The Intergenerational Transmission of Human Capital: Evidence from the Golden Age of Upward Mobility

David Card (UC Berkeley & NBER)
Ciprian Domnisoru (UC Berkeley)
Lowell Taylor (Carnegie Mellon & NBER)

NBER Summer Institute
July 2018

1. Introduction

- Societies want to organize in ways that allow children to be prosperous regardless of family circumstances
  - Can public schooling help level the playing field? (Loury, 1981)
- Chetty, Hendren, Kline, and Saez (2014) and Chetty and Hendren (2018a, 2018b) examine intergenerational links in income using IRS data
  - Upward mobility in income is related to local contextual factors (segregation, schooling quality, etc.)
  - Thier *child generation* was born in the 1980s
- We examine intergenerational links in human capital during the "golden era" of increasing education—using population files from the 1940 U.S. Census
  - Our *child generation* was born in the 1920s; the *parent generation* approximately 1880–1910
  - We estimate impact of schooling quality metrics on educational attainment

1. Introduction

Overview

1. Introduction
2. Historical Backdrop
3. A Benchmark Model in the spirit of Becker and Tomes (1979, 1986) and Loury (1981)
4. Empirical Evidence at the State Level
   - An evaluation of state-level geographical variation in upward mobility—focusing on a potential role for school quality
5. Empirical Evidence from Border-County Pairs in the South
   - County-level analyses along state borders in Southern states

2. Historical Backdrop

We are studying a period of rapid growth in human capital

Parent generation (born roughly 1880–1910)

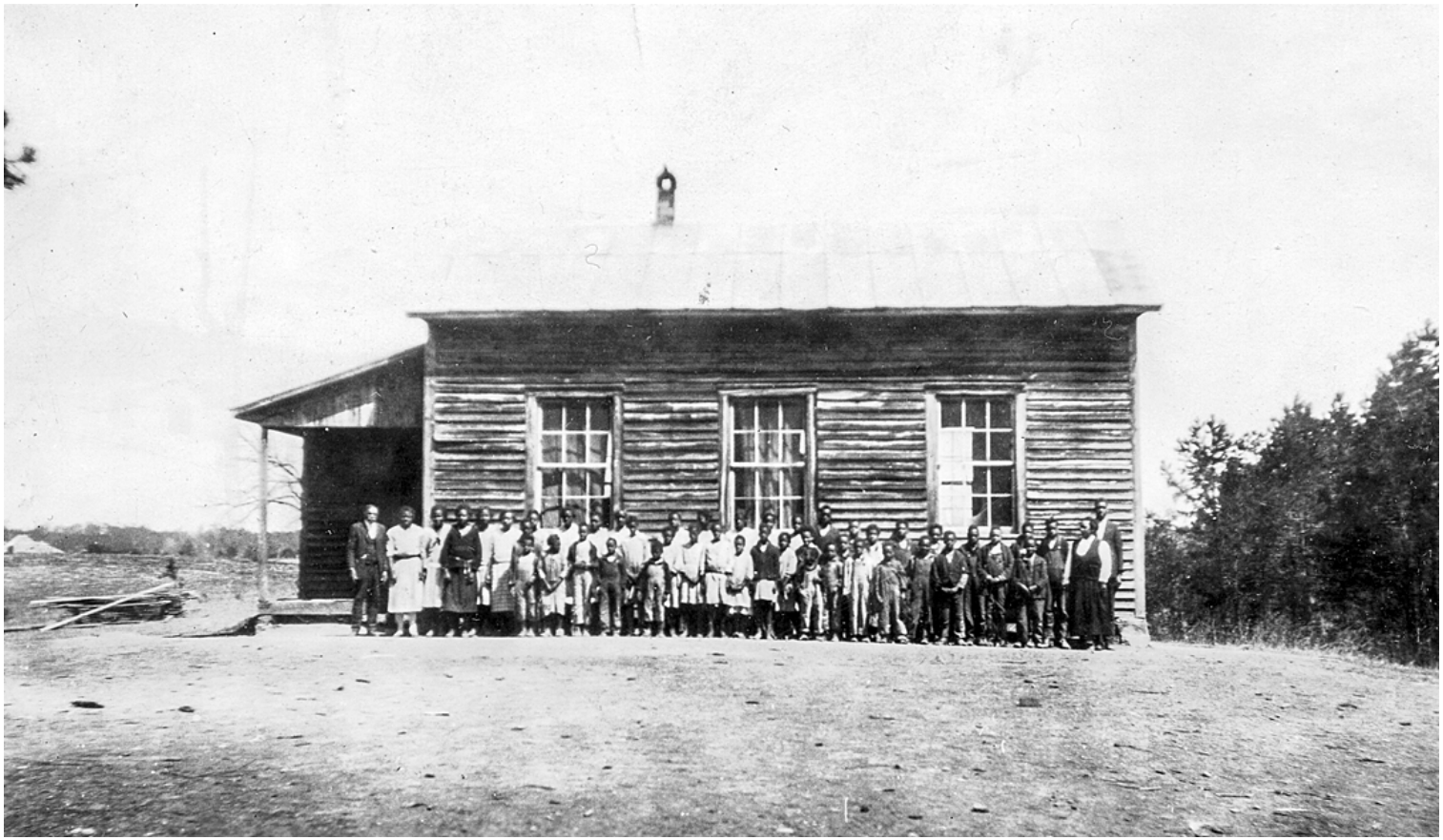
- Access to primary school was near-universal, but availability of public high schools was uneven (Goldin and Katz, 2008)
- African American students, and also Chinese and Mexican American students, often attended segregated schools
- The parent generation was characterized by substantial systematic variation in educational attainment

Child generation (born 1922–1926)

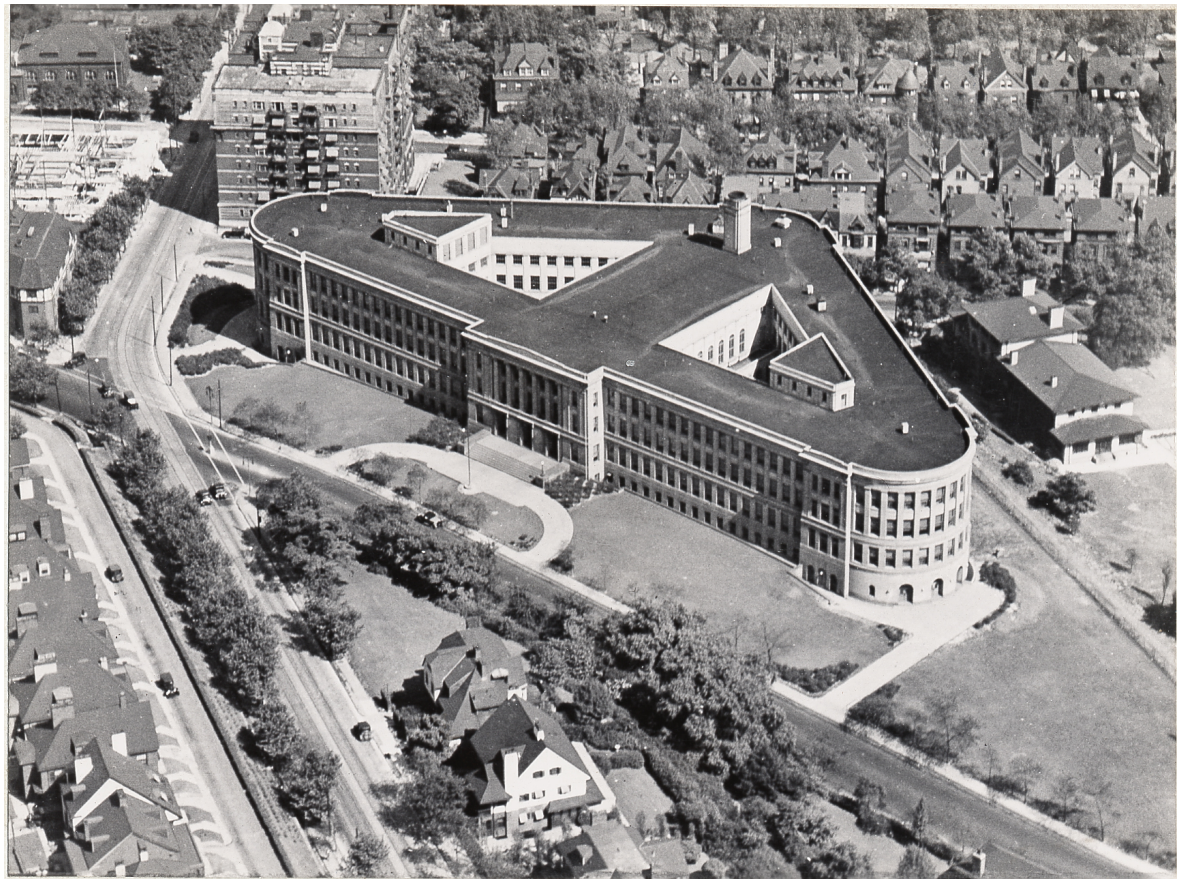
- Most students had access to high school, but the quality of public education varied substantially across states
- Schooling options were generally very poor for black students in Southern states

2. Resources Available to the *Child Generation*

School for African American students in Cottonville, North Carolina (1923)



Schenley High School in Pittsburgh, Pennsylvania (1916)

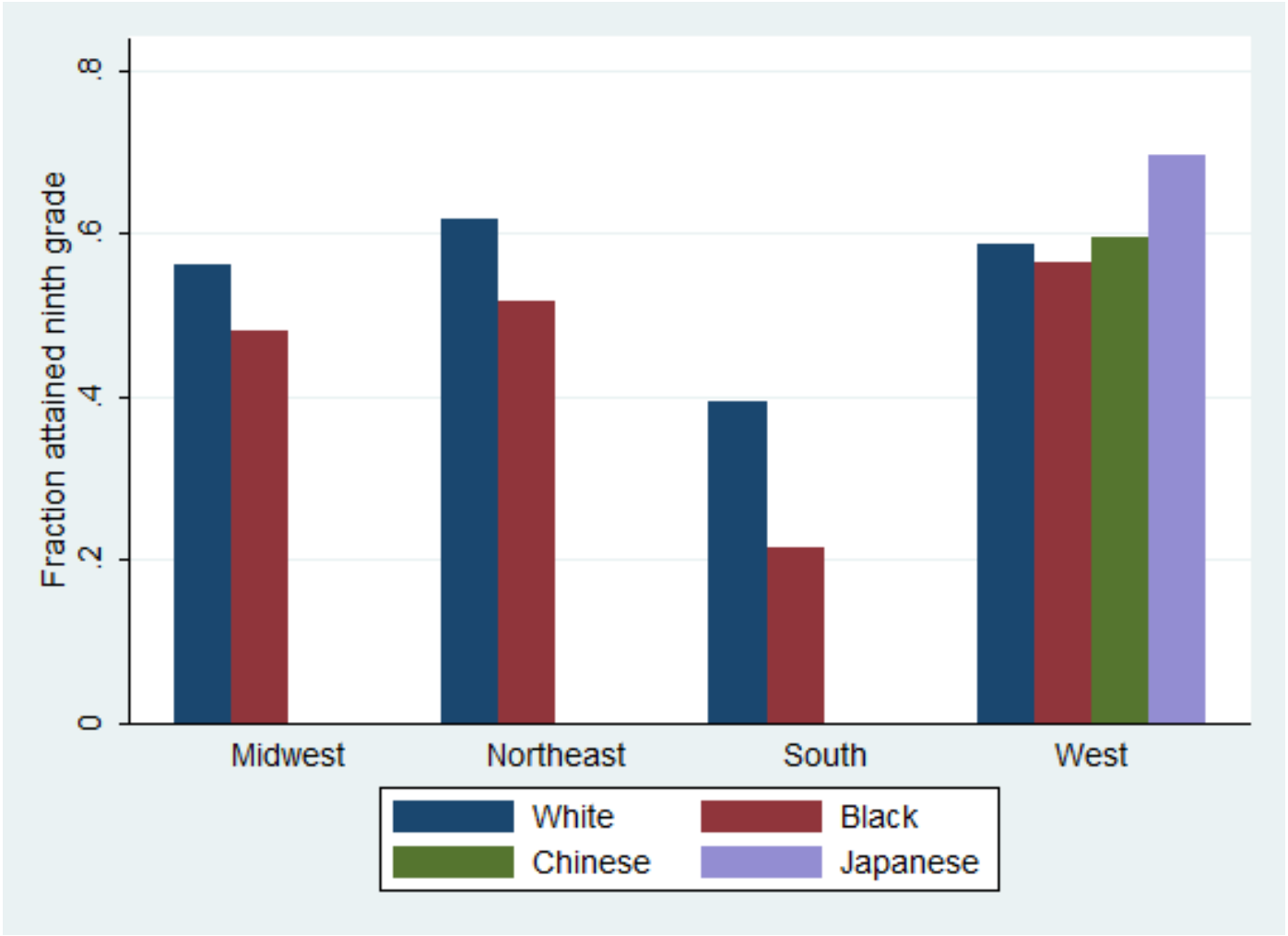


2. Upward Mobility in Education (Preview)

- For the moment—for descriptive purposes—we use a very simple measure
  - Proportion of children aged 16–18 attaining 9+ years of education in families where parental education is 5–8 years
- We observe substantial racial and geographic variation in this upward mobility measure

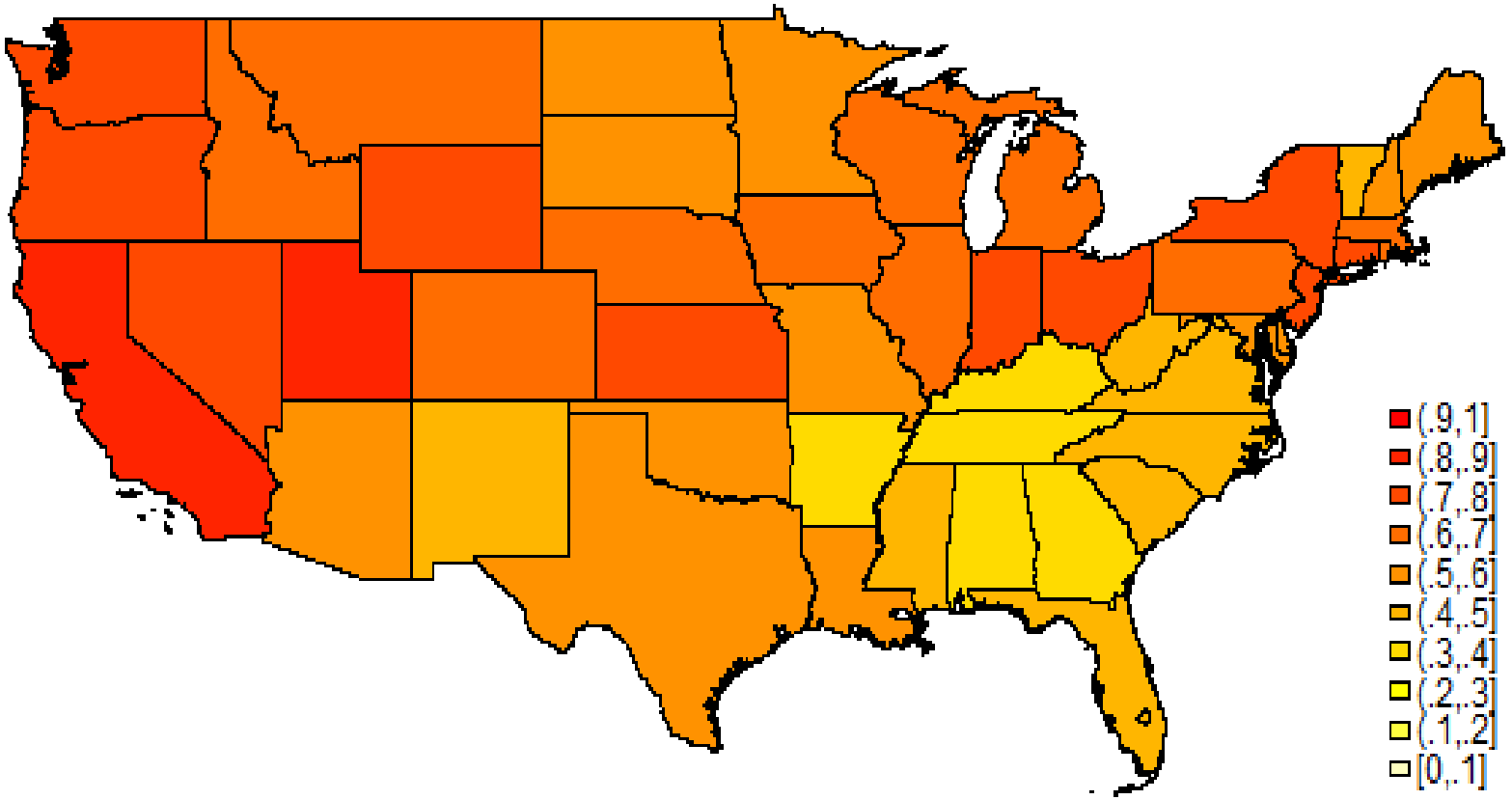
2. Upward Mobility in Education (Preview)

9th Grade Attainment for Children Aged 16–18
in Families with Parental Education of 5–8 Grades



