Simple instrumental variables regressions[1]

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[1] From Wooldridge (2013, Chapter 15)

Return to education (for women)

Estimating the return (log wages) to education for $n = 428$ married working women as

$$\text{lwage}_i = \beta_0 + \beta_1 \text{educ}_i + u_i.$$

OLS:

$$\widehat{\text{lwage}}_i = \underset{(0.1852)}{-0.1852} + \underset{(0.0144)}{0.1086}\text{educ}_i \qquad R^2 = 0.1158.$$

95% C.I. for β_1 : $(0.0798, 0.1374)$.

Conclusion: Roughly 12% return for another year of education.

Fathers education as an instrument for education

1st requirement: $cov(\text{fathereduc}, u) = 0$.

2nd requirement: $cov(\text{fathereduc}, educ) \neq 0$.

$$\widehat{\text{educ}}_i = \underset{(0.2759)}{10.2371} + \underset{(0.0286)}{0.2694}\text{fatheduc}_i \qquad R^2 = 0.1706.$$

IV regression:

$$\widehat{\text{lwage}}_i = \underset{(0.446)}{0.441} + \underset{(0.035)}{0.059}\text{educ}_i \qquad R^2 = 0.09.$$

95% C.I. for β_1 : $(-0.011, 0.129)$.

Conclusion: About 6% return to education $\Rightarrow$ omitted ability bias.

R output

```
Call:
lm(formula = lwage ~ educ)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.1852     0.1852  -1.000    0.318
educ          0.1086     0.0144   7.545 2.76e-13 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 0.68 on 426 degrees of freedom
Multiple R-squared:  0.1179, Adjusted R-squared:  0.1158
F-statistic: 56.93 on 1 and 426 DF,  p-value: 2.761e-13

Call:
lm(formula = educ ~ fatheduc)

Residuals:
    Min      1Q  Median      3Q     Max
-8.4704 -1.1231 -0.1231  0.9546  5.9546

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 10.23705    0.27594  37.099   <2e-16 ***
fatheduc     0.26944    0.02859   9.426   <2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 2.081 on 426 degrees of freedom
Multiple R-squared:  0.1726, Adjusted R-squared:  0.1706
F-statistic: 88.84 on 1 and 426 DF,  p-value: < 2.2e-16
```

Return to education (men)

If the number of siblings is an instrument for education, ie.

$$\text{educ}_i = \beta_0 + \beta_1 \text{sibs}_i + u_i,$$

so

$$\widehat{\text{educ}}_i = \underset{(0.1131)}{14.1388} - \underset{(0.0303)}{-0.2279}\text{sibs}_i \qquad R^2 = 0.05625.$$

Assuming that $cov(\text{sibs}, u) = 0$, then the IV fit is

$$\widehat{\text{lwage}}_i = \underset{(0.36)}{5.13} + \underset{(0.026)}{1.122}\text{sibs}_i$$

OLS: $\hat{\beta}_1 = 0.0598$ with a standard error of 0.006 and $R^2 = 0.096$.

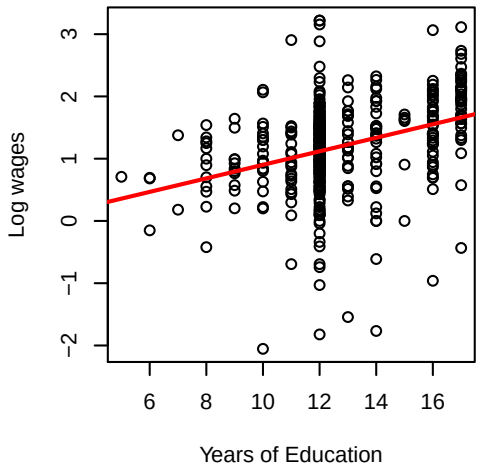
Conjecture: Maybe more siblings means, on average, less parental attention, which could result in lower ability.

