



# Returns to Schooling in the United States

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# Motivation



- ▶ Why estimating the returns to education is important?
  - Expenses + opportunity cost of education
  - Education's contribution to economic growth
  - Education and income disparity

# Research Question



▶ Research Questions:

- What is the rate of return to years of schooling?
- What is the rate of return to higher education?

▶ My study:

- US data
- Estimate return to years of schooling using instrumental variables
- Estimate return to higher education using propensity matching method

# Literature

Paper	Data	IV	Note	Schooling estimation	
				OLS	IV
Angrist and Krueger (1991)	US, 1970 and 1980 Census, Men	Quarter of birth X year of birth	1920-29 cohort in 1970	0.070 (0.000)	0.101 (0.033)
Kane and Rouse (1993)	US, NLSY79 Class of 1972, Women	Tuition at 2 and 4-year state colleges; Distance to nearest college	Model without test score or parental education	0.080 (0.005)	0.091 (0.033)
			Model with test scores and parental education	0.063 (0.005)	0.094 (0.042)
Card (1993)	US, NLSY79, 1966 cohort, Men	Geographic variation in college proximity		0.073 (0.004)	0.132 (0.049)
		College proximity X Family background		-	0.097 (0.048)
Blackburn and Neumark (1993)	US, NLSY79	Family backgrounds (parental education)	Without ability (1985 wages)	0.046 (0.007)	0.062 (0.012)
			With ability (1985 wages)	0.043 (0.009)	0.040 (0.017)
Staiger and Stock (1997)	US, 1980 census, Men	Quarter of birth X state X year of birth	1930-39 cohort in 1980	0.063 (0.000)	0.098 (0.015)
Lemke and Rischall (2003)	US, NLSY79	Quarter of birth	Include skill and parental income	0.047 (0.010)	0.133 (0.114)
		College proximity		-	0.041 (0.199)
		Parental education		-	0.038 (0.055)
Arkes (2010)	US, 1980 Census	Quarter of birth		0.0655 (0.012)	0.098 (0.030)
		Unemployment rates		-	0.096 (0.045)

# Literature

Paper	Data	Findings
Olitsky(2014)	US	Benefit to STEM major choice ranges from 5 to 28% depending on academic achievement
Blundell (2005)	UK (NCDS)	Returns of high education: 20-40%
Heoling et al (2014)	UK (Quarterly Labor Force Survey)	Returns to both bachelor's and master's degree have fallen over the years  Bachelor's degree: 24.54% in 1997 19.45% in 2005 17.85% in 2013

# Contribution

- ▶ Estimate return on years of schooling in the US using different IV controlling for ability and economic condition:

Using 3 IVs:

Quarter of birth

Parental education

States unemployment rates during teenage years

- ▶ Test if unemployment rates can be an instrument for education or not (using quality, validity test)
- ▶ Estimate the effect of high education (above high school) on earnings
- ▶ Younger cohort

# Theoretical Framework

## Mincerian earnings function

$$\ln w = \beta_0 + \beta_1 educ + \beta_2 exp + \beta_3 exp^2 + \varepsilon$$

Potential earnings:  $E_{t+1}$  depends on investment in previous period

$$E_{t+1} = E_t + C_t \rho_t = E_t(1 + k_t \rho_t)$$

Repeat substitution:

$$E_{t+1} = \prod_{j=0}^{t-1} (1 + \rho_j k_j) E_0$$

Full time schooling  $k_t=1$ ; rate of return on formal schooling investment is  $\rho_t = \rho_s$ ; rate of return on post-school investment is  $\rho_t = \rho_o$

$$\ln E_t = \ln E_0 + s \ln(1 + \rho_s) + \sum_{j=s}^{t-1} \ln(1 + \rho_o k_j)$$

$$\ln E_t \approx \ln E_0 + s \rho_s + \rho_o \sum_{j=s}^{t-1} k_j$$

# Methodology

- ▶ Returns to years of schooling:

$$\ln w = \alpha S + \beta X + \varepsilon$$

X: Personal characteristics, ability, economic conditions (state unemployment rate)

- ▶ Returns to higher education:

$$\ln w = \alpha HE + \beta X + \varepsilon$$

# Methodology

▶ **Instrumental variable:**

$$\ln w = \alpha X + \beta S + \epsilon$$

$$S = \theta Z + \epsilon$$

W: wages

X: personal characteristics

S: schooling

Z: includes X and IV

- Instrument must be **correlated with S** but **not correlated with  $\epsilon$**