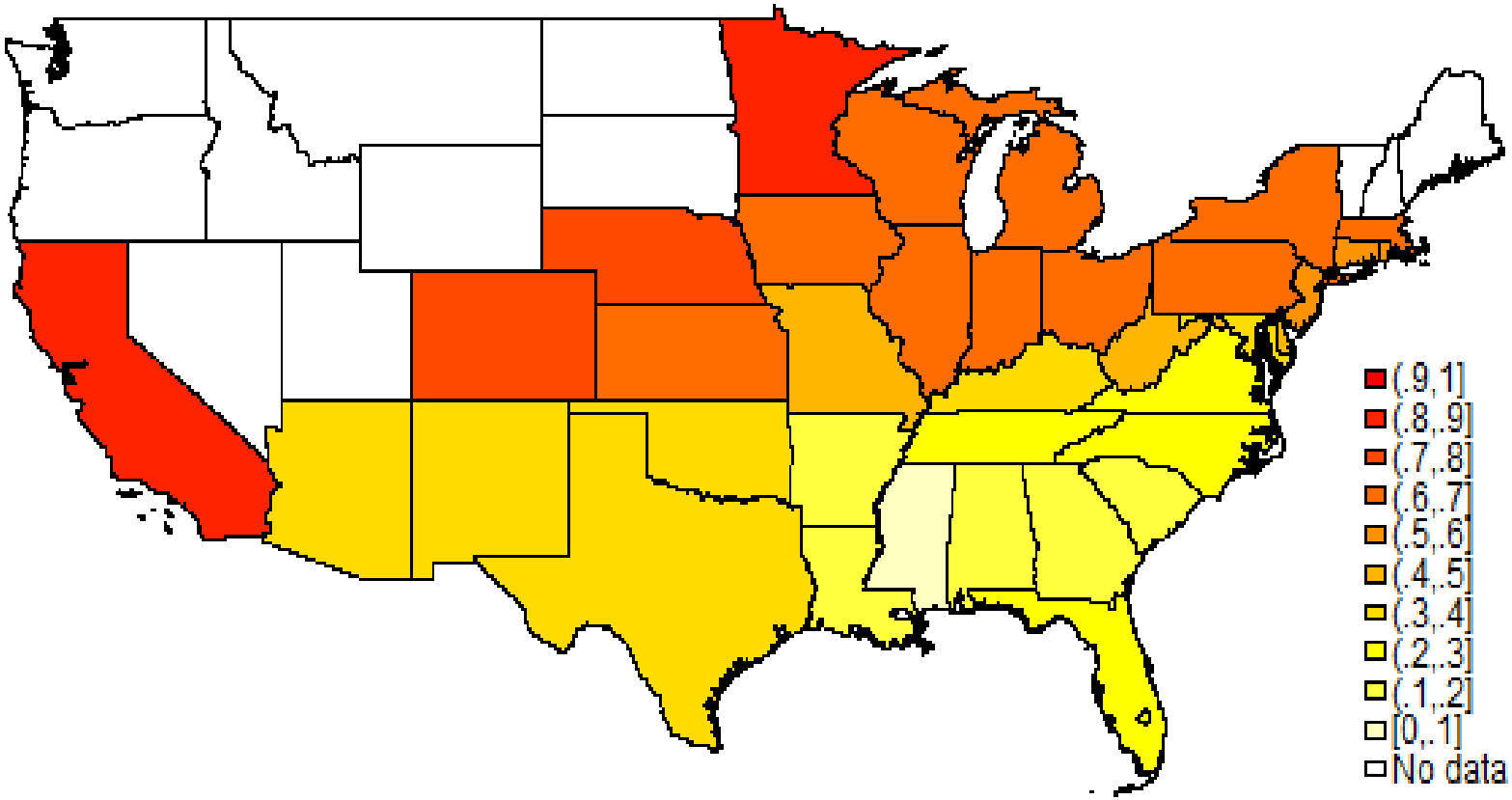
2. Variation in Upward Mobility, White Sons (Preview)

Proportion with 9+ years of education,
parents have 5–8 years of education



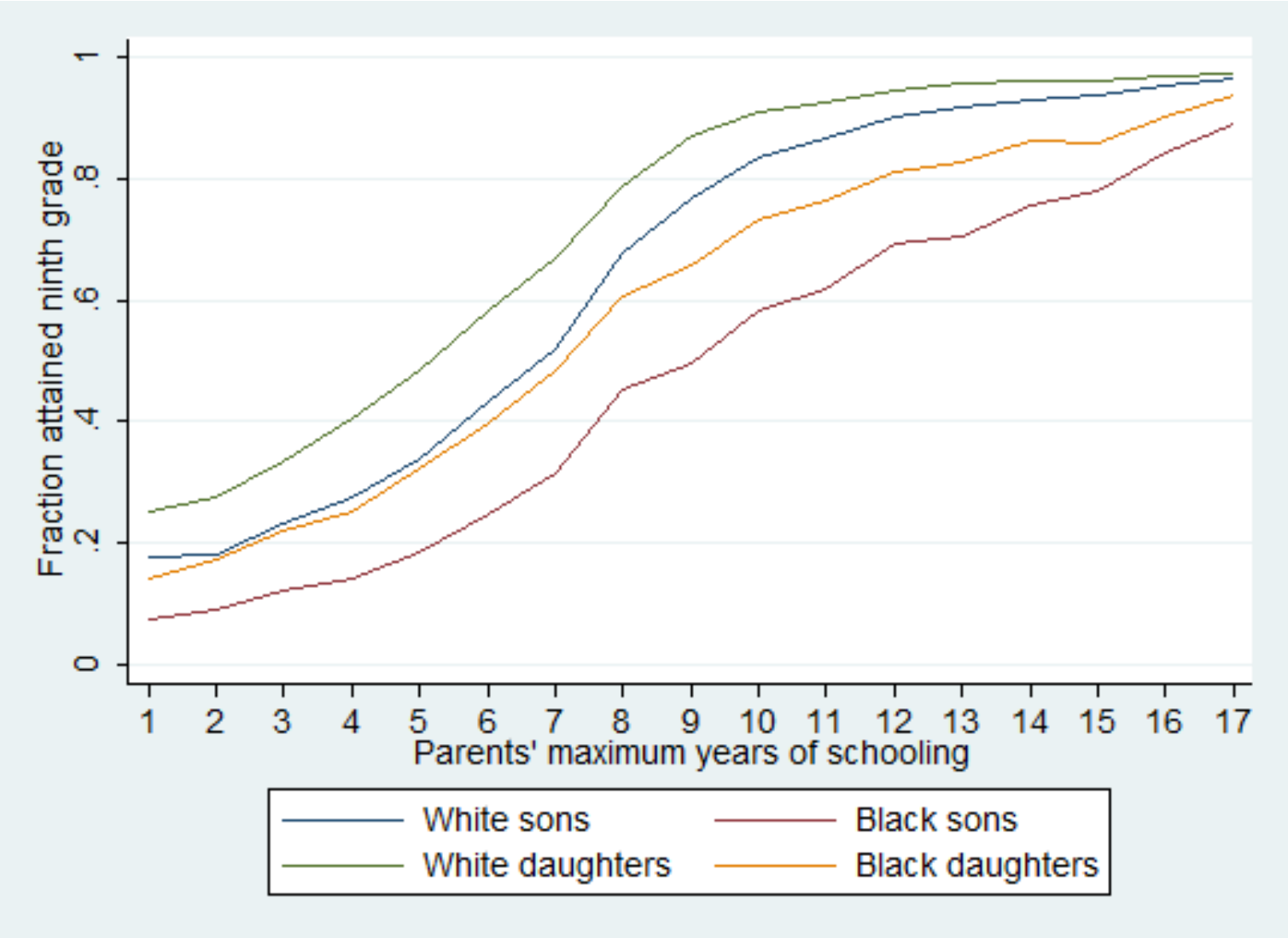
2. Variation in Upward Mobility, Black Sons (Preview)

Proportion with 9+ years of education,
parents have 5–8 years of education

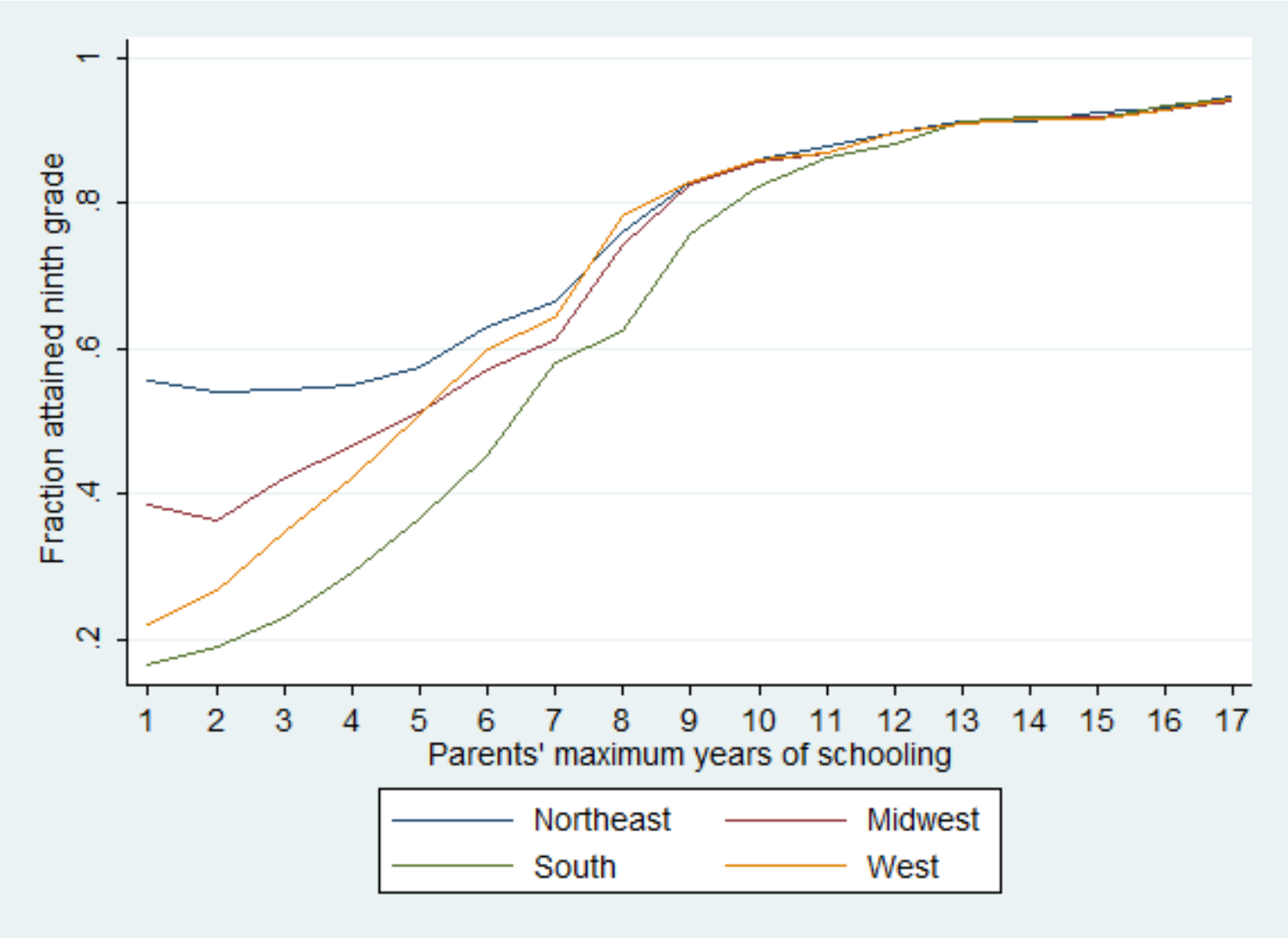


2. Parent and Child Education, Children Aged 16–18

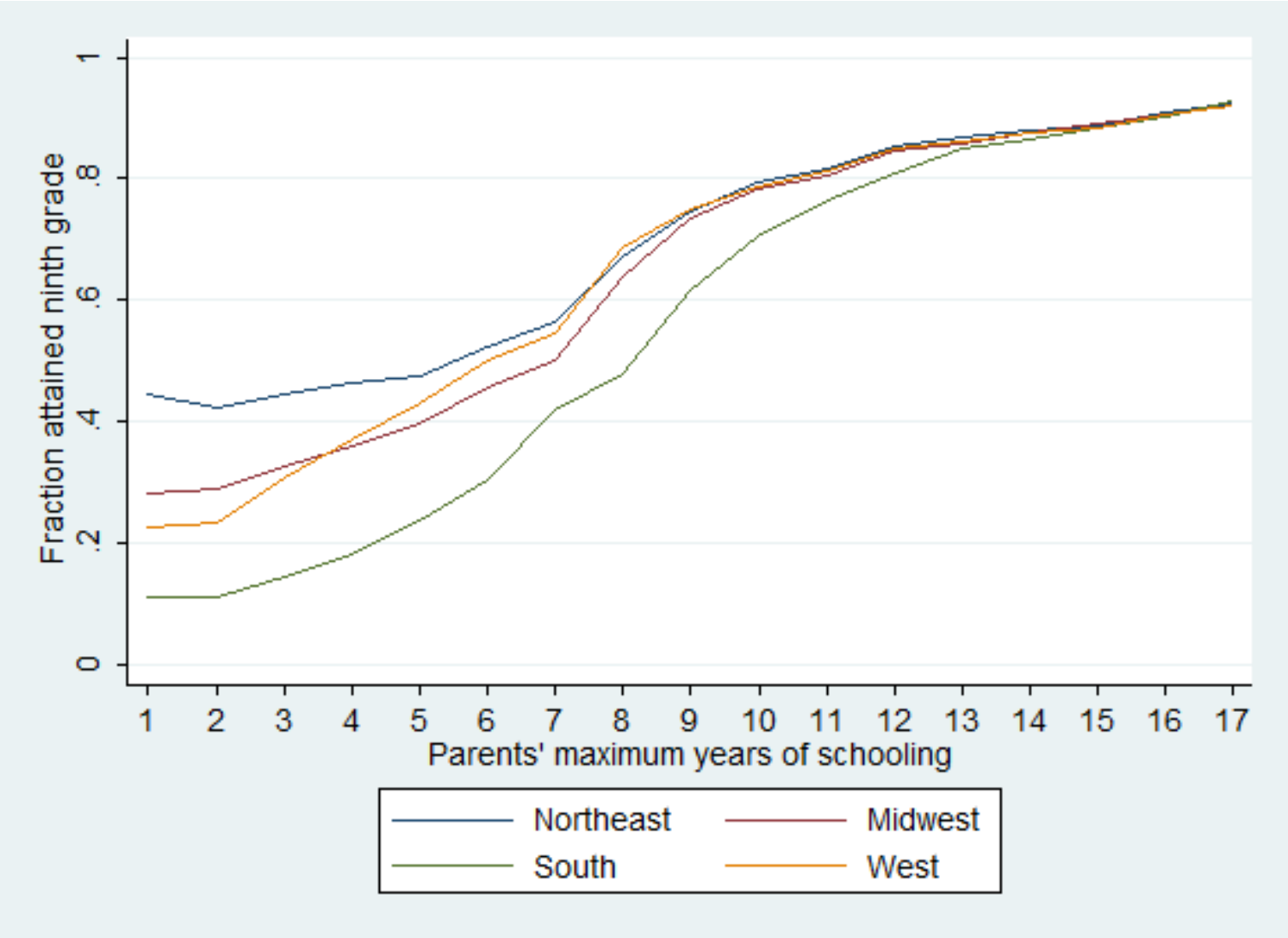
Differences among Black and White Children by Gender



