Problem Set 4:
Returns to Schooling

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Q1: Questions on Ashenfelter and Krueger (1994)

(a) Research question and difficulties

RQ:
What are the (wage) returns to schooling?

Difficulties:

- Omitted Variable Bias (OVB): Unobserved variables such as ability or work ethic influence both education and wages
- Measurement error in years of schooling

Q1: Questions on Ashenfelter and Krueger (1994)

(b) Approach by Ashenfelter & Krueger

Adress problems by:

- Omitted Variable Bias (OVB): use differences within pairs of identical twins $\Rightarrow$ addresses omited variables due to family background and genetic endowment (constant)
- Measurement error: Instrumenting difference in years of schooling reported by one twin by difference reported by other twin

Is this approach convincing?

- Internal validity:
  - Rules out OVB bias due to variables that are constant across twins
  - But: ΔS due to individual-specific variables that also influences Δy? (e.g., health shock)
- External validity: Returns to schooling for identical twins may not be representative for whole population

Q1: Questions on Ashenfelter and Krueger (1994)

(c) Key Results

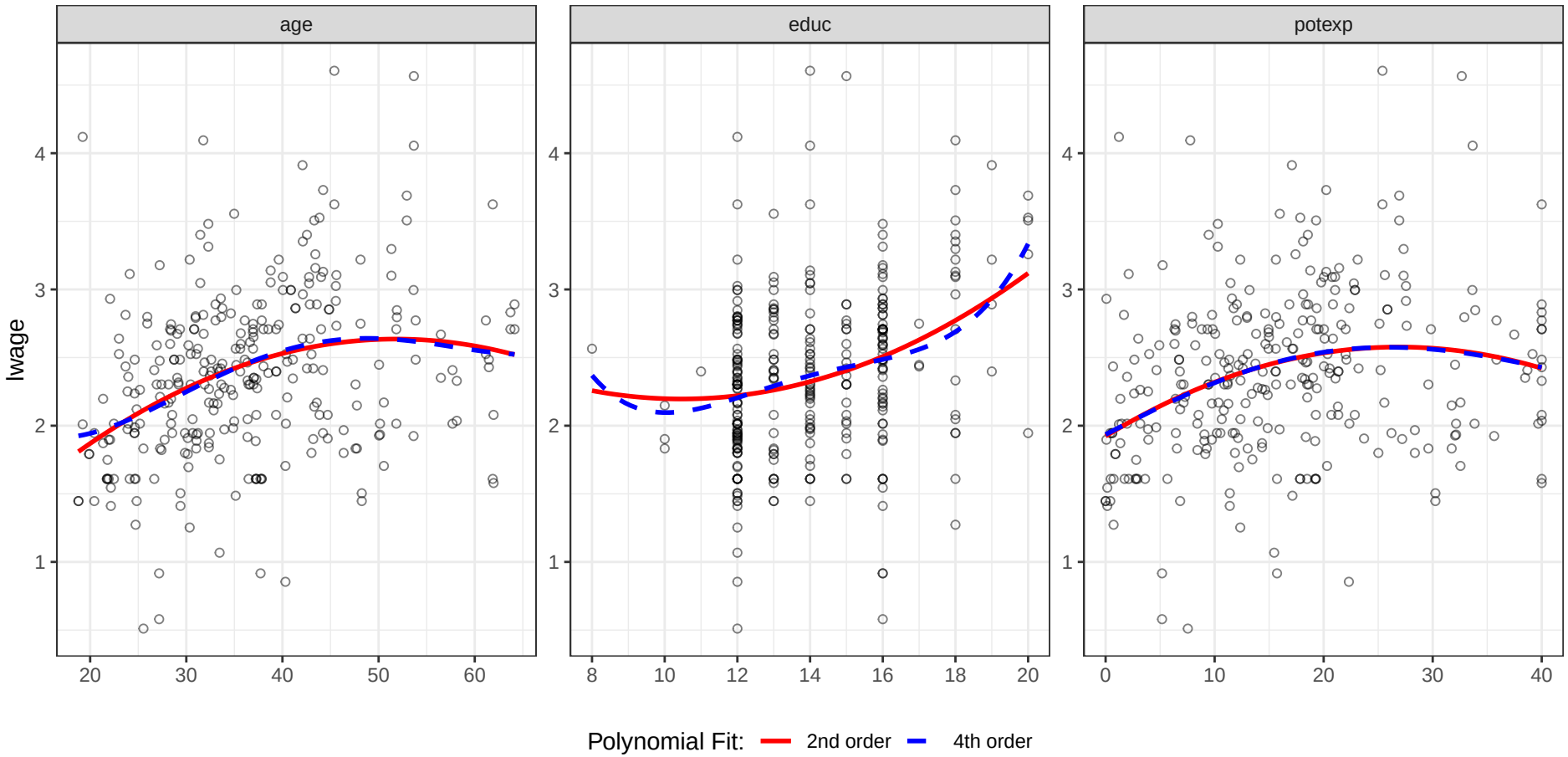
- Main Results:
  - Estimates for returns to schooling between 8 and 16%
  - Estimate larger when using first differences compared to individual level data
  - Estimates notably larger with IV
  - Unobserved ability weakly negatively correlated to schooling level completed
- Implication: Bias due to measurement error bigger issue than OVB
- Effect magnitude of IV FD estimate quite large (compared to other twin studies and research designs)

