- NULL
vars.c <- c('sex', 'hgt0', 'wgt0')
# Regression
regf.iv(var.y, vars.x, vars.c, vars.z, df, transpose=FALSE)
```

Example No Instrument, OLS

```
##                 esti.val                value
## 1   (Intercept)_Estimate      52.1186286658651
## 2          prot_Estimate     0.374472386357917
## 3       sexMale_Estimate     0.611043720578292
## 4          hgt0_Estimate     0.148513781160842
## 5          wgt0_Estimate   0.00150560230505631
## 6  (Intercept)_Std.Error      1.57770483608693
## 7         prot_Std.Error   0.00418121191133815
```

```
## 8      sexMale_Std.Error     0.118396259120659
## 9         hgt0_Std.Error    0.0393807494783186
## 10        wgt0_Std.Error  0.000187123663624397
## 11    (Intercept)_tvalue      33.0344608660332
## 12           prot_tvalue      89.5607288744356
## 13       sexMale_tvalue      5.16100529794248
## 14          hgt0_tvalue      3.77122790013449
## 15          wgt0_tvalue      8.04602836377991
## 16  (Intercept)_Pr(>|t|) 9.92126150975783e-233
## 17         prot_Pr(>|t|)                     0
## 18      sexMale_Pr(>|t|)  2.48105505495642e-07
## 19         hgt0_Pr(>|t|)  0.000162939618371183
## 20         wgt0_Pr(>|t|)  9.05257561534111e-16
## 21                df1_v                     5
## 22                df2_v                 18958
## 23                df3_v                     5
## 24              sigma_v      8.06197784622979
## 25           r.squared_v     0.319078711001325
## 26       adj.r.squared_v     0.318935041565942
## 27            vars_var.y                   hgt
## 28           vars_vars.x                  prot
## 29           vars_vars.c         sex+hgt0+wgt0
```

```
# One Instrucments
var.y <- c('hgt')
vars.x <- c('prot')
vars.z <- c('momEdu')
vars.c <- c('sex', 'hgt0', 'wgt0')
# Regression
regf.iv(var.y, vars.x, vars.c, vars.z, df, transpose=FALSE)
```

Example 1 Insturment

```
## Warning: attributes are not identical across measure variables;
## they will be dropped
```

```
##                     esti.val                value
## 1       (Intercept)_Estimate      43.4301969117558
## 2              prot_Estimate     0.130833343849446
## 3          sexMale_Estimate     0.868121847262411
## 4             hgt0_Estimate     0.412093881817148
## 5             wgt0_Estimate  0.000858630042617921
## 6      (Intercept)_Std.Error      1.82489550971182
## 7             prot_Std.Error    0.0192036220809189
## 8          sexMale_Std.Error      0.13373016700542
## 9             hgt0_Std.Error    0.0459431912927002
## 10            wgt0_Std.Error   0.00022691057702563
## 11        (Intercept)_zvalue       23.798730766023
## 12               prot_zvalue      6.81295139521853
## 13           sexMale_zvalue      6.49159323361366
## 14              hgt0_zvalue      8.96963990141069
## 15              wgt0_zvalue       3.7840018472164
## 16     (Intercept)_Pr(>|z|)  3.4423766196876e-125
## 17            prot_Pr(>|z|)  9.56164541643828e-12
```

```
## 18          sexMale_Pr(>|z|)  8.49333228172763e-11
## 19             hgt0_Pr(>|z|)  2.97485394526792e-19
## 20             wgt0_Pr(>|z|)  0.000154326676608523
## 21       Weakinstruments_df1                     1
## 22            Wu-Hausman_df1                     1
## 23                Sargan_df1                     0
## 24       Weakinstruments_df2                 16394
## 25            Wu-Hausman_df2                 16393
## 26 Weakinstruments_statistic      935.817456612075
## 27      Wu-Hausman_statistic      123.595856606729
## 28   Weakinstruments_p-value 6.39714929178024e-200
## 29        Wu-Hausman_p-value  1.30703637796748e-28
## 30                vars_var.y                   hgt
## 31               vars_vars.x                  prot
## 32               vars_vars.z                momEdu
## 33               vars_vars.c         sex+hgt0+wgt0
```