▶ **Propensity Score Matching (PSM):**

- Difference in outcome between these two groups may depend on characteristics that affect whether or not the individual goes to college instead of due to the effect of obtaining college degree
- **Propensity score:** probability of getting higher education given a set of observation variables:

$$p(x) = \Pr(HE = 1|X = x)$$

- Match observations from HE group and non-HE group based on their propensity score so that:

$$[\ln w(0), \ln w(1)] \perp HE|X$$

- Matching methods: nearest neighbor, kernel and radius matching

# Instruments



## Instrument 1: Season of birth

- ▶ **Relative age effect:** Elder children have developmental advantage -> better grades -> higher education
- ▶ **Compulsory schooling effect** Elder children can dropout earlier -> shorter schooling year

## Instrument 2: Parental education

- ▶ Highly educated parents -> higher educated children

## Instrument 3: State unemployment rates

Introduced by Arkes (2010)

- ▶ **Income effect:** high unemployment rate -> reduce household income -> quit school
- ▶ **Substitution effect:** high unemployment rate -> reduce opportunity cost of education -> encourage education

# Data



- ▶ The National Longitudinal Survey of Youth 97 (NLSY97)
  - Consists approximately 9,000 American youth born from 1980 to 1984.
  - Respondents were ages 12-17 when first interviewed in 1997. Round 1 contains information about the youths' family background and history.
  - Youths continue to be interviewed on an annual basis (15 rounds so far)
- ▶ Sample
  - Panel data 1997-2011
  - Number of observations: 25,543
  - Using only observations 18 years old or older

# Results



- ▶ Part 1: Returns to years of schooling
- ▶ Part 2: Returns to higher education

# Part 1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Hourly wage (cent)	1419.72	4611.28	1	346287.80
Log(wage)	6.93	0.86	0	12.76
Years of schooling	12.84	2.32	6	20
High education (HE)	0.19	0.39	0	1
Female	0.49	0.50	0	1
Male	0.51	0.50	0	1
White	0.69	0.46	0	1
Black	0.20	0.40	0	1
Other races	0.11	0.32	0	1
Experience (years)	5.05	3.35	0	21.40
Tenure (years)	1.69	1.92	0	21.40
Standard math score	96.62	13.88	55	145
Child	0.30	0.70	0	6
Married	0.16	0.36	0	1
State unemployment rates	5.9968	2.1178	2.30	13.80
Quarter 1 (Jan-Mar)	0.2269	0.4188	0	1
Quarter 2 (Apr-May)	0.2084	0.4061	0	1
Quarter 3 (June-Sep)	0.2762	0.4471	0	1
Quarter 4 (Oct-Dec)	0.2885	0.4530	0	1
Father's education (years)	12.82	3.07	2	20
Mother's education (years)	12.96	2.73	1	20
State unemployment rates during teenage years	4.2773	0.8531	2.55	8.2

# OLS Estimates for Years of Schooling

	OLS	Instrumental Variables		
		Quarter of Birth	Parental Education	State Unemployment Rates
Constant		6.4410 (0.0000)***	6.2242 (0.0000)***	5.6272 (0.0010)***
Years of schooling	<b>0.0498</b> (0.0000)***	<b>0.0096</b> (0.8700)	<b>0.0523</b> (0.0010)***	<b>0.1698</b> (0.5950)
Female	-0.1423 (0.0000)***	-0.1155 (0.0100)***	-0.1461 (0.0000)***	-0.2301 (0.3190)
Black	0.0174 (0.4320)	0.0124 (0.601)	0.0050 (0.8190)	-0.0153 (0.8000)
Other races	0.0153 (0.5510)	0.0119 (0.6460)	0.0139 (0.5940)	0.0193 (0.5530)
Experience	0.0111 (0.1370)	0.0111 (0.3870)	0.0051 (0.6080)	-0.0114 (0.8040)
Experience Square	0.0018 (0.0000)***	0.0016 (0.0320)*	0.0018 (0.0130)	0.0022 (0.1180)
Tenure	0.0493 (0.0000)***	0.0665 (0.0000)***	0.0649 (0.0000)***	0.0604 (0.0000)***
Tenure Square	-0.0053 (0.0000)***	-0.0065 (0.0000)***	-0.0062 (0.0000)***	-0.0053 (0.0570)*
Standard math score	0.0002 (0.7400)	0.0023 (0.4540)	0.0001 (0.8790)	-0.0057 (0.7200)
Children	0.0084 (0.3980)	-0.0173 (0.7280)	0.0181 (0.2710)	0.1157 (0.6640)
Married	0.0878 (0.0000)***	0.1114 (0.0000)***	0.0988 (0.0000)***	0.0641 (0.5150)
State unemployment rates	-0.0327 (0.0000)***	-0.0330 (0.0000)***	-0.0331 (0.0000)***	-0.0334 (0.0000)***
R-squared	0.0940	0.0898	0.0949	0.0288
Hansen J statistic		0.1819	0.3912	0.0000