Regional Differences for White Daughters

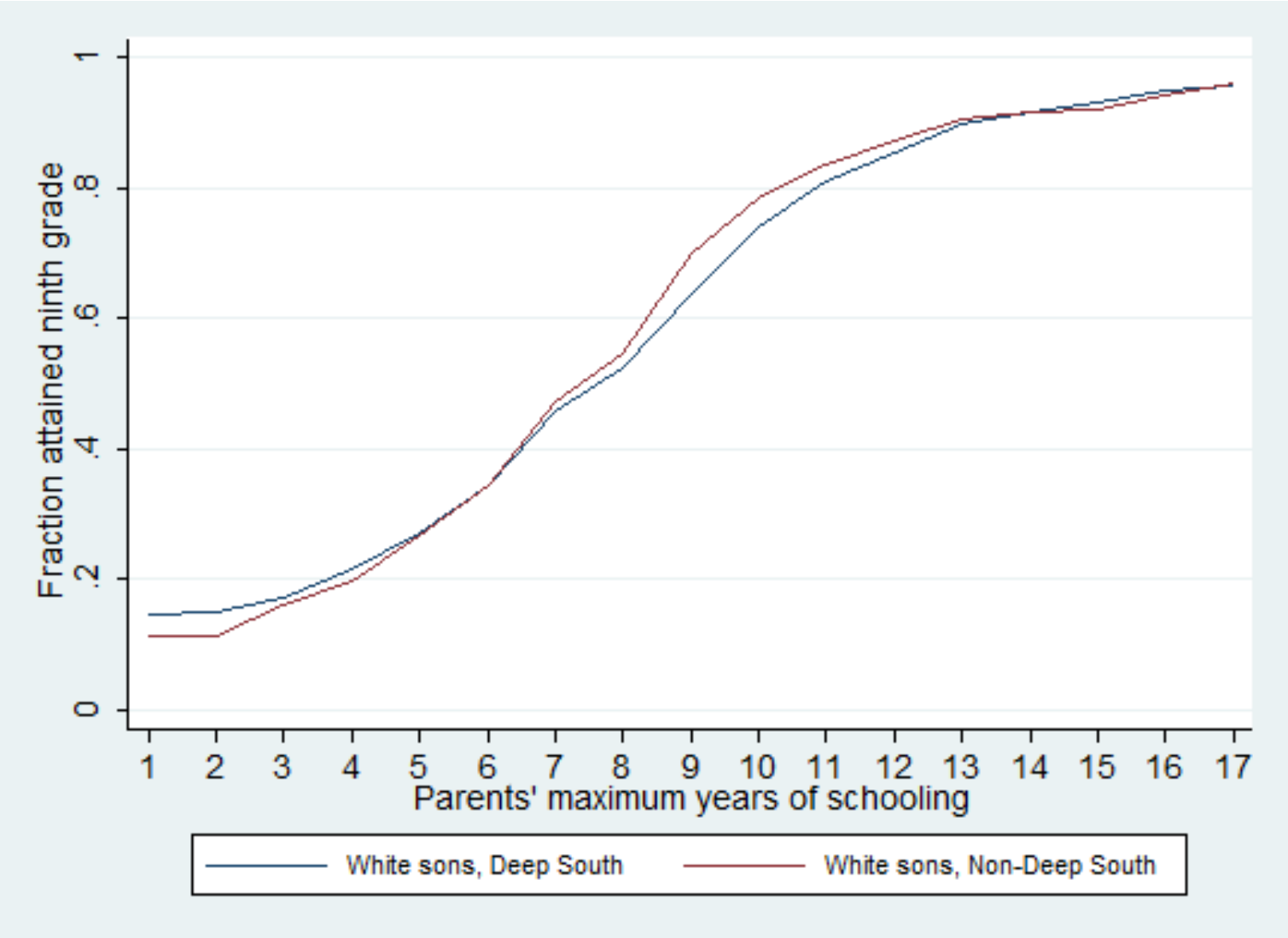


Regional Differences for White Sons



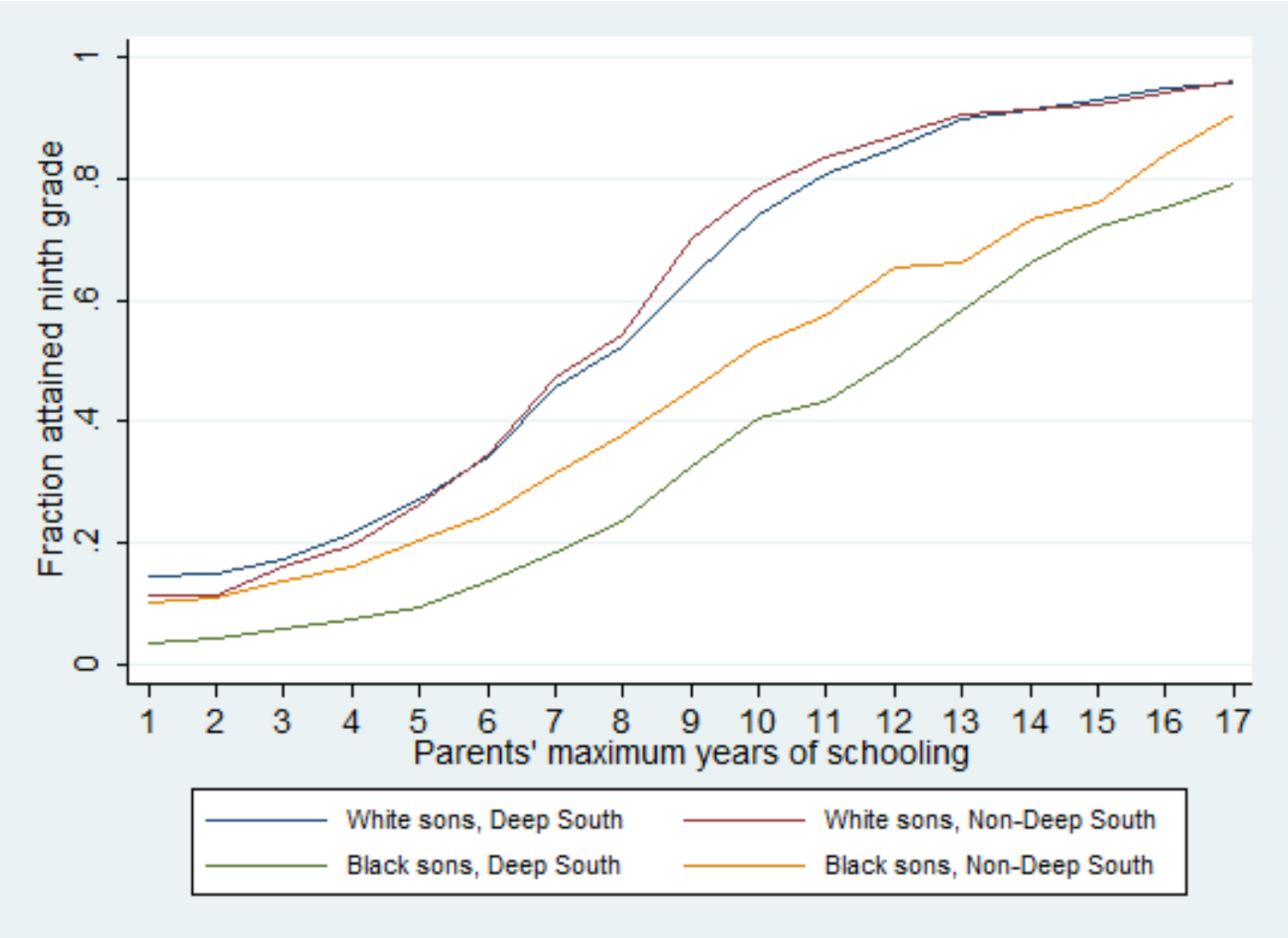
2. Parent and Child Education, Children Aged 16–18

Deep South and Peripheral South, White Sons



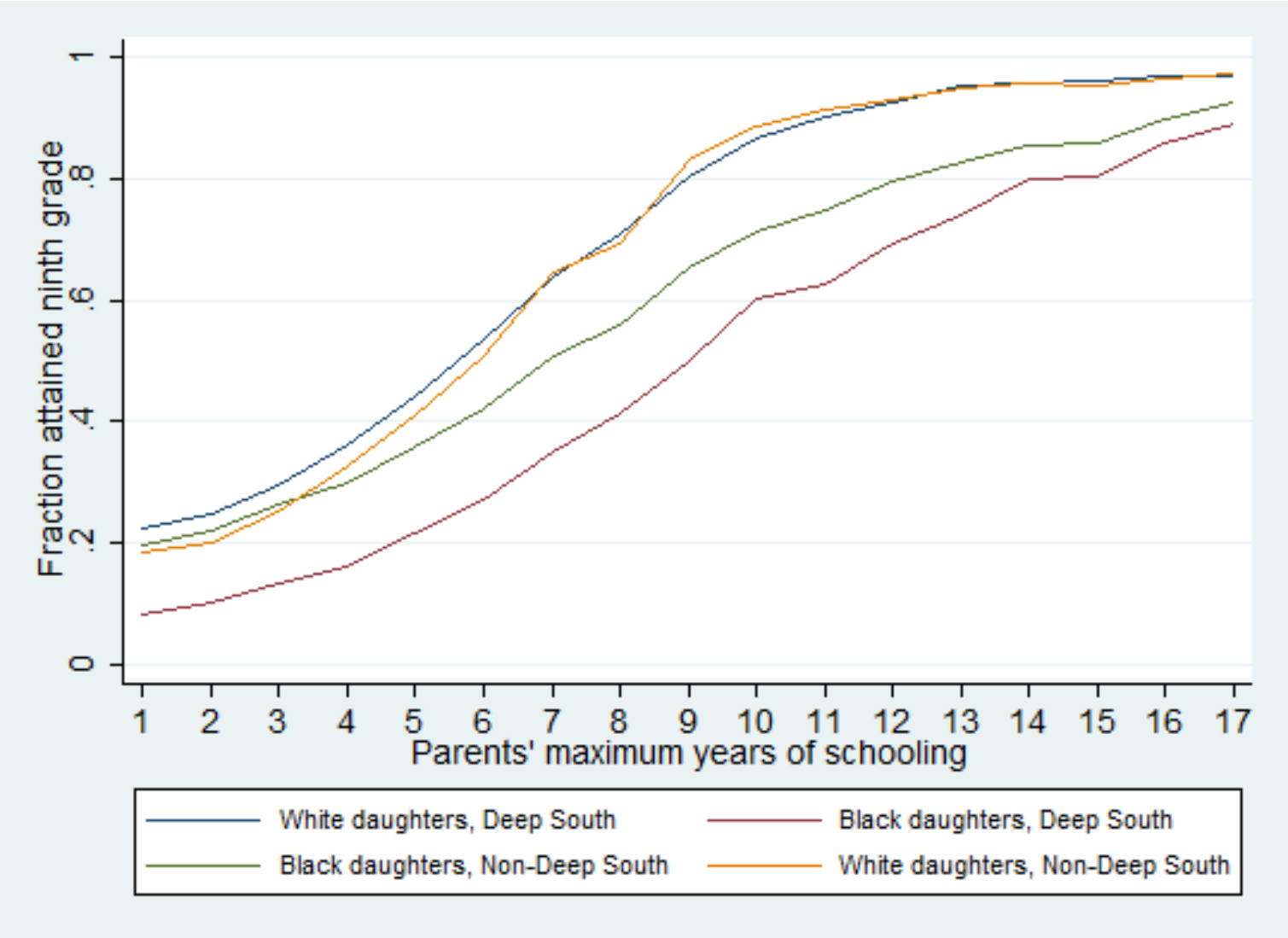
2. Parent and Child Education, Children Aged 16–18

Deep South and Peripheral South, Sons



2. Parent and Child Education, Children Aged 16–18

Deep South and Peripheral South, Daughters



3. Benchmark Model

- We set up a model in which we investigate the role of schooling quality in shaping educational choice
- As in Becker and Tomes (1979) we have a *household* model of educational attainment
- In our model the optimal choice for child education is
  - increasing in parental income
  - increasing in the quality of local schooling

The parent maximizes utility U

$$U(E) = \int_0^E [u(y_0 - c(t))]\, e^{-rt} dt + \int_E^L [u(y_0 + y_1(E))]\, e^{-rt} dt$$

$$+ \int_L^\infty \theta v(y_1(E)) e^{-rt} dt$$

where

- E = years of schooling
- $L > E$ is age leaving home
- y_0 = parent's income
- $c(t)$ = is the net cost of year t of school
- v = the child's utility ($\theta \geq 0$ is an altruism parameter)
- $y_1(E)$ = earnings per year for a child with E years of schooling

The marginal value of an additional unit of child's education is

$$U'(E) = e^{-rE}\left[\frac{y_1'(E)}{r}\lambda_1 - (y_1(E) + c(E))\lambda_0\right]$$

where, roughly speaking, λ_0 is marginal utility at the time child's education is completed, and λ_1 is future marginal utility

- Specifically

$$\lambda_1 = u'(y_0 + y_1(E))(1 - e^{-r(L-E)}) + \theta v'(y_1(E))e^{-r(L-E)}$$

  is a weighted average of $u'(y_0 + y_1(E))$ and $\theta v'(y_1(E))$
  - weights depend on the fraction of the child's life outside the parental home after completion of education

- And

$$\lambda_0 = \frac{u(y_0 + y_1(E)) - u(y_0 - c(E))}{y_1(E) + c(E)}$$
$$= u'(\widetilde{y}_0) \text{ for } \widetilde{y}_0 \in [y_0 - c(E), y_0 + y_1(E)]$$

Optimal schooling choice

$$\frac{y_1'(E)}{y_1(E)} = r\frac{\lambda_0}{\lambda_1}\left[1 + d(E)\right]$$

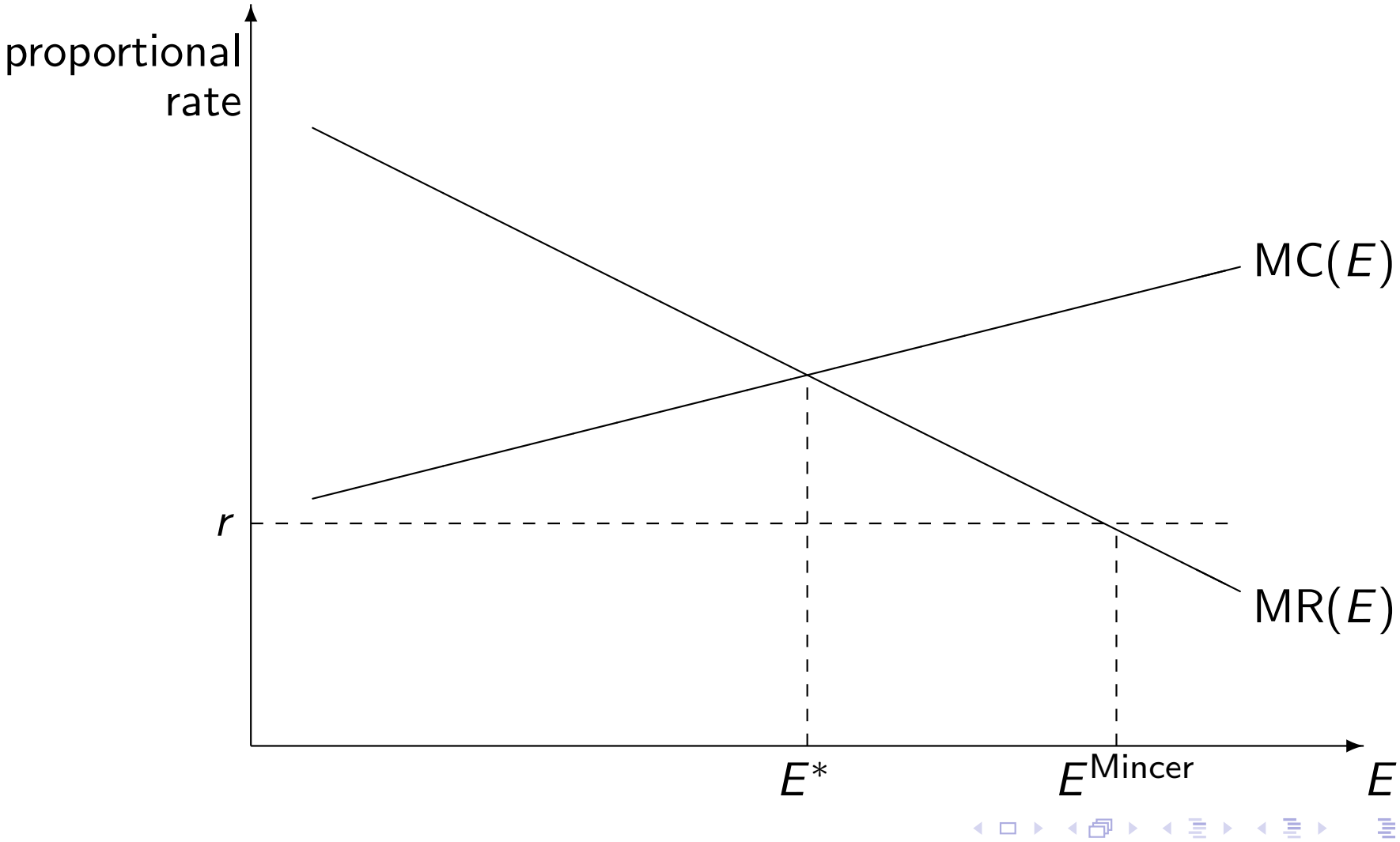
where $d(E) = \frac{c(E)}{y_1(E)}$

- The left-hand side, MR(E), is the proportional return to an additional unit of schooling
- The right-hand side, MC(E), is the annuitized proportional cost, adjusted for any difference in the marginal utility of \$1 when the child is nearing the end of school (λ_0) versus a perpetuity paid to a combination of the parent and child (λ_1)
  - For families that are less than perfectly altruistic, or have relatively low income and cannot borrow against their children's future income

$$\frac{\lambda_0}{\lambda_1} > 1$$

  - If families maximize dynastic income $\lambda_0 = \lambda_1$, and $d(E) = 0$, we have Mincer's (1958) case