```
# Multiple Instrucments
var.y <- c('hgt')
vars.x <- c('prot')
vars.z <- c('momEdu', 'wealthIdx', 'p.A.prot', 'p.A.nProt')
vars.c <- c('sex', 'hgt0', 'wgt0')
# Regression
regf.iv(var.y, vars.x, vars.c, vars.z, df, transpose=FALSE)
```

Example Multiple Instrucments

```
## Warning: attributes are not identical across measure variables;
## they will be dropped
```

```
##                     esti.val                           value
## 1       (Intercept)_Estimate                 42.2437613555242
## 2              prot_Estimate                 0.26699945194704
## 3           sexMale_Estimate                0.695548488812932
## 4              hgt0_Estimate                0.424954881263031
## 5              wgt0_Estimate              0.000486951420329484
## 6      (Intercept)_Std.Error                  1.85356686789642
## 7             prot_Std.Error                0.0154939347964083
## 8          sexMale_Std.Error                 0.133157977814374
## 9             hgt0_Std.Error                0.0463195803786233
## 10            wgt0_Std.Error              0.000224867994873235
## 11        (Intercept)_zvalue                  22.7905246296649
## 12               prot_zvalue                  17.2325142357597
## 13            sexMale_zvalue                  5.22348341593581
## 14               hgt0_zvalue                  9.17441129192849
## 15               wgt0_zvalue                  2.16549901022595
## 16     (Intercept)_Pr(>|z|)             5.69294074735747e-115
## 17            prot_Pr(>|z|)              1.51424021931607e-66
## 18         sexMale_Pr(>|z|)              1.75588197502565e-07
## 19            hgt0_Pr(>|z|)              4.54048595587756e-20
## 20            wgt0_Pr(>|z|)                 0.030349491114332
## 21       Weakinstruments_df1                                 4
## 22            Wu-Hausman_df1                                 1
## 23                Sargan_df1                                 3
```

```
## 24       Weakinstruments_df2                                14914
## 25            Wu-Hausman_df2                                14916
## 26 Weakinstruments_statistic                     274.147084958343
## 27      Wu-Hausman_statistic                     17.7562545747101
## 28         Sargan_statistic                     463.729664547249
## 29   Weakinstruments_p-value                8.61731956233366e-228
## 30        Wu-Hausman_p-value                 2.52567249124181e-05
## 31            Sargan_p-value                3.45452874915475e-100
## 32                vars_var.y                                  hgt
## 33               vars_vars.x                                 prot
## 34               vars_vars.z momEdu+wealthIdx+p.A.prot+p.A.nProt
## 35               vars_vars.c                       sex+hgt0+wgt0
```

```
# Multiple Instrucments
var.y <- c('hgt')
vars.x <- c('prot', 'cal')
vars.z <- c('momEdu', 'wealthIdx', 'p.A.prot', 'p.A.nProt')
vars.c <- c('sex', 'hgt0', 'wgt0')
# Regression
regf.iv(var.y, vars.x, vars.c, vars.z, df, transpose=FALSE)
```

Example Multiple Endogenous Variables

```
## Warning: attributes are not identical across measure variables;
## they will be dropped
```

```
##                            esti.val                            value
## 1              (Intercept)_Estimate                  44.0243196254297
## 2                    prot_Estimate                  -1.4025623247106
## 3                     cal_Estimate                  0.065104895750151
## 4                 sexMale_Estimate                  0.120832787571818
## 5                    hgt0_Estimate                  0.286525437984517
## 6                    wgt0_Estimate               0.000850481389651033
## 7             (Intercept)_Std.Error                   2.75354847244082
## 8                   prot_Std.Error                  0.198640060273635
## 9                    cal_Std.Error                0.00758881298880996
## 10                sexMale_Std.Error                  0.209984580636303
## 11                   hgt0_Std.Error                 0.0707828182888255
## 12                   wgt0_Std.Error                0.00033711210444429
## 13             (Intercept)_zvalue                   15.9882130516502
## 14                   prot_zvalue                  -7.06082309267581
## 15                    cal_zvalue                   8.57906181719737
## 16                sexMale_zvalue                  0.575436478267434
## 17                   hgt0_zvalue                   4.04795181812859
## 18                   wgt0_zvalue                   2.52284441418383
## 19            (Intercept)_Pr(>|z|)               1.54396598126854e-57
## 20                  prot_Pr(>|z|)               1.65519210848649e-12
## 21                   cal_Pr(>|z|)               9.56500648203187e-18
## 22               sexMale_Pr(>|z|)                  0.564996139463599
## 23                  hgt0_Pr(>|z|)               5.16677787108928e-05
## 24                  wgt0_Pr(>|z|)                 0.0116409892837831
## 25       Weakinstruments(prot)_df1                                  4
## 26        Weakinstruments(cal)_df1                                  4
## 27                  Wu-Hausman_df1                                  2
```