# Schooling Production Function (Stage 1)

	Instrumental Variables		
	Quarter of Birth	Parental Education	unemployment rates
Quarter 2	0.3509 (0.0000)***		
Quarter 3	0.0014 (0.9870)		
Quarter 4	0.0856 (0.2990)		
Father education		0.1179 (0.0000)***	
Mother education		0.0859 (0.0000)***	
State unemployment rate during teenage years			-0.0562 (0.3800)

# IV Estimates for Years of Schooling

	OLS	Instrumental Variables		
		Quarter of Birth	Parental Education	Unemployment Rates
Constant		6.4410 (0.0000)***	6.2242 (0.0000)***	5.6272 (0.0010)***
Years of schooling	<b>0.0498</b> <b>(0.0000)***</b>	<b>0.0096</b> <b>(0.8700)</b>	<b>0.0523</b> <b>(0.0010)***</b>	<b>0.1698</b> <b>(0.5950)</b>
Female	-0.1423 (0.0000)***	-0.1155 (0.0100)***	-0.1461 (0.0000)***	-0.2301 (0.3190)
Black	0.0174 (0.4320)	0.0124 (0.601)	0.0050 (0.8190)	-0.0153 (0.8000)
Other races	0.0153 (0.5510)	0.0119 (0.6460)	0.0139 (0.5940)	0.0193 (0.5530)
Experience	0.0111 (0.1370)	0.0111 (0.3870)	0.0051 (0.6080)	-0.0114 (0.8040)
Experience Square	0.0018 (0.0000)***	0.0016 (0.0320)*	0.0018 (0.0130)	0.0022 (0.1180)
Tenure	0.0493 (0.0000)***	0.0665 (0.0000)***	0.0649 (0.0000)***	0.0604 (0.0000)***
Tenure Square	-0.0053 (0.0000)***	-0.0065 (0.0000)***	-0.0062 (0.0000)***	-0.0053 (0.0570)*
Standard math score	0.0002 (0.7400)	0.0023 (0.4540)	0.0001 (0.8790)	-0.0057 (0.7200)
Children	0.0084 (0.3980)	-0.0173 (0.7280)	0.0181 (0.2710)	0.1157 (0.6640)
Married	0.0878 (0.0000)***	0.1114 (0.0000)***	0.0988 (0.0000)***	0.0641 (0.5150)
State unemployment rates	-0.0327 (0.0000)***	-0.0330 (0.0000)***	-0.0331 (0.0000)***	-0.0334 (0.0000)***

# Returns to Years of Schooling

## Quality & Validity of IV

Tests	Instrumental Variables		
	Quarter of Birth	Parental Education	Unemployment Rates
Quality: F-statistic of excluded instruments (Prob>F)	F( 3, 2871) = 7.26 (0.0001)	<b>F( 2, 2871) = 138.78 (0.0000)</b>	F( 1, 2871) = 0.77 (0.3801)
Validity: Hansen J statistic (Prob>F)	0.1819	<b>0.3912</b>	0.0000

=> **Parental education** outperforms quarters of birth and state unemployment rates

## Part 2: Summary Statistics (Higher Education)

Variables	Non HE (20,784) (80%)	HE (4,745) (20%)
Hourly wage (cent)	1307.83	1910.45
Log(wage)	6.85	7.28
Female	0.47	0.57
Male	0.53	0.43
White	0.66	0.77
Black	0.22	0.12
Other races	0.11	0.10
Experience (years)	4.45	7.64
Tenure (years)	1.54	2.34
Standard math score	95.08	103.40
Child	0.32	0.22
Married	0.13	0.28
State unemployment rates	5.75	4.23

# Part 2: Propensity Score Matching Results

Method	Method	ATE	ATT	ATU
OLS		<b>0.2635</b> (0.0000)***	-	-
IV	Quarter of birth	0.0844 (0.1230)	-	-
	Parental education	<b>0.0974</b> (0.0000)***	-	-
	Unemployment rate	0.1160 (0.1060)	-	-
Propensity score matching	Nearest Neighbor	<b>0.2026</b> (0.0000)***	0.2565 (0.0000)***	0.1861 (0.0000)***
	Kernel matching	<b>0.2234</b> (0.0000)***	0.2697 (0.0000)***	0.2092 (0.0000)***
	Radius matching	<b>0.3697</b> (0.0000)***	0.3697 (0.0000)***	0.3697 (0.0000)***

# Concluding Remarks



- ▶ Weak corr (education, unemployment rates) and unemployment rates is not a good instrument for education
- ▶ An additional year of schooling contributes to an increase of 5% in earnings
- ▶ College and higher educated people earn about 20 to 37% more than lower educated people



**Thank you**