Figure: MR and MC of Education

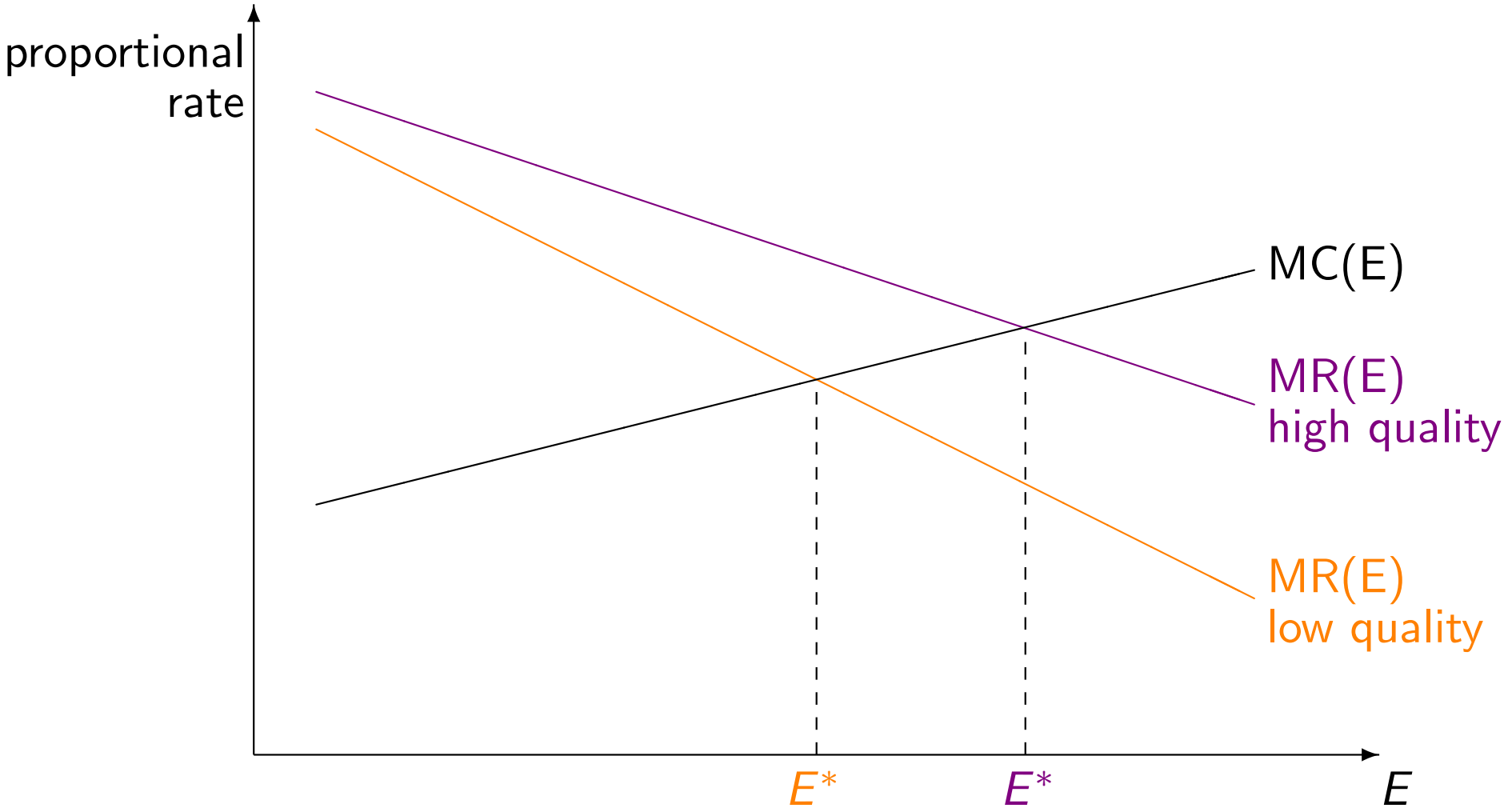


3. Benchmark Model

- MR(E) is likely decreasing in E, increasing in schooling "quality" Q, and possibly increasing in parental education P
- Assuming linearity

$$\text{MR}(E) = \gamma_0 + \gamma_E E + \gamma_Q Q + \gamma_P P + \phi$$

Figure: Link between School Quality and Child Education



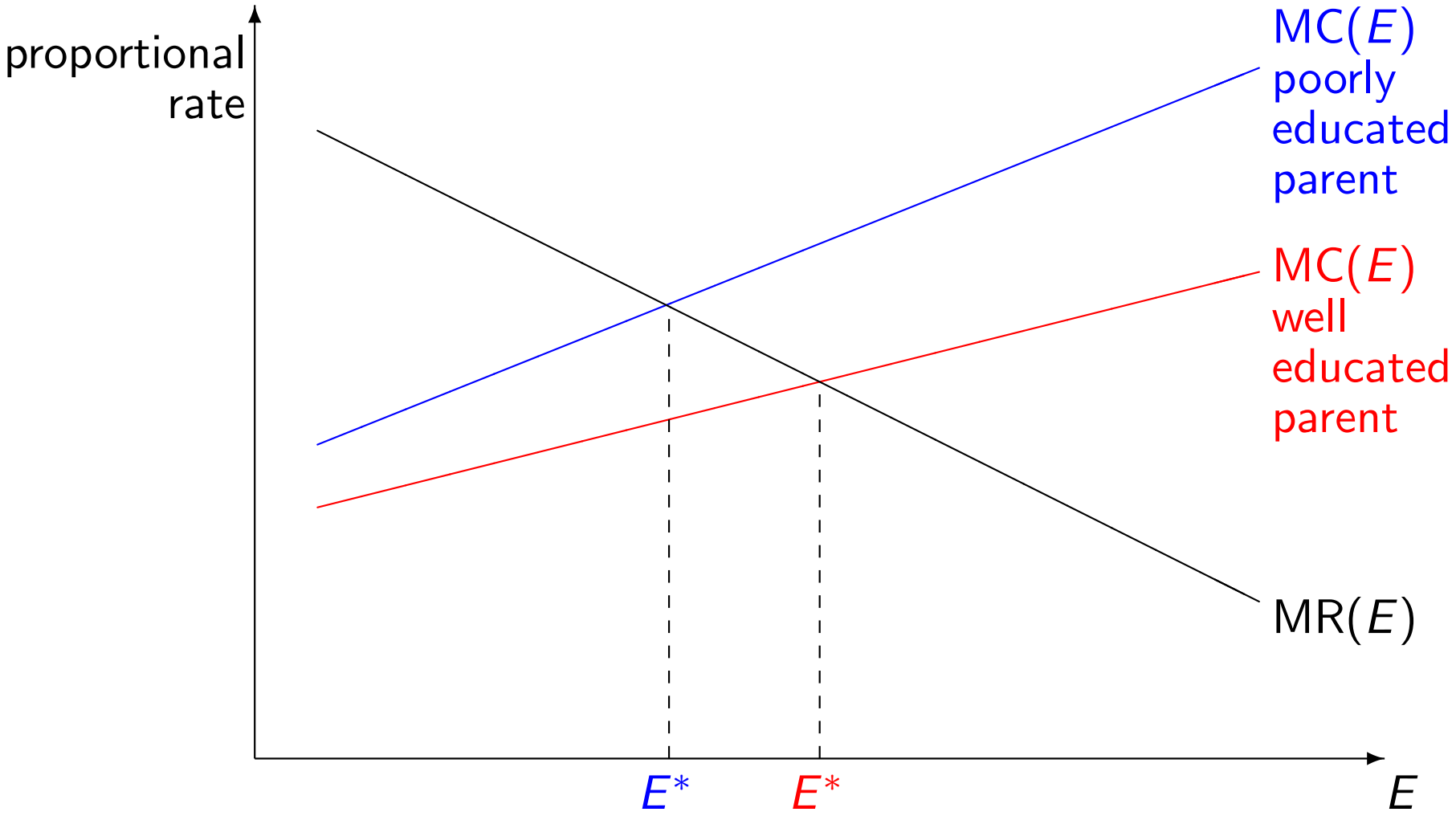
3. Benchmark Model

- MC(E) is likely increasing in E
- It is decreasing in parental education P
  - This is true because P is negatively correlated with $\frac{\lambda_0}{\lambda_1}$
- MC(E) is also possibly decreasing in Q
- One simple function form has

$$\text{MC}(E) = \delta_0 + \delta_E E + \delta_Q Q + \delta_P P + \xi$$

- More prosperous families have a lower MC

Figure: Link between Parental and Child Education



- So in our setup

$$E = \beta_0 + \beta_Q Q + \beta_P P + \eta,$$

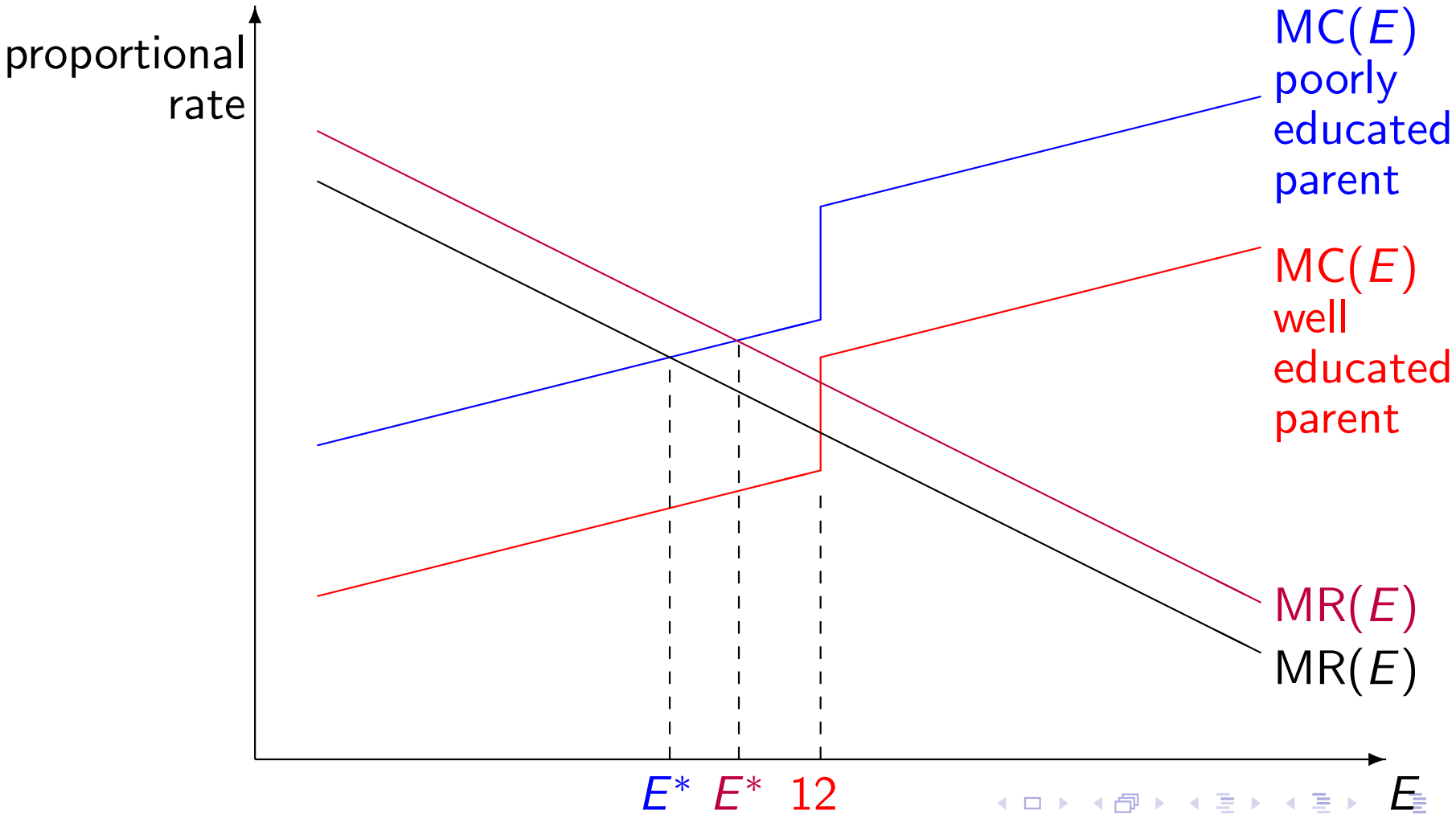
with $\beta_Q > 0$ and $\beta_P > 0$

- We expect to observe
  1. **Educational attainment is "inherited" from parents**
  2. **The availability of higher quality schools leads to a shift in the mapping from parent's education to child's education**

3. Benchmark Model

- A more nuanced prediction arises if the marginal cost function jumps discontinuously (e.g., at the end of high school)
- This case is illustrated on the next slide
  - Improvements in school quality *reduce* educational inequality in the next generation

Figure: An Increase in School Quality (Shift in MR) Can Disproportionately Affect Children of Poorly Educated Parents



3. Benchmark Model

- A general way to allow for differential effects of school quality across different parental-education groups is to estimate

$$E = \beta_0 + \beta_1 Q + \eta$$

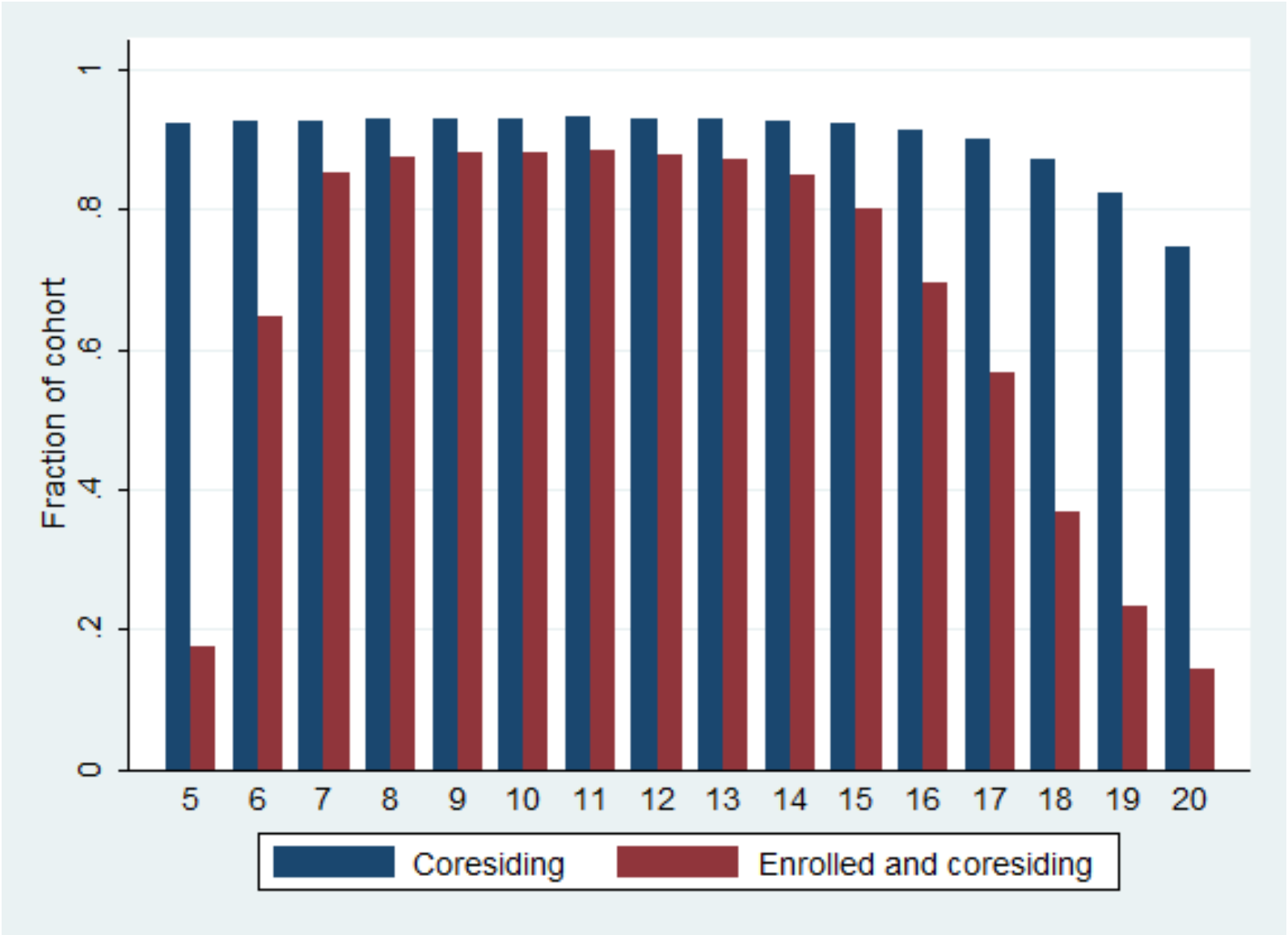
  separately by parental education bins
  - This is feasible (for whites especially) because we have millions of families
- **We are interested to see if there is a "leveling up" effect**
  - If so β_1 will be larger in families with low parental education P