```
## 28                      Sargan_df1                                   2
## 29       Weakinstruments(prot)_df2                               14914
## 30        Weakinstruments(cal)_df2                               14914
## 31                    Wu-Hausman_df2                               14914
## 32 Weakinstruments(prot)_statistic                   274.147084958343
## 33  Weakinstruments(cal)_statistic                   315.036848606231
## 34            Wu-Hausman_statistic                   94.7020085425169
## 35                Sargan_statistic                   122.081979628898
## 36   Weakinstruments(prot)_p-value              8.61731956233366e-228
## 37    Weakinstruments(cal)_p-value              1.18918641220866e-260
## 38              Wu-Hausman_p-value               1.35024050408262e-41
## 39                  Sargan_p-value               3.09196773720398e-27
## 40                      vars_var.y                                hgt
## 41                     vars_vars.x                           prot+cal
## 42                     vars_vars.z momEdu+wealthIdx+p.A.prot+p.A.nProt
## 43                     vars_vars.c                     sex+hgt0+wgt0
```

Examples Line by Line The examples are just to test the code with different types of variables.

```
# Selecting Variables
var.y <- c('hgt')
vars.x <- c('prot', 'cal')
vars.z <- c('momEdu', 'wealthIdx', 'p.A.prot', 'p.A.nProt')
vars.c <- c('sex', 'hgt0', 'wgt0')
```

```
# A. create Equation
str.vars.x <- paste(vars.x, collapse='+')
str.vars.c <- paste(vars.c, collapse='+')
str.vars.z <- paste(vars.z, collapse='+')
print(str.vars.x)
```

```
## [1] "prot+cal"
```

```
print(str.vars.c)
```

```
## [1] "sex+hgt0+wgt0"
```

```
print(str.vars.z)
```

```
## [1] "momEdu+wealthIdx+p.A.prot+p.A.nProt"
```

```
equa.iv <- paste(var.y,
                 paste(paste(str.vars.x, str.vars.c, sep='+'),
                       paste(str.vars.z, str.vars.c, sep='+'),
                       sep='|'),
                 sep='~')
print(equa.iv)
```

```
## [1] "hgt~prot+cal+sex+hgt0+wgt0|momEdu+wealthIdx+p.A.prot+p.A.nProt+sex+hgt0+wgt0"
```

```
# B. regression
res.ivreg <- ivreg(as.formula(equa.iv), data=df)
coef(res.ivreg)
```

```
##   (Intercept)          prot           cal       sexMale          hgt0          wgt0
## 44.0243196254 -1.4025623247  0.0651048958  0.1208327876  0.2865254380  0.0008504814
```

```r
# C. Regression Summary
ivreg.summ <- summary(res.ivreg, vcov = sandwich, df = Inf, diagnostics = TRUE)

ivreg.summ$coef
```

```
##                  Estimate   Std. Error    z value     Pr(>|z|)
## (Intercept) 44.0243196254 2.7535484724 15.9882131 1.543966e-57
## prot        -1.4025623247 0.1986400603 -7.0608231 1.655192e-12
## cal          0.0651048958 0.0075888130  8.5790618 9.565006e-18
## sexMale      0.1208327876 0.2099845806  0.5754365 5.649961e-01
## hgt0         0.2865254380 0.0707828183  4.0479518 5.166778e-05
## wgt0         0.0008504814 0.0003371121  2.5228444 1.164099e-02
## attr(,"df")
## [1] 0
```