Results convincing?

- General qualitative direction of their results convincing
- Slightly negative correlation between unobserved ability and schooling level seems dubious

Q2: Descriptives

Figure 1: Wage Profiles



Q3: OLS

Table 1: OLS Results

	DV: Log Wage
Education	0.084^{***}
	(0.014)
Age	0.088^{***}
	(0.019)
Age Squared	-0.001^{***}
	(0.0002)
Male	0.204^{**}
	(0.063)
White	-0.410^{**}
	(0.127)
Constant	-0.471
	(0.426)
Observations	298
R^2	0.272
Adjusted R^2	0.260
Note:	*p<0.05; **p<0.01; ***p<0.001

Key Take-Aways

- Age:
  - Non-linear effect on income
  - Matches the concavity of the age-life-cycle profile
  - Peak at ≈50 years
  - Consistent with Fig. 1
- Education:
  - $\hat{\beta}_{\text{educ}} = 0.084$: identical to Ashenfelter and Krueger (1994)
  - Potential bias due to (1) OVB and (2) measurement error

Q4: Standard Errors

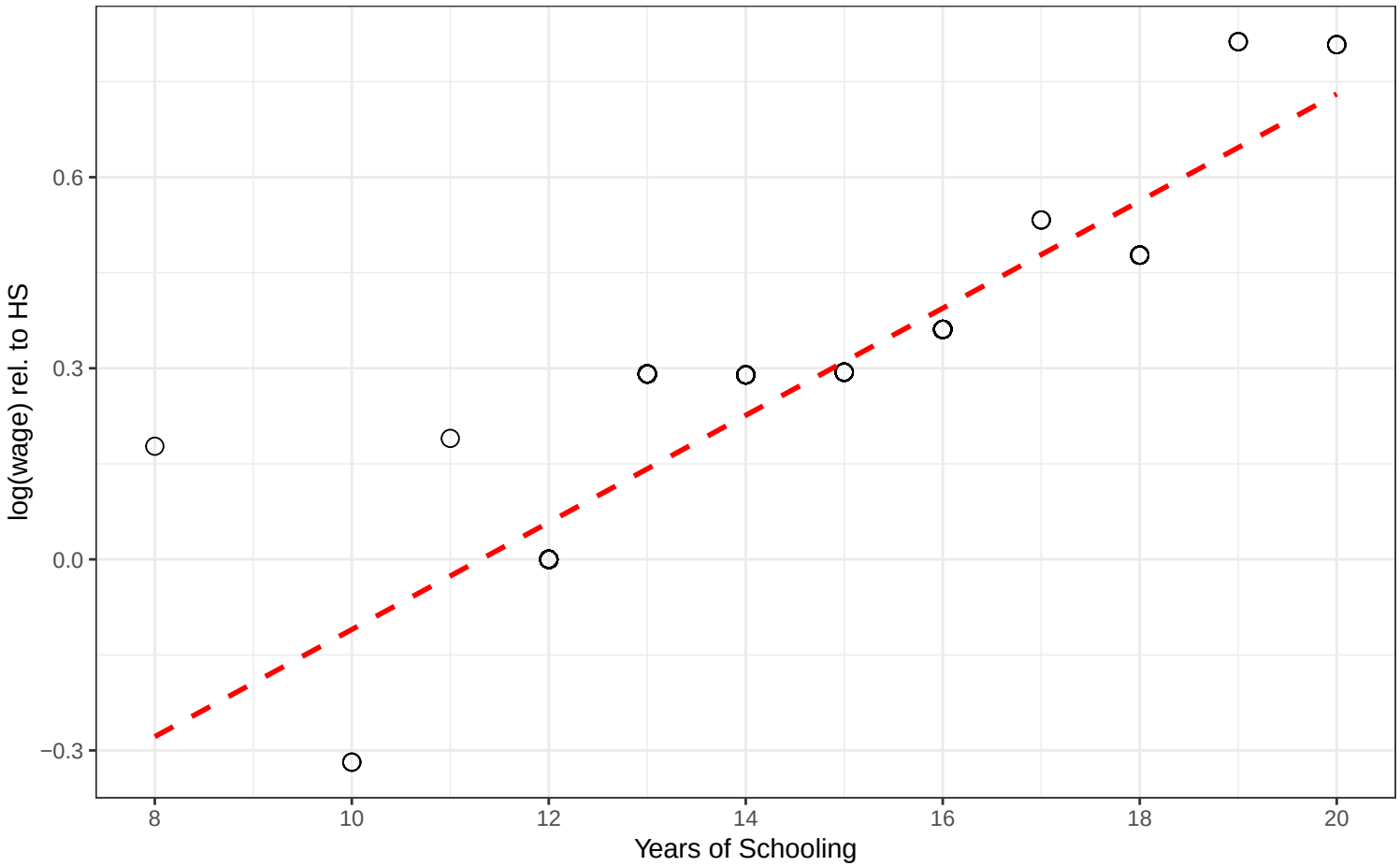
Table 2: OLS with Alternative SEs

	DV: Log Wage		
	Baseline	HC1 Robust	Clustered (famid)
	(1)	(2)	(3)
Education	0.084^{***}	0.084^{***}	0.084^{***}
	(0.014)	(0.015)	(0.015)
Age	0.088^{***}	0.088^{***}	0.088^{***}
	(0.019)	(0.020)	(0.020)
Age Squared	-0.001^{***}	-0.001^{***}	-0.001^{***}
	(0.0002)	(0.0002)	(0.0002)
Male	0.204^{**}	0.204^{***}	0.204^{**}
	(0.063)	(0.062)	(0.062)
White	-0.410^{**}	-0.410^{***}	-0.410^{**}
	(0.127)	(0.117)	(0.125)
Constant	-0.471	-0.471	-0.471
	(0.426)	(0.496)	(0.513)
Observations	298	298	298
R^2	0.272	0.272	0.272
Adjusted R^2	0.260	0.260	0.260