4. Empirical Strategy

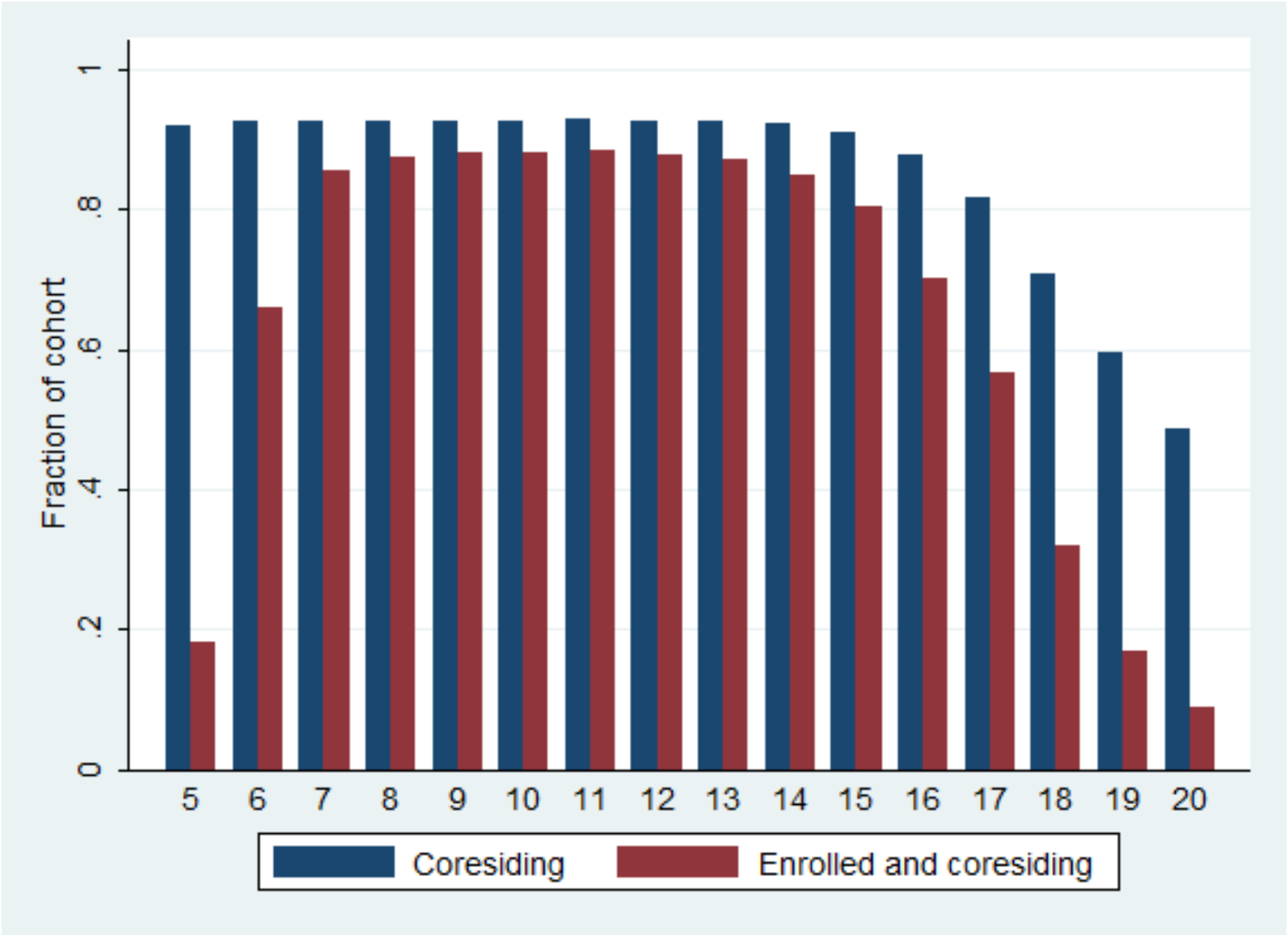
Turning to the 1940 Census data

- We study educational outcomes among children aged 14–18 who live with at least one parent
- In regressions our samples are formed with
  - Sons aged 14–18
  - Daughters aged 14–16
- "Parental education" is defined to be grades completed by the best-educated parent

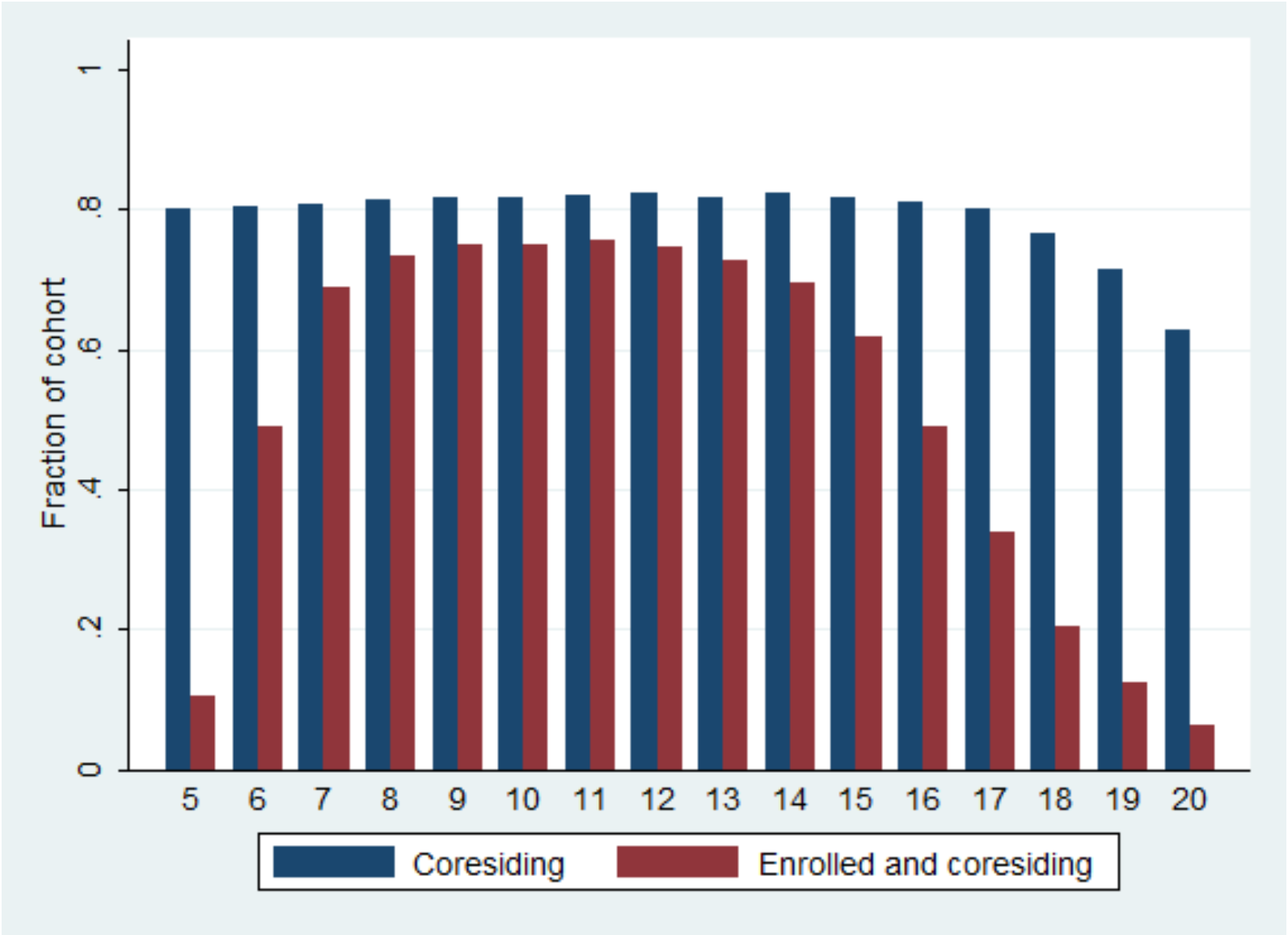
4. White Sons Aged 5–20



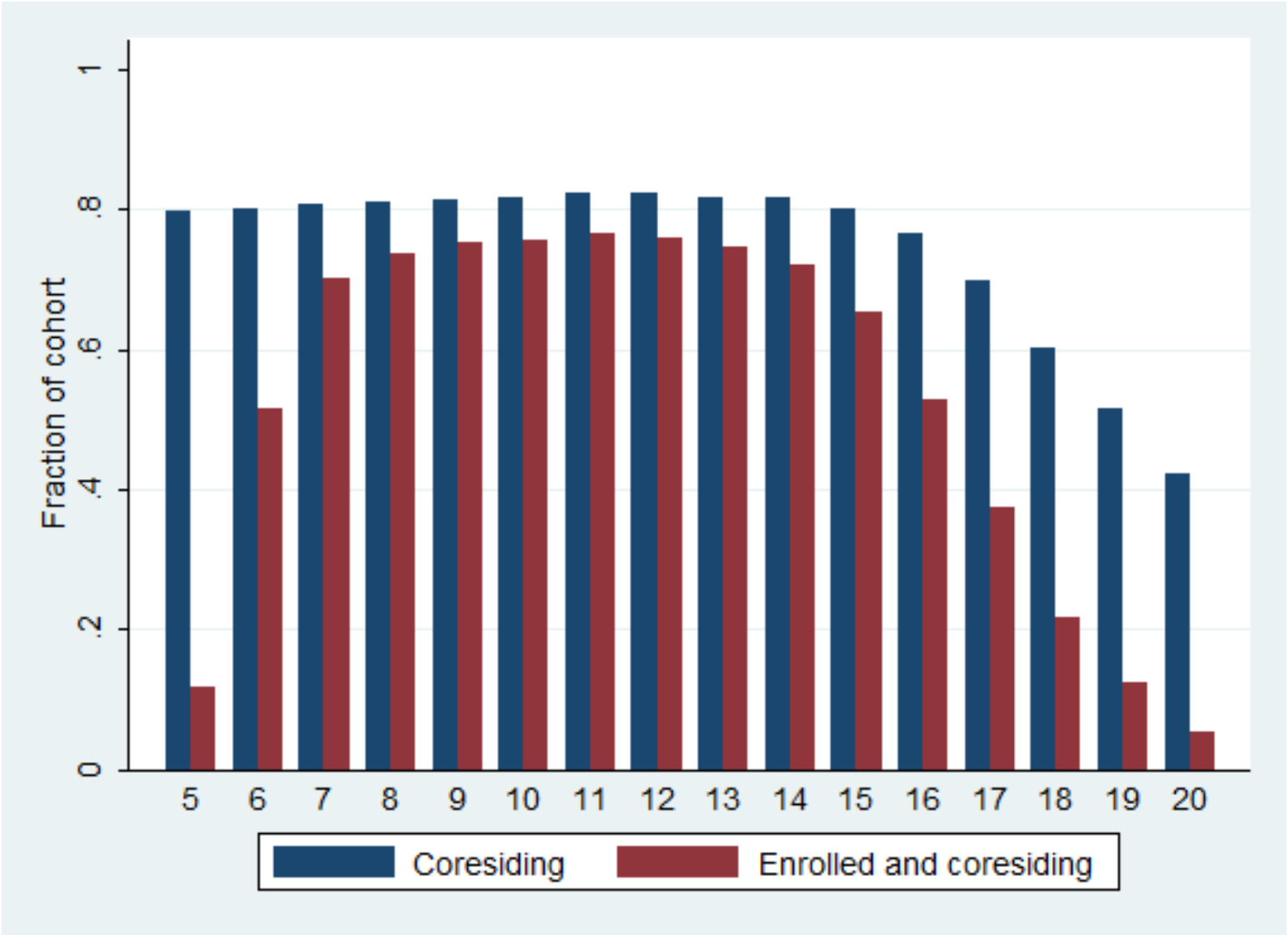
4. White Daughters Aged 5–20



4. Black Sons Aged 5–20



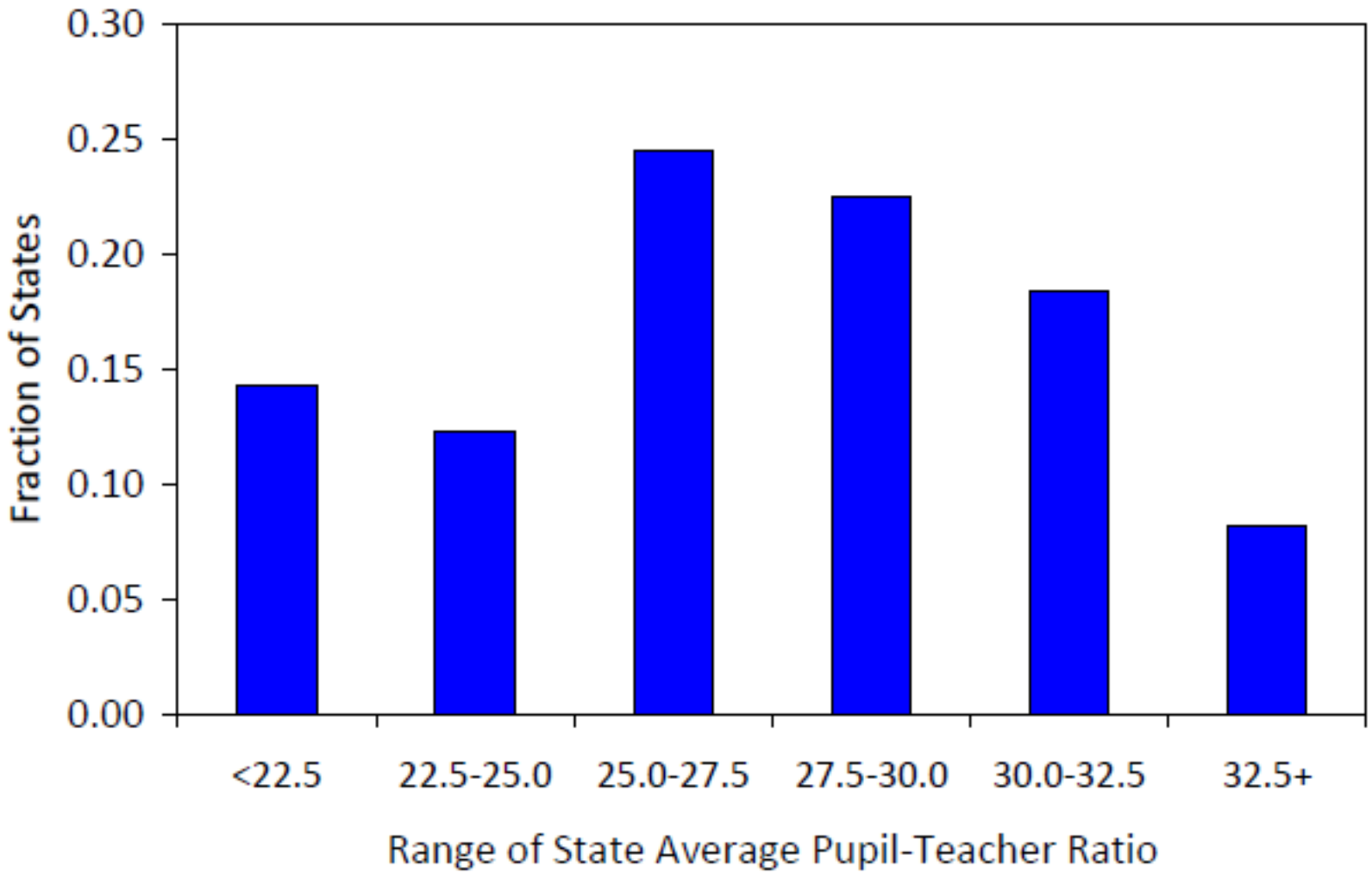
4. Black Daughters Aged 5–20



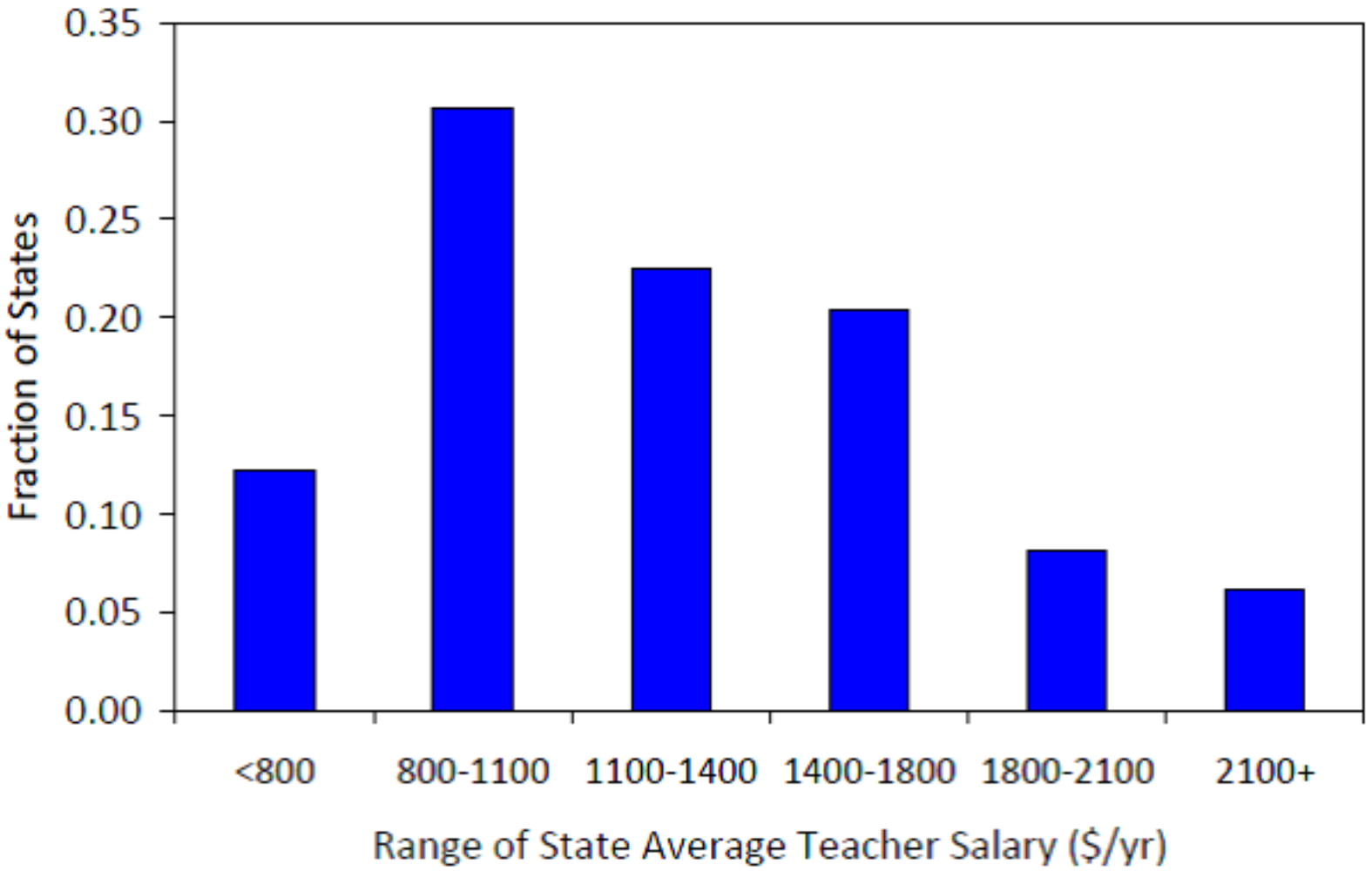
4. State Variation in Upward Mobility and School Quality