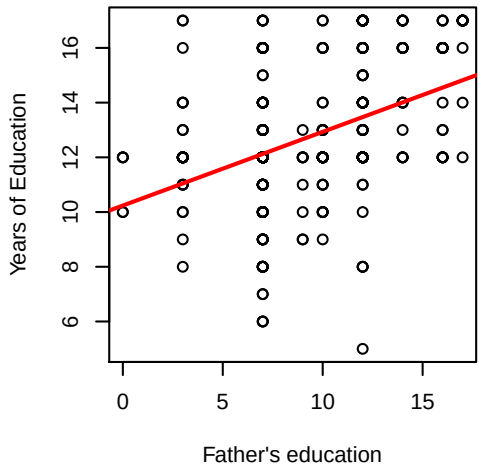
R output

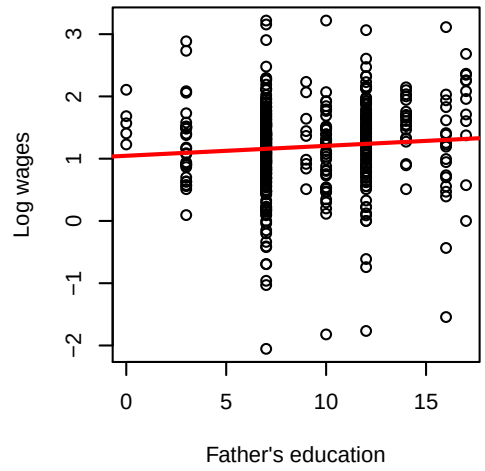
```
Call:
lm(formula = lwage ~ educ)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 5.973062   0.081374   73.40   <2e-16 ***
educ        0.059839   0.005963   10.04   <2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 0.4003 on 933 degrees of freedom
Multiple R-squared:  0.09742, Adjusted R-squared:  0.09645
F-statistic: 100.7 on 1 and 933 DF,  p-value: < 2.2e-16
```

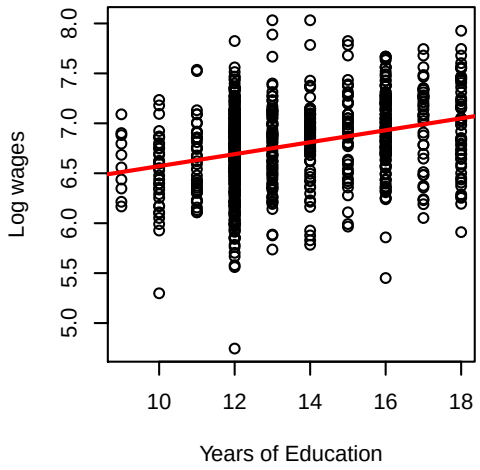
```
Call:
lm(formula = educ ~ sibs)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 14.13879    0.11314 124.969  < 2e-16 ***
sibs        -0.22792    0.03028  -7.528 1.22e-13 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 2.134 on 933 degrees of freedom
Multiple R-squared:  0.05726, Adjusted R-squared:  0.05625
F-statistic: 56.67 on 1 and 933 DF,  p-value: 1.215e-13
```

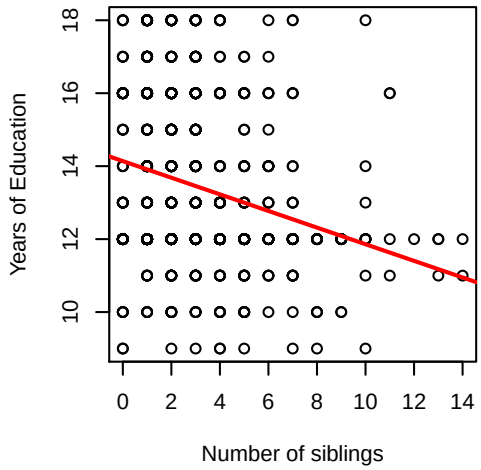
Graphical summaries

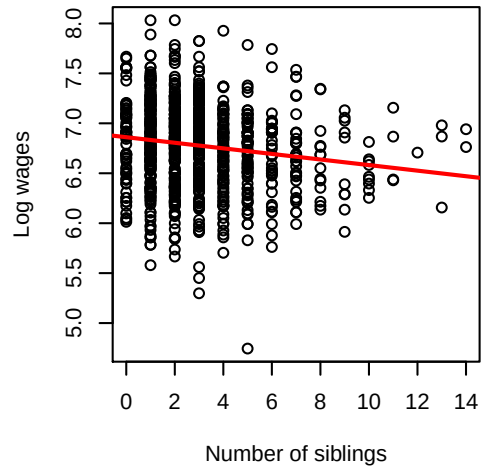












Binary/categorical instrument

Angrist and Krueger (1991) proposed **frstqrt** (=1 if born in the 1st quarter of the year) as an instrumental variable for education.

$cov(\text{lwage} - \beta_0 - \beta_1 \text{educ}, \text{frstqrt}) = 0$
$cov(\text{ability}, \text{frstqrt}) = 0$

Compulsory school attendance $\Longrightarrow cov(\text{educ}, \text{frstqrt}) \neq 0$.

Years of education varies only slightly across quarter of birth.
Based on $n = 247,199$ they found that

- OLS: $\hat{\beta}_1 = 0.0801$ (standard error 0.0004)
- IV: $\hat{\beta}_1 = 0.0715$ (0.0219).

Headache: Even a small amount of correlation between z and u can cause serious problems for the IV estimator.

Graphical summaries