Simultaneous Equations| R programming language

Preliminaries

Script Editor

```r
# setup
rm(list = ls())
directory <- "C:/Users/amalz/OneDrive/Desktop/"

# Install packages
PackageNames <- c("tidyverse", "stargazer", "magrittr", "AER", "car")
for(i in PackageNames){
  if(!require(i, character.only = T)){
    install.packages(i, dependencies = T)
    require(i, character.only = T)
  }
}

# Labor supply and demand data for working women
MROZ <- read.csv(paste0(directory, "MROZ.csv"))
# keep only working women
MROZ %<>% filter(inlf == 1)
# Regression for hours using OLS estimation
model1 <- lm(hours ~ lwage + educ + age + kidslt6 + nwifeinc, MROZ)
summary(model1)
```

Simultaneous equations

Script Editor

```r
# Regression for hours using 2SLS estimation
# lwage is instrumented by variables from the other equation
model2 <- ivreg(hours ~ lwage + educ + age + kidslt6 + nwifeinc |
                  . - lwage + exper + expersq, data = MROZ)
summary(model2, diagnostics = TRUE)

# Regression for lwage using OLS estimation
model3 <- lm(lwage ~ hours + educ + exper + expersq, MROZ)
summary(model3)

# Regression for lwage using 2SLS estimation
model4 <- ivreg(lwage ~ hours + educ + exper + expersq |
                  ~ . - hours + age + kidslt6 + nwifeinc,
                data = MROZ)
summary(model4, diagnostics = TRUE)
```

hours is instrumented by variables from the other equation

Console

```
> summary(model2, diagnostics = TRUE)

Call:
ivreg(formula = hours ~ lwage + educ + age + kidslt6 + nwifeinc |
    . - lwage + exper + expersq, data = MROZ)

Residuals:
     Min       1Q   Median       3Q      Max
-4570.13  -654.08   -36.94   569.86  8372.91

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 2225.662    574.564   3.874 0.000124 ***
lwage       1639.556    470.576   3.484 0.000545 ***
educ        -183.751     59.100  -3.109 0.002003 **
age           -7.806      9.378  -0.832 0.405664
kidslt6     -198.154    182.929  -1.083 0.279325
nwifeinc     -10.170      6.615  -1.537 0.124942
```

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Console ctd...

```
Diagnostic tests:
                 df1 df2 statistic  p-value
Weak instruments   2 421     9.329 0.000109 ***
Wu-Hausman         1 421    43.665 1.18e-10 ***
Sargan             1  NA     0.862 0.353123
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1354 on 422 degrees of freedom
Multiple R-Squared: -2.008,     Adjusted R-squared: -2.043
Wald test: 3.441 on 5 and 422 DF,  p-value: 0.004648
> summary(model3)

Call:
lm(formula = lwage ~ hours + educ + exper + expersq, data = MROZ)

Residuals:
     Min       1Q   Median       3Q      Max
-3.08669 -0.31040  0.06009  0.38325  2.33164

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.620e-01  2.038e-01  -2.266 0.023933 *
hours       -5.655e-05  4.378e-05  -1.292 0.197206
educ         1.062e-01  1.417e-02   7.496  3.9e-13 ***
exper        4.470e-02  1.339e-02   3.339 0.000914 ***
expersq     -8.585e-04  3.946e-04  -2.176 0.030144 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6659 on 423 degrees of freedom
Multiple R-squared:  0.1601,    Adjusted R-squared:  0.1522
F-statistic: 20.16 on 4 and 423 DF,  p-value: 3.258e-15
> summary(model4, diagnostics = TRUE)

Call:
ivreg(formula = lwage ~ hours + educ + exper + expersq | ~. -
    hours + age + kidslt6 + nwifeinc, data = MROZ)

Residuals:
     Min       1Q   Median       3Q      Max
-3.49800 -0.29307  0.03208  0.36486  2.45912

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.6557254  0.3377883  -1.941   0.0529 .
hours        0.0001259  0.0002546   0.494   0.6212
educ         0.1103300  0.0155244   7.107 5.08e-12 ***
exper        0.0345824  0.0194916   1.774   0.0767 .
expersq     -0.0007058  0.0004541  -1.554   0.1209

Diagnostic tests:
                 df1 df2 statistic p-value
Weak instruments   3 421     4.457 0.00426 **
Wu-Hausman         1 422     0.551 0.45834
Sargan             2  NA     2.925 0.23164
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6794 on 423 degrees of freedom
Multiple R-Squared: 0.1257,     Adjusted R-squared: 0.1174
Wald test: 19.03 on 4 and 423 DF,  p-value: 2.108e-14
```

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Testing for rank condition

Testing for rank condition involves estimating the reduced form equation and testing for significance of the instrument variables.

Script Editor

```
# Reduced form equation for lwage, identifying equation for hours
model5 <- lm(lwage ~ educ + age + kidslt6 + nwifeinc + exper + expersq, MROZ)
linearHypothesis(model5, c("exper = 0", "expersq = 0"))
# Reduced form equation for hours, identifying equation for lwage
model6 <- lm(hours ~ educ + age + kidslt6 + nwifeinc + exper + expersq, MROZ)
linearHypothesis(model6, c("age = 0", "kidslt6 = 0", "nwifeinc = 0"))
```

Console

```
> model5 <- lm(lwage ~ educ + age + kidslt6 + nwifeinc + exper + expersq, MROZ)
> linearHypothesis(model5, c("exper = 0", "expersq = 0"))

Linear hypothesis test:
exper = 0
expersq = 0

Model 1: restricted model
Model 2: lwage ~ educ + age + kidslt6 + nwifeinc + exper + expersq

  Res.Df    RSS Df Sum of Sq      F    Pr(>F)
1    423 195.14
2    421 186.86  2    8.2815 9.3293 0.0001085 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> # Reduced form equation for hours, identifying equation for lwage
> model6 <- lm(hours ~ educ + age + kidslt6 + nwifeinc + exper + expersq, MROZ)
> linearHypothesis(model6, c("age = 0", "kidslt6 = 0", "nwifeinc = 0"))

Linear hypothesis test:
age = 0
kidslt6 = 0
nwifeinc = 0

Model 1: restricted model
Model 2: hours ~ educ + age + kidslt6 + nwifeinc + exper + expersq

  Res.Df       RSS Df Sum of Sq      F   Pr(>F)
1    424 231321286
2    421 224200428  3   7120858 4.4571 0.004265 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```