- Our goal is to see if upward mobility in education is related to school quality
- Card and Krueger (1992a, 1992b) assemble three measures of school quality
  - Pupil-teacher ratio
  - Teacher salaries
  - Term length
- We use the *pupil-teacher ratio* and *teacher salaries*

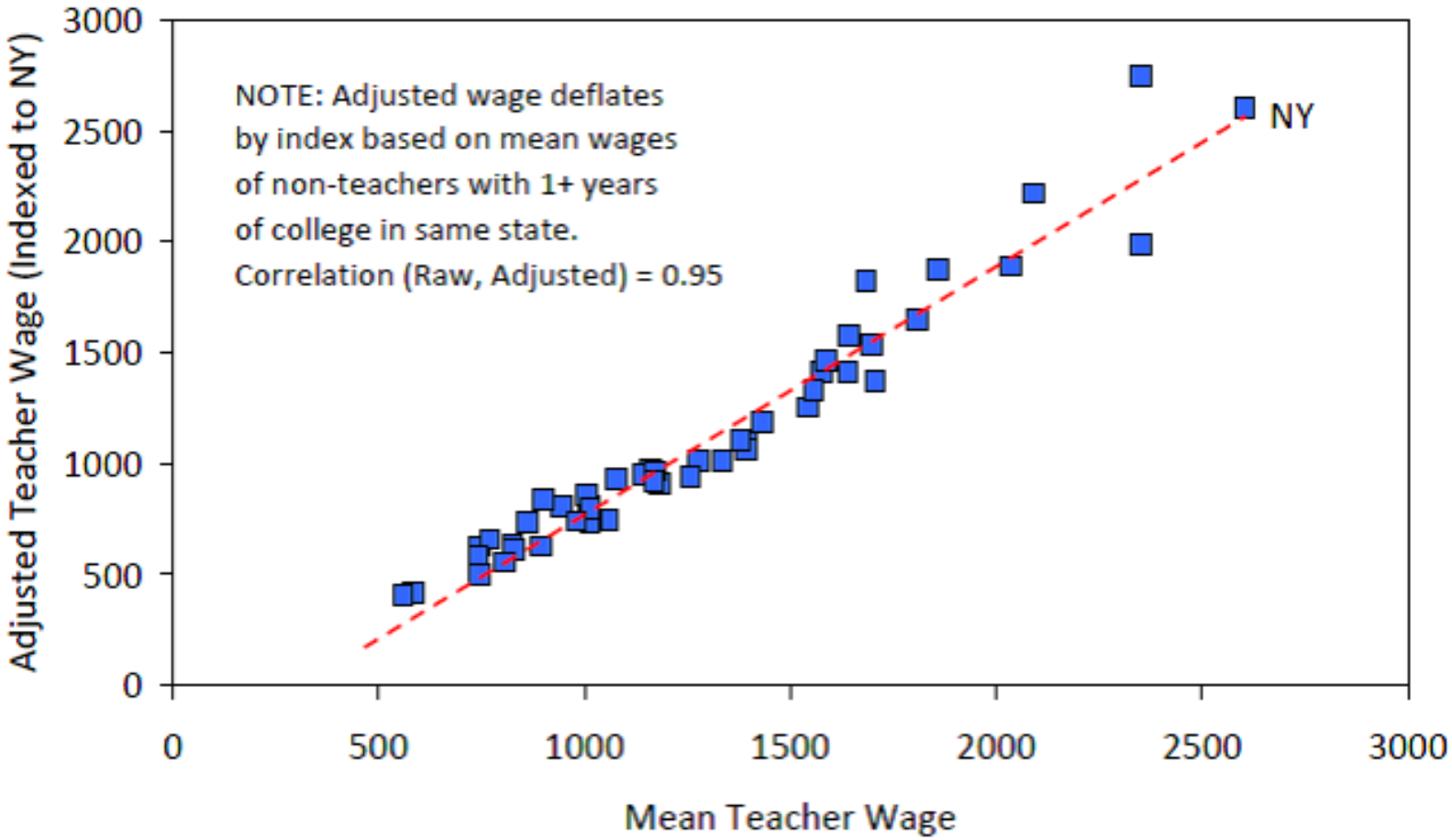
4. Distribution of Pupil-Teacher Ratio



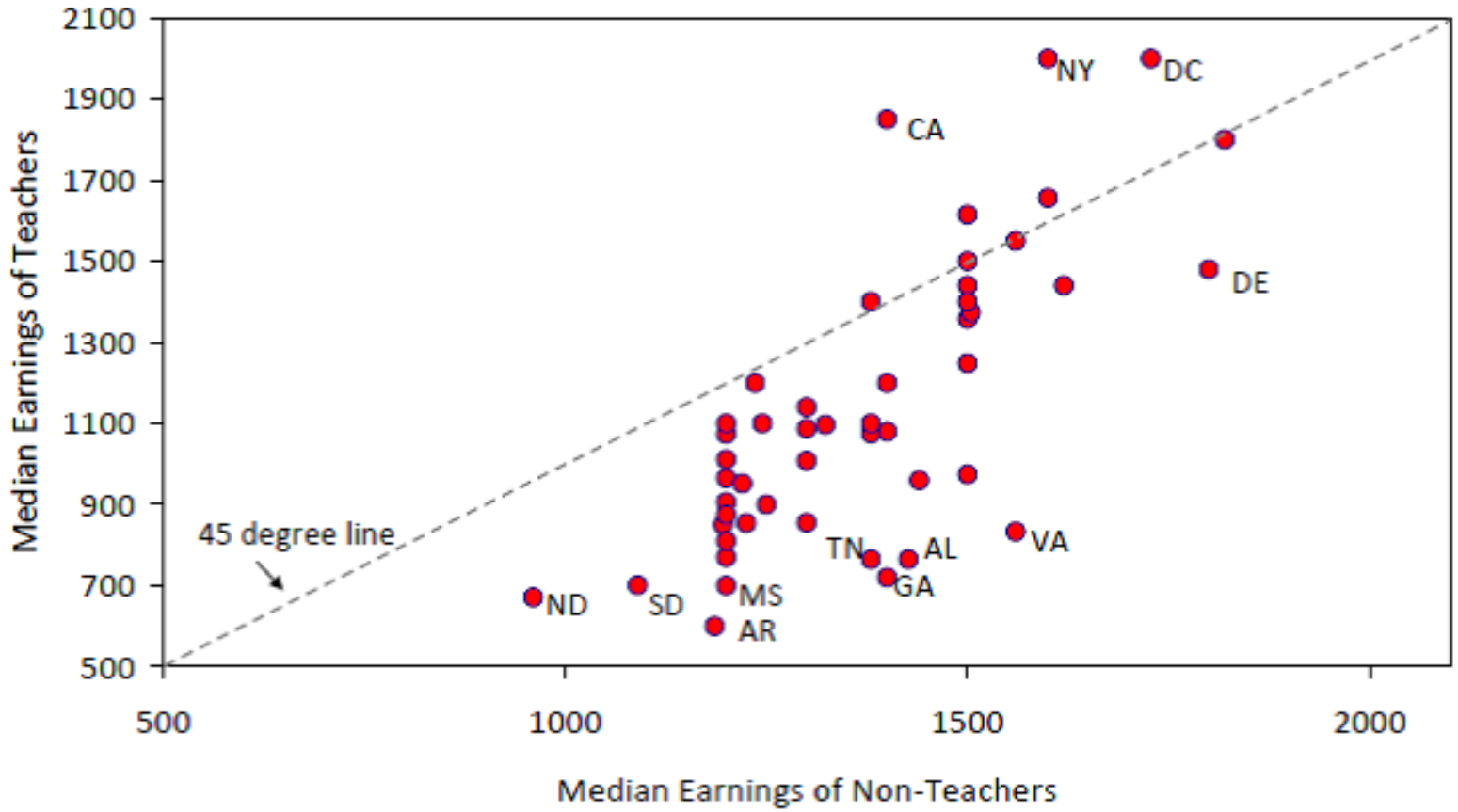
4. Distribution of Teacher Salaries



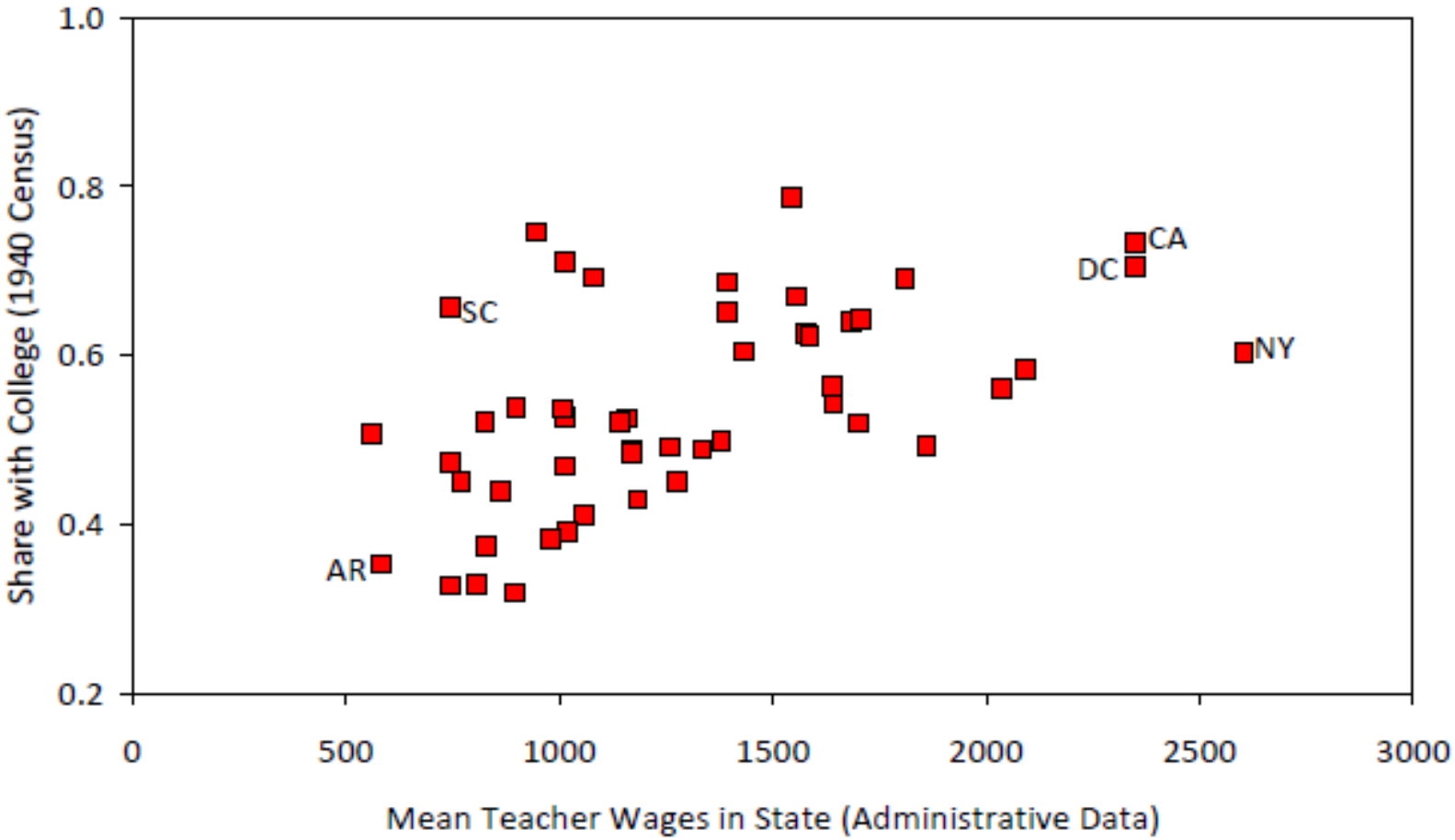
4. Relationship between Mean Teacher Wages and Adjusted Wages