Note:		*p<0.05; **p<0.01; ***p<0.001	

- Assumption of homoskedastic and independent errors is likely violated in the twin data
- HC1: corrects for heteroskedasticity
- Family cluster: accounts for correlation of unobserved shocks within twin pairs

Q5: (Non-)Linearity of Returns to Education

Figure 2: Returns to Education rel. to High School



Q6: OLS vs. FE

Table 3: OLS vs. FE

	DV: Log Wage	
	Baseline OLS	Family FE
	(1)	(2)
Education	0.084***	0.089***
	(0.014)	(0.024)
Family FE		X
Observations	298	298
R^2	0.272	0.798
Adjusted R^2	0.260	0.594
Note:	*p<0.05; **p<0.01; ***p<0.001	

- only slight differences
- Economic reasons: family traits that are positively correlated with both education and wages are filtered out

Q7: FE vs. FD

$$\log(y_{1f}) - \log(y_{2f}) = (\beta S_{1f} + \alpha_f + u_{1f}) - (\beta S_{2f} + \alpha_f + u_{2f})$$
$$\Rightarrow \quad \Delta \log(y_f) = \beta \Delta S_f + \Delta u_f$$

Table 4: FE vs. FD

	DV: Log Wage	
	Family FE	Family FD
	(1)	(2)
Education	0.089***	0.089***
	(0.024)	(0.024)
Observations	298	149
R^2	0.798	0.087
Adjusted R^2	0.594	0.080
Note:	*p<0.05; **p<0.01; ***p<0.001	

- Theoretically, $\beta_{FE} = \beta_{FD} = \beta$
- Identical estimates: $\hat{\beta}_{FE} = \hat{\beta}_{FD}$
- Note: need to exclude intercept in R to run correct FD model!

References

Ashenfelter, O., & Krueger, A. (1994). Estimates of the economic return to schooling from a new sample of twins. *The American Economic Review*, *84*(5), 1157–1173.