```r
ivreg.summ$diagnostics
```

```
##                          df1   df2 statistic       p-value
## Weak instruments (prot)    4 14914 274.14708 8.617320e-228
## Weak instruments (cal)     4 14914 315.03685 1.189186e-260
## Wu-Hausman                 2 14914  94.70201  1.350241e-41
## Sargan                     2    NA 122.08198  3.091968e-27
```

```r
# D. Combine Regression Results into a Matrix
df.results <- suppressMessages(as_tibble(ivreg.summ$coef, rownames='rownames') %>%
    full_join(as_tibble(ivreg.summ$diagnostics, rownames='rownames')) %>%
    full_join(tibble(rownames=c('vars'),
                     var.y=var.y,
                     vars.x=str.vars.x,
                     vars.z=str.vars.z,
                     vars.c=str.vars.c)))
# E. Flatten Matrix, All IV results as a single tibble row to be combined with other IV results
df.row.results <- df.results %>%
    gather(variable, value, -rownames) %>%
    drop_na() %>%
    unite(esti.val, rownames, variable) %>%
    mutate(esti.val = gsub(' ', '', esti.val))
```

```
## Warning: attributes are not identical across measure variables;
## they will be dropped
```

```r
# F. Results as Single Colum
df.row.results
```

```
## # A tibble: 43 x 2
##    esti.val              value
##    <chr>                 <chr>
##  1 (Intercept)_Estimate  44.0243196254297
##  2 prot_Estimate         -1.4025623247106
##  3 cal_Estimate          0.065104895750151
##  4 sexMale_Estimate      0.120832787571818
##  5 hgt0_Estimate         0.286525437984517
##  6 wgt0_Estimate         0.000850481389651033
##  7 (Intercept)_Std.Error 2.75354847244082
##  8 prot_Std.Error        0.198640060273635
##  9 cal_Std.Error         0.00758881298880996
```

```
## 10 sexMale_Std.Error     0.209984580636303
## # ... with 33 more rows
```

```
# G. Results as Single Row
df.row.results
```

```
## # A tibble: 43 x 2
##    esti.val              value
##    <chr>                 <chr>
##  1 (Intercept)_Estimate  44.0243196254297
##  2 prot_Estimate         -1.4025623247106
##  3 cal_Estimate          0.065104895750151
##  4 sexMale_Estimate      0.120832787571818
##  5 hgt0_Estimate         0.286525437984517
##  6 wgt0_Estimate         0.000850481389651033
##  7 (Intercept)_Std.Error 2.75354847244082
##  8 prot_Std.Error        0.198640060273635
##  9 cal_Std.Error         0.00758881298880996
## 10 sexMale_Std.Error     0.209984580636303
## # ... with 33 more rows
```

```
df.row.results %>% spread(esti.val, value)
```

```
## # A tibble: 1 x 43
##   `(Intercept)_Es~ `(Intercept)_Pr~ `(Intercept)_St~ `(Intercept)_zv~ cal_Estimate `cal_Pr(>|z|)` cal
##   <chr>            <chr>            <chr>            <chr>            <chr>        <chr>          <ch
## 1 44.0243196254297 1.5439659812685~ 2.75354847244082 15.9882130516502 0.065104895~ 9.56500648203~ 0.0
## # ... with 33 more variables: hgt0_Std.Error <chr>, hgt0_zvalue <chr>, prot_Estimate <chr>, `prot_Pr
## #   Sargan_df1 <chr>, `Sargan_p-value` <chr>, Sargan_statistic <chr>, sexMale_Estimate <chr>, `sexMal
## #   sexMale_zvalue <chr>, vars_var.y <chr>, vars_vars.c <chr>, vars_vars.x <chr>, vars_vars.z <chr>,
## #   `Weakinstruments(cal)_df2` <chr>, `Weakinstruments(cal)_p-value` <chr>, `Weakinstruments(cal)_sta
## #   `Weakinstruments(prot)_df2` <chr>, `Weakinstruments(prot)_p-value` <chr>, `Weakinstruments(prot)_
## #   `wgt0_Pr(>|z|)` <chr>, wgt0_Std.Error <chr>, wgt0_zvalue <chr>, `Wu-Hausman_df1` <chr>, `Wu-Hausm
## #   `Wu-Hausman_statistic` <chr>
```