4. Relationship between Teacher and Non-Teacher Earnings, Whites Only, with One or More Years of College



4. Relationship between Teacher Salaries (Administrative Records) and College Degree Attainment (Census)

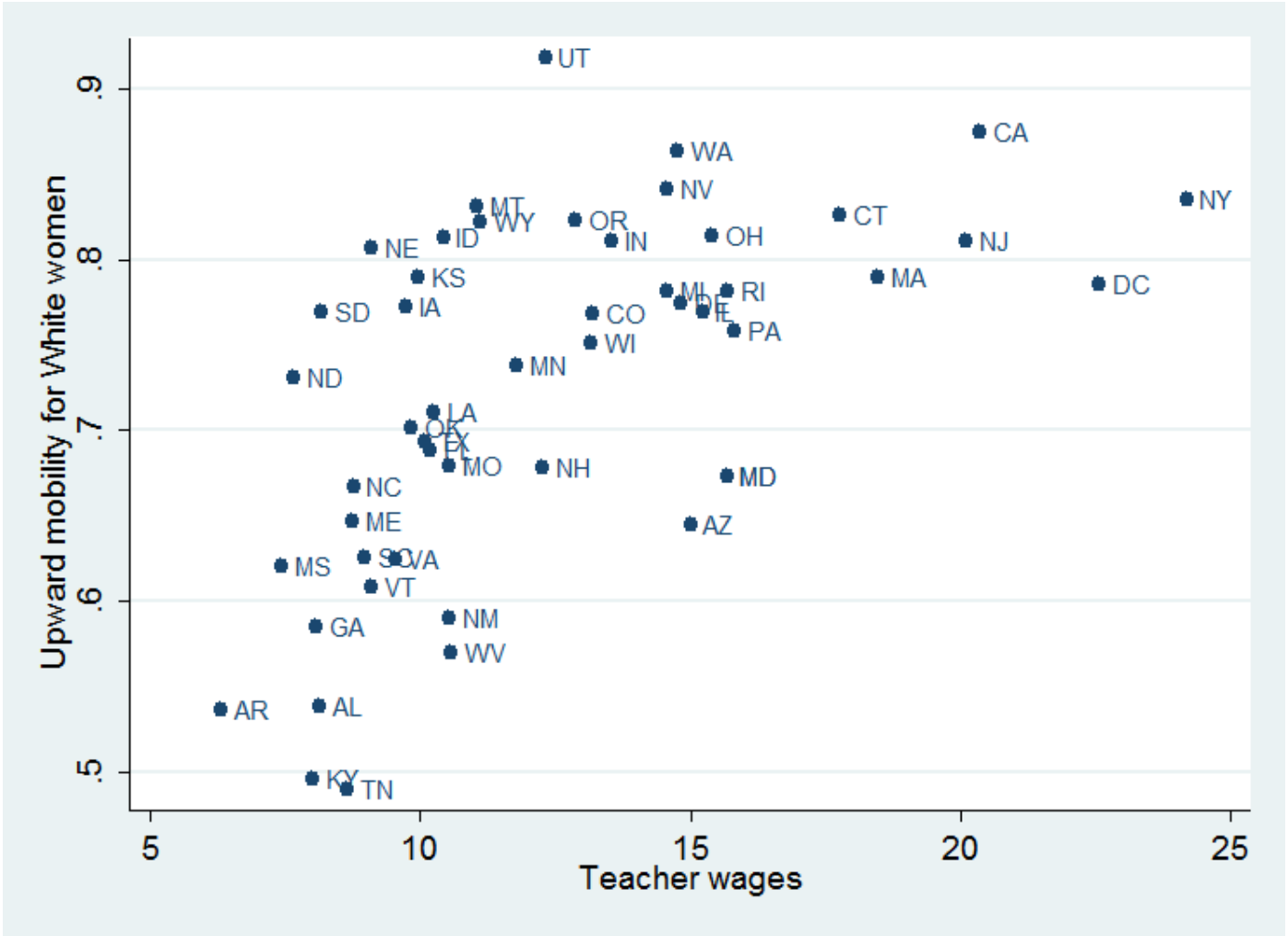


4. State-Level Analysis

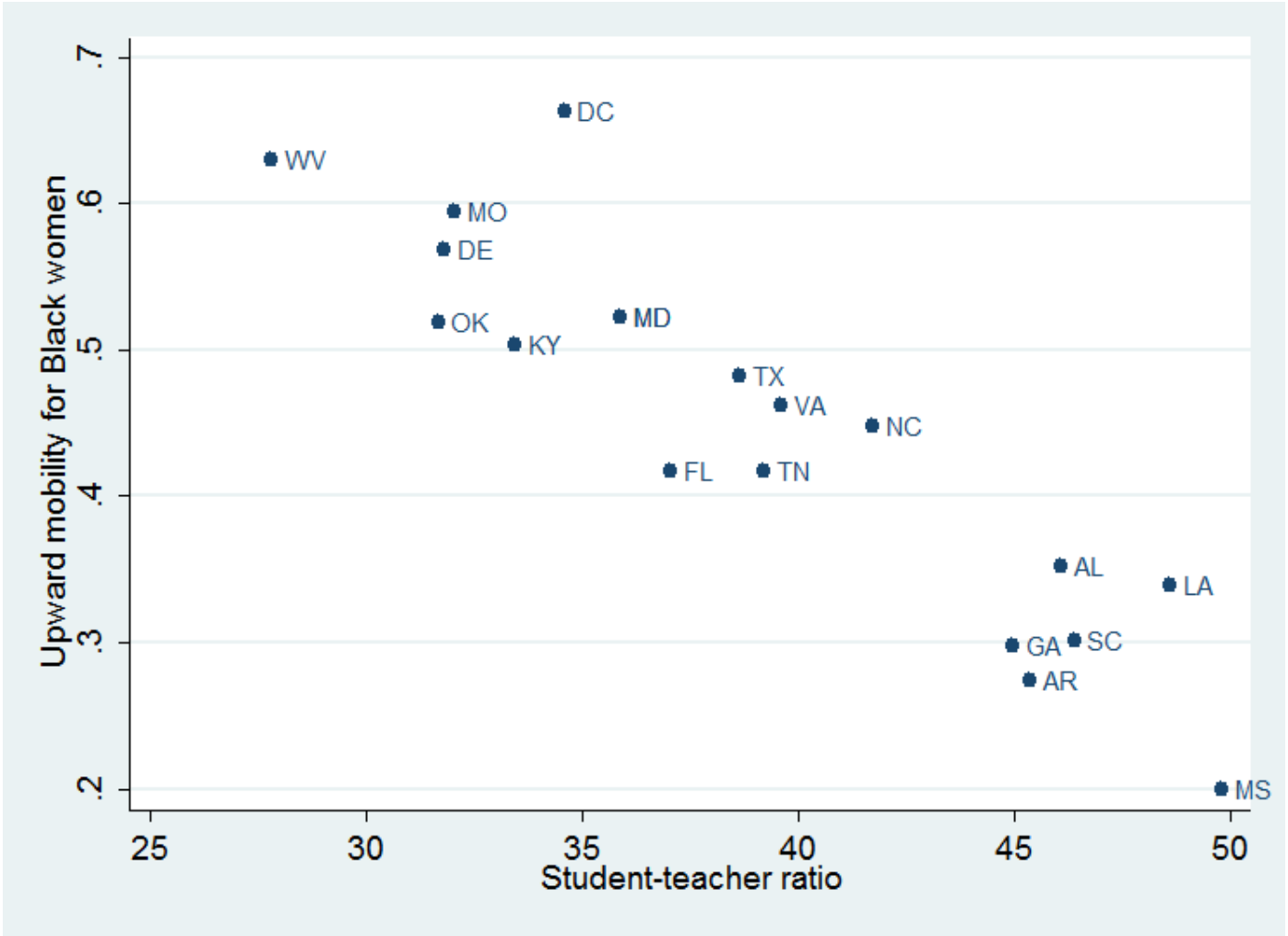
- Let's begin by looking at scatter plots
- Then we'll proceed with some regression analysis

4. Upward Mobility and School Quality Scatter Plots, White Daughters

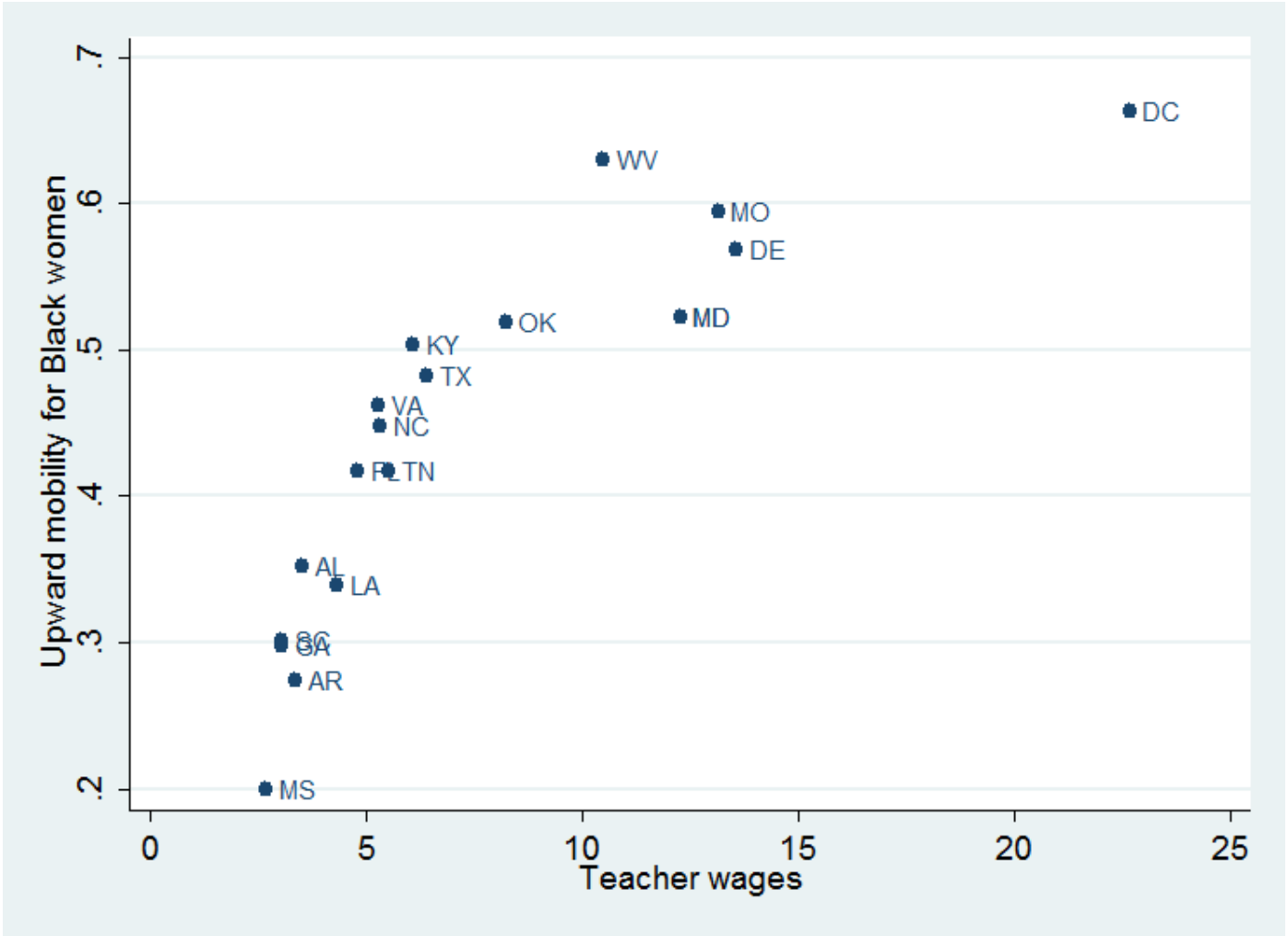
4. Upward Mobility and School Quality Scatter Plots, White Daughters



4. Upward Mobility and School Quality Scatter Plots, Black Daughters



4. Upward Mobility and School Quality Scatter Plots, Black Daughters



4. Regression Analysis

We form narrow "parental education bins" and then for each bin we use a two step procedure (separately for daughters and sons)

- **Step 1** is a Tobit model of educational attainment for children in parental education group g

$$E^*_{ig} = A_{ig}\alpha_{Ag} + C_{ig}\alpha_{Cg} + \alpha_{s(i)g} + u_{ig},$$

- A is a vector of child age dummy variables
- C are additional family-level control variables
  - Indicator variables for *only mother present*, *only father present*, *both parents born in a different state*, *one parent born in a different state*, *urban area*, *living on a farm*, *parents' age*, and *parent's education*
- α_{sg} **are state s effects for group g**
  - These indicate the extent to which state-level contextual factors are associated with educational attainment
- **Step 2** explores the relationship between state effects and measures of school quality

4. Regression Analysis

- In step 2 our independent variables are the pupil-teacher ratio (PT_{sg}) and the average teacher wage W_{sg} (in \$100s)

$$\hat{\alpha}_{sg} = \pi_{0g} + PT_s\pi_{PTg} + W_s\pi_{Wg} + \varepsilon_{sg}$$

- We use weighted least squares
- We estimate our regressions separately by fairly narrow parental education bins
  - We expect school quality to be particularly important for children of poorly-educated parents
- For whites sample size is 49, and for blacks it is 17 (Southern states only)

4. Education and School Quality, White Families

	Models (1) and (2)		Model (3)		Model (3) with Covariates	
Parent Educ.	P-T Ratio	Teacher Salary	P-T Ratio	Teacher Salary	P-T Ratio	Teacher Salary
A. Daughters						
0–4	-0.189***	0.307***	-0.113***	0.273***	-0.063*	0.231***
	(0.039)	(0.030)	(0.034)	(0.029)	(0.033)	(0.059)
5–8	-0.117***	0.180***	-0.084***	0.160***	-0.036*	0.137***
	(0.034)	(0.025)	(0.025)	(0.019)	(0.021)	(0.031)
9–12	-0.050***	0.071***	-0.041***	0.066***	-0.018	0.047**
	(0.017)	(0.014)	(0.014)	(0.012)	(0.013)	(0.017)
> 12	-0.007	0.018	-0.005	0.018	0.002	0.004
	(0.016)	(0.014)	(0.015)	(0.013)	(0.014)	(0.020)
B. Sons						
0–4	-0.232***	0.303***	-0.155***	0.254***	-0.107***	0.259***
	(0.033)	(0.034)	(0.027)	(0.032)	(0.030)	(0.057)
5–8	-0.152***	0.190***	-0.116***	0.162***	-0.068***	0.169***
	(0.026)	(0.027)	(0.016)	(0.023)	(0.016)	(0.031)
9–12	-0.060***	0.087***	-0.050***	0.080***	-0.019**	0.082***
	(0.014)	(0.016)	(0.010)	(0.014)	(0.009)	(0.014)
> 12	0.006	0.020**	0.008	0.021**	0.020**	0.015
	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)	(0.015)

4. Education and School Quality, Black Families

	Model (1) and (2)		Model (3)		Model (3) with Covariates	
Parent Educ.	P-T Ratio	Teacher Salary	P-T Ratio	Teacher Salary	P-T Ratio	Teacher Salary
A. Daughters						
0–4	-0.131***	0.211***	-0.072***	0.121***	-0.068**	0.186**
	(0.021)	(0.037)	(0.028)	(0.031)	(0.028)	(0.070)
5–8	-0.107***	0.208***	-0.072***	0.068*	-0.067*	0.112*
	(0.017)	(0.031)	(0.027)	(0.036)	(0.032)	(0.057)
> 8	-0.104***	0.129***	-0.082**	0.040	-0.076*	0.061
	(0.016)	(0.028)	(0.027)	(0.027)	(0.036)	(0.067)
All	-0.145***	0.211***	-0.091**	0.105**	-0.085*	0.181*
	(0.023)	(0.037)	(0.036)	(0.042)	(0.039)	(0.084)
B. Sons						
0–4	-0.132***	0.211***	-0.070**	0.125**	-0.061**	0.220**
	(0.022)	(0.038)	(0.029)	(0.040)	(0.024)	(0.080)
5–8	-0.116***	0.168***	-0.072**	0.084**	-0.056**	0.179**
	(0.019)	(0.038)	(0.026)	(0.027)	(0.024)	(0.069)
> 8	-0.116***	0.151***	-0.078**	0.067*	-0.066	0.126
	(0.018)	(0.031)	(0.029)	(0.035)	(0.042)	(0.087)
All	-0.150***	0.223***	-0.086**	0.122**	-0.071*	0.234**
	(0.026)	(0.042)	(0.036)	(0.045)	(0.036)	(0.096)

4. Education and Teacher Wages (2SLS), White Families

There are 23 states with minimum teacher wage, which we use as an instrument:

Parental Education	OLS	2SLS	Partial F-Stat	n
A. White Daughters				
Grades 0–4	0.300***	0.293***	111.7	23
	(0.036)	(0.129)		
Grades 5–8	0.196***	0.200***	100.4	23
	(0.032)	(0.136)		
Grades 9–12	0.089***	0.102***	88.8	23
	(0.018)	(0.021)		
$>$ 12 Grades	0.031**	0.035***	87.5	23
	(0.019)	(0.016)		
B. White Sons				
Grades 0–4	0.287***	0.288***	118.7	23
	(0.036)	(0.040)		
Grades 5–8	0.192***	0.209***	96.6	23
	(0.030)	(0.033)		
Grades 9–12	0.093***	0.114***	77.2	23
	(0.019)	(0.021)		
$>$ 12 Grades	0.029**	0.033***	78.0	23
	(0.012)	(0.016)		

4. Education and Teacher Wages (2SLS), Black Families

There are 10 states with minimum teacher wage, which we use as an instrument:

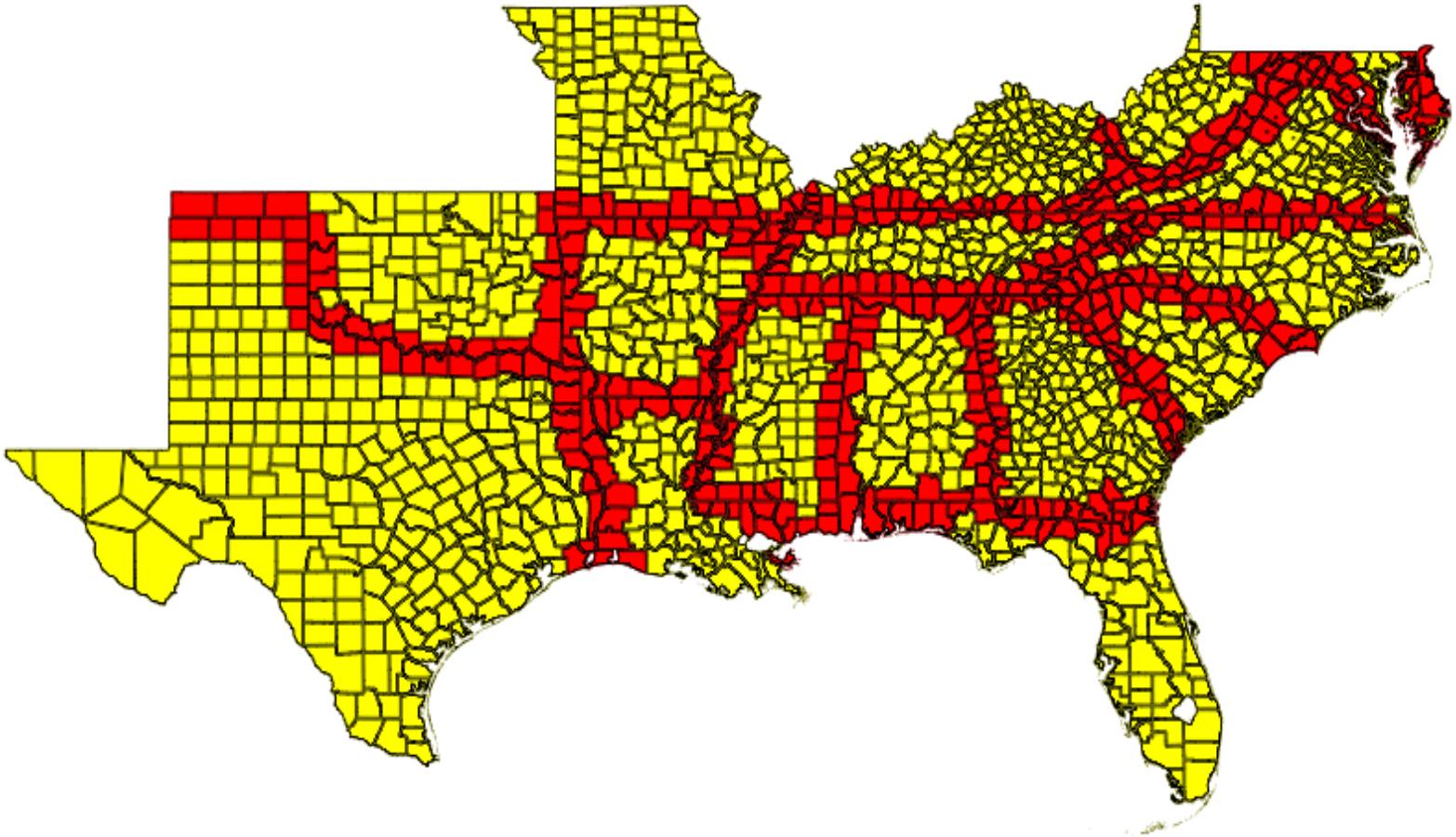
Parental Education	OLS	2SLS	Partial F-Stat	n
C. Black Daughters				
0–4 Grades	0.220**	0.253***	32.2	10
	(0.065)	(0.068)		
5–8 Grades	0.170**	0.222***	33.3	10
	(0.072)	(0.061)		
$>$ 8 Grades	0.179**	0.226***	35.5	10
	(0.081)	(0.058)		
D. Black Sons				
Grades 0–4	0.249***	0.282***	28.9	10
	(0.070)	(0.064)		
Grades 5–8	0.211***	0.255***	30.8	10
	(0.075)	(0.054)		
$>$ 8 Grades	0.192*	0.262***	35.9	10
	(0.081)	(0.067)		

5. Black Teacher Wages and Educational Attainment

- We've seen that in black families in the South educational attainment is strongly associated with teacher salaries
- What was the source of state-level variation in teacher salaries in the South?
  - Early in the 20th century many states adopted state education equalization policies
    - Several states mandated minimum teacher salaries
    - Minimum salaries were generally lower for black teachers
  - Horace Mann Bond (1932, 1934) argues that policies were chosen largely to satisfy white land owners
- With this in mind we turn to an analysis of educational attainment along state borders in the South

5. Black Teacher Wages and Educational Attainment

- We proceed with a border-county analysis of Deep South states and surrounding states



5. Black Teacher Wages and Educational Attainment

- Minimum annual salaries appeared in many Southern states—starting as early as 1882
- Some examples:

	Black Teachers		White Teachers	
	Border County Earnings (Census)	Minimum Salary	Border County Earnings (Census)	Minimum Salary
Alabama	412	262.50	784	350
Delaware	1003	1000	1189	1000
Georgia	458	175	831	280
Kentucky	628	525	737	525
Maryland	776	585	1208	1000
Mississippi	280	80	751	–
N. Carolina	687	504	911	656
Oklahoma	704	585	847	585
Tennessee	676	320	859	320
W. Virginia	982	585	1024	585

5. Black Teacher Wages and Educational Attainment

- We have 208 border county pairs, 28 state border segments
- We study differences in educational outcomes for children in the border county pairs
  - e.g., "upward mobility"—fraction of 16–18 year olds attaining 9th grade in families with parental education is 5–8
- Example: Counties along the Alabama-Florida border

State Border	Education of Adults		Farm	Urban	Mean Income		Upward Mobility	
	White	Black			White	Black	White	Black
Alabama	7.68	4.63	0.55	0.13	619	310	0.44	0.17
Florida	7.44	4.82	0.45	0.12	642	330	0.47	0.31
AL-FL Gap	0.24	-0.19	0.09	0.01	-23	-20	-0.03	-0.14

5. Black Teacher Wages and Educational Attainment

- Model 1: Construct Δy_p from estimated county-level dummies in a Tobit educational attainment equation, and then estimate

$$\Delta y_p = \pi_0 + \Delta W_p \pi_W + \Delta X_p \pi_X + \epsilon_p,$$

  where ΔW_p is the with-pair difference in average teacher wages for border pair p, and ΔX_p is a vector of within-pair differences in a set of controls, including
  - fraction urban
  - fraction on farm
  - average parental income
  - average parental education
  - average education of adult whites (aged 25–55)
  - Rosenwald coverage
- Model 2: Use a similar approach but construct Δy_p from county-level dummies in a linear probability model of *9th grade attainment* among 16–18 year olds

5. Black Teacher Wages and Educational Attainment

- We proceed with OLS and with 2SLS
  - Our instrument is based on state-mandated minimum salary standards
    - *State Minimum Salary Standards, 1940* (National Education Association of the US)
  - For states that did not have a statutory minimum salary, we treated the 10th percentile as the "effective minimum"

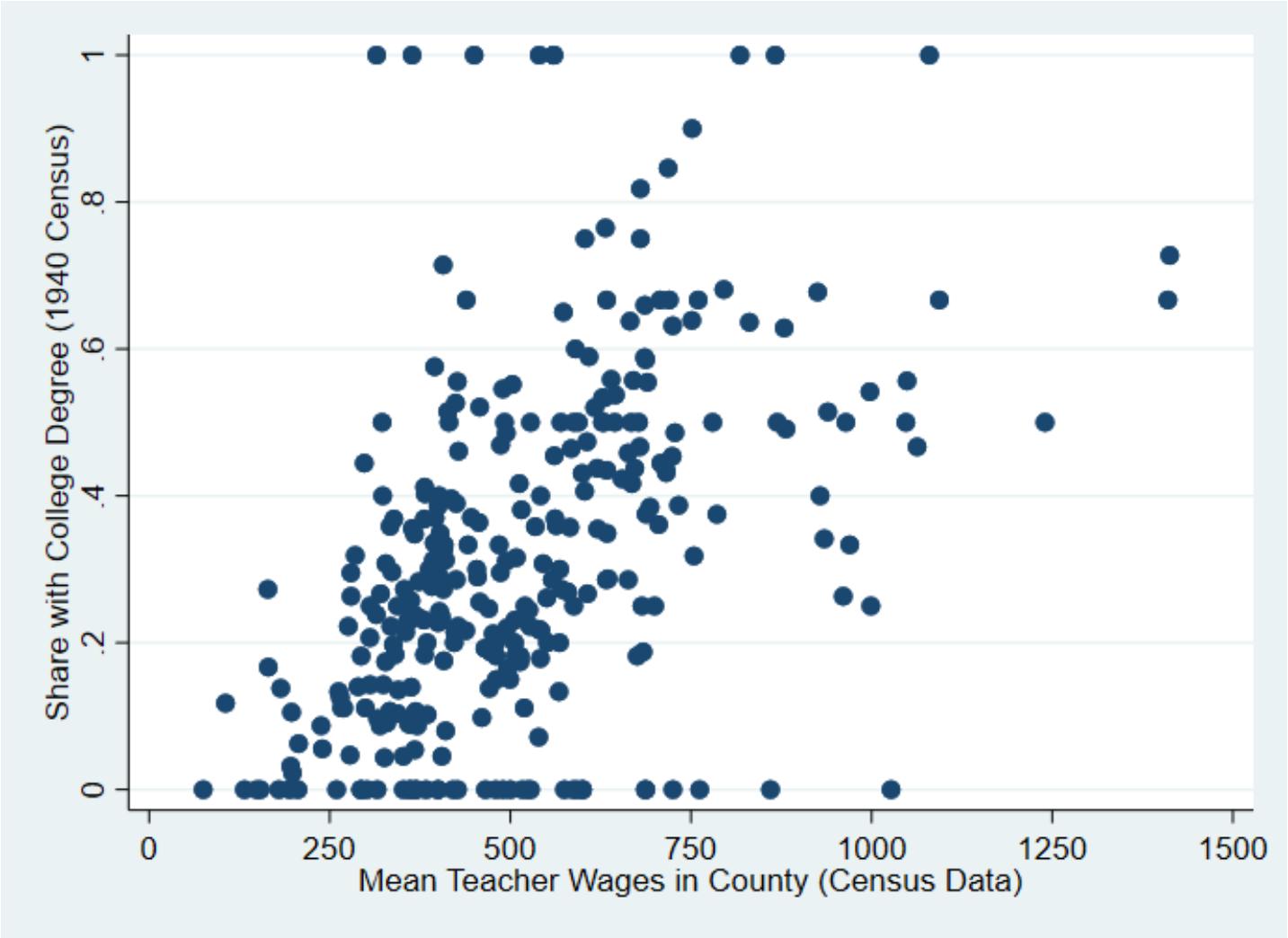
5. Black Teacher Wages and Educational Attainment

	OLS	First Stage	Reduced Form	2SLS	F-Stat	n	n_c
A. Effects on Years of Schooling							
1. Baseline	0.285***	0.800***	0.265***	0.331***	66.8	207	28
	(0.057)	(0.097)	(0.061)	(0.064)			
2. Rural Areas	0.327***	0.814***	0.295***	0.362***	65.9	206	28
	(0.074)	(0.100)	(0.076)	(0.080)			
B. Effects on 9th Grade Attainment							
1. Baseline	0.012**	0.845***	0.012	0.014*	69.0	208	28
	(0.005)	(0.102)	(0.008)	(0.009)			
2. Rural Areas	0.010	0.860***	0.016*	0.018**	66.4	207	28
	(0.007)	(0.105)	(0.008)	(0.009)			

5. White Teacher Wages and Educational Attainment

	OLS	First Stage	Reduced Form	2SLS	F-Stat	n	n_c
A. Effects on Years of Schooling (Parental Education 0-4 Grades)							
1. Baseline	0.149**	0.477***	0.114**	0.238**	31.4	269	32
	(0.059)	(0.085)	(0.053)	(0.110)			
2. Rural Areas	0.138***	0.483***	0.111**	0.231**	32.3	269	32
	(0.059)	(0.085)	(0.053)	(0.103)			
C. Effects on 9th Grade Attainment (Parental Education 5–8 Grades)							
1. Baseline	0.009**	0.477***	0.012**	0.027**	29.1	270	32
	(0.004)	(0.088)	(0.005)	(0.010)			
2. Rural Areas	0.009*	0.486***	0.014***	0.029***	31.2	269	32
	(0.005)	(0.087)	(0.005)	(0.010)			

5. Teacher Compensation and Teacher Qualification (Black Teachers)



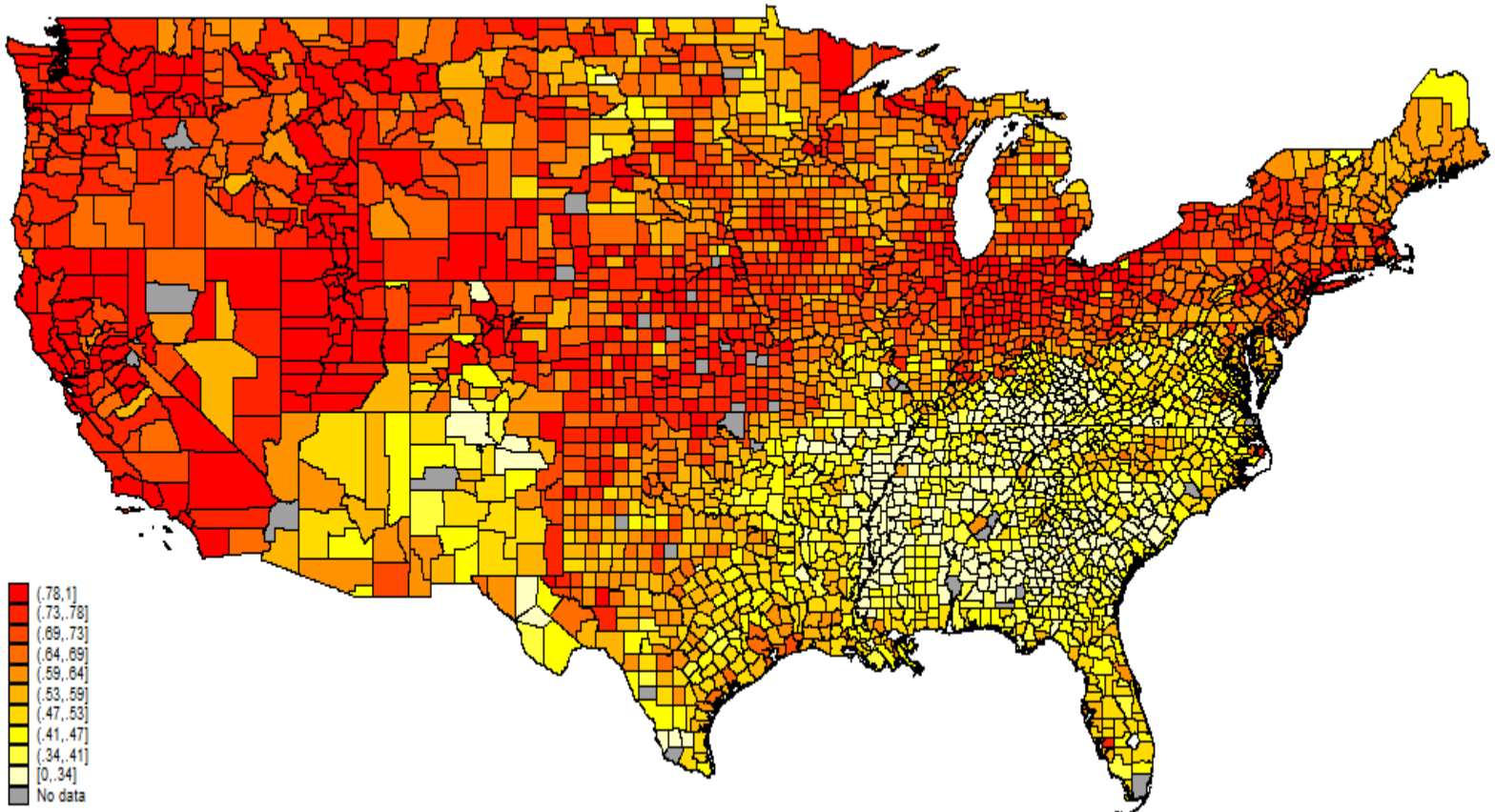
5. Teacher Compensation and Teacher Qualification (White Teachers)

Observations about Our Paper

- We find evidence that upward mobility in human capital is linked to education policy
- In the U.S. circa 1940 there were sharp racial differences in the quality of available public schooling
  - The median black child lived in a state with cost-of-living adjusted salary of black teachers = \$649
  - The corresponding median for whites was \$1727
  - Taking our IV estimate at face value (0.33), this gap results in a disadvantage in completed schooling of 3.5 years
    - Assume an average return of 7%, and note the decline in returns due to low-quality schooling (Card and Krueger 1992a): the disadvantage in annual earnings is 35%
- On a more positive note, high-quality schooling led to big increases in upward mobility in many parts of the county
- County-level maps suggest substantial persistence in forces that shape upward mobility

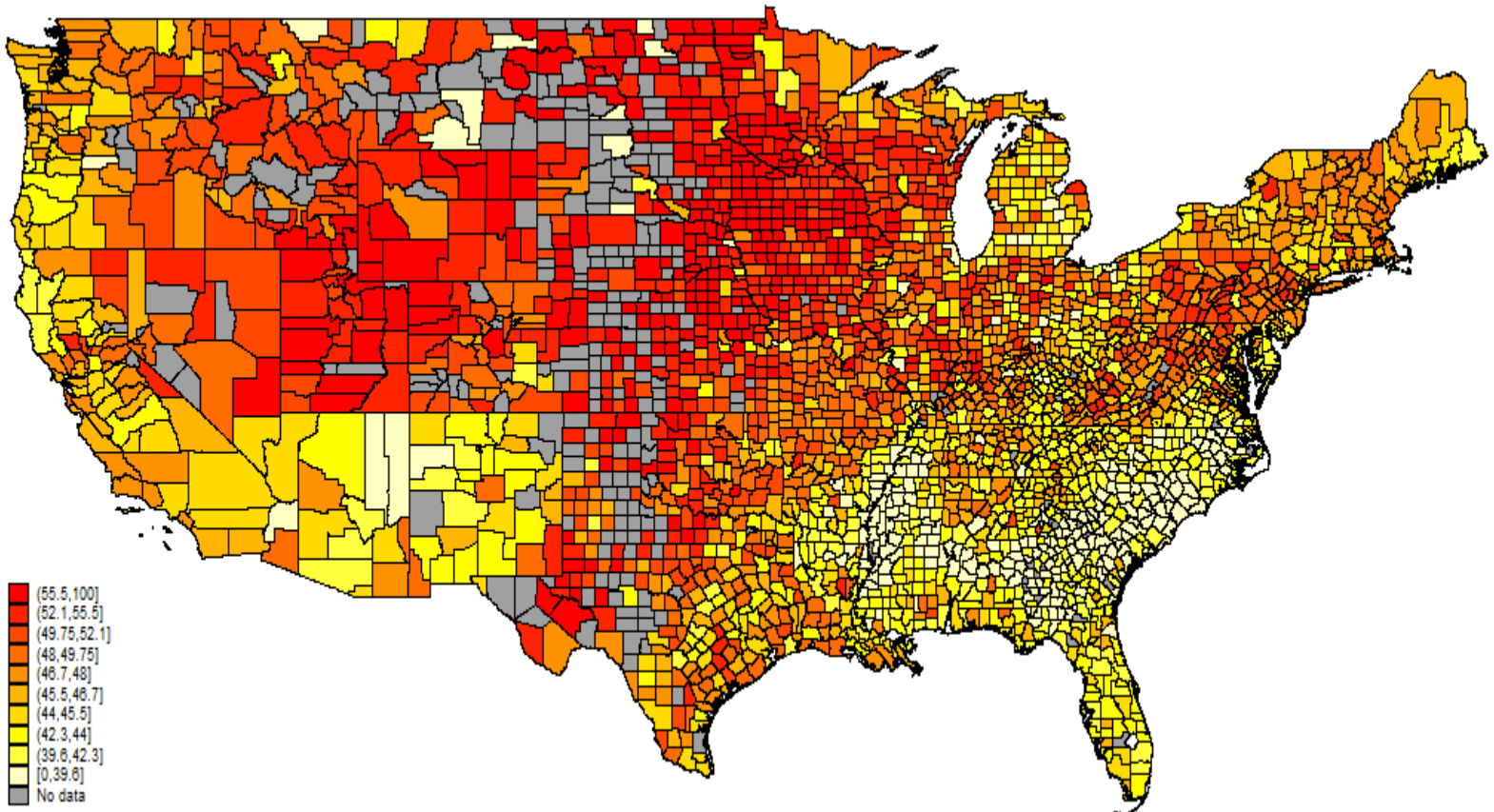
The Geography of Upward Mobility in Education

1922–26 Birth Cohorts



The Geography of Upward Mobility in Income

1980–93 Birth Cohorts (Chetty et al., 2014)



Observations about Our Paper

- We have plenty of work ahead
  - In a project with Seth Sanders, we intend to match 1940 Census data to death records, the CPS, the NHIS, etc. (for the 1922–1940 birth cohorts)
- We appreciate suggestions