Trends and Group Differences in the Association between Educational Attainment and Adult Mortality: Implications for Understanding Education's Causal Influence

REVES 26th Annual Meeting
May 30, 2014

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We gratefully acknowledge financial support from the NICHD (RO1 HD053696 & 5 R24 HD042849), expert data preparation from the National Center for Health Statistics, and the input from former and current members of the PRC Population Health Lab group.

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Key Questions

- Has the *functional form* of the association between educational attainment and U.S. adult mortality changed in recent decades?
- If the functional form has changed, how is it changing and for whom?
- What are the theoretical and practical implications of those changes? (e.g., growing importance of advanced education for gaining “health capital”)

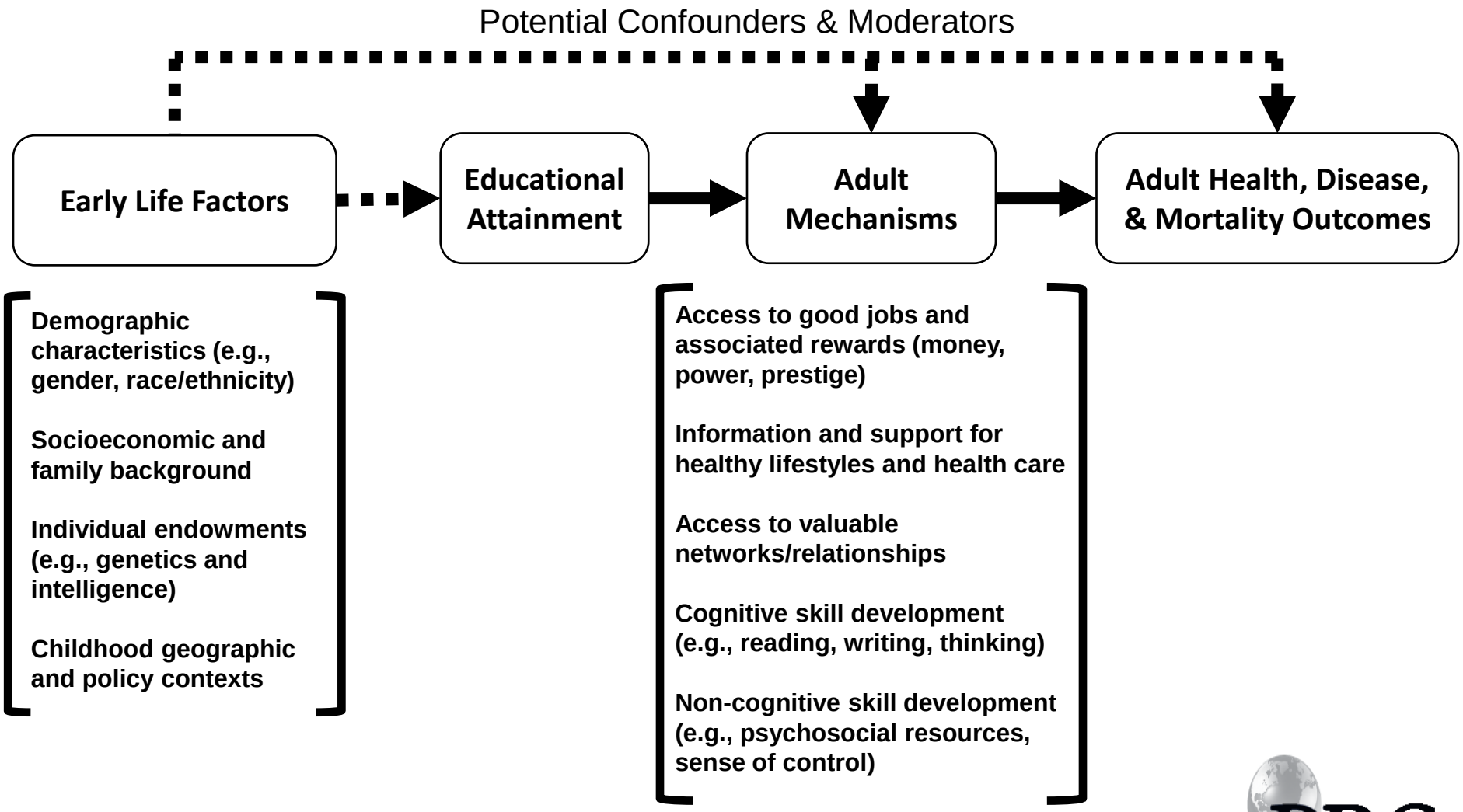
Motivation

Changes in the functional form reflect:

- The types of mechanisms linking educational attainment with mortality
- Whether the association is becoming more/less causal over time
- What types of macro societal conditions may be contributing to changes in the functional form

Most studies *assume* that the association is linear or treat education categorically based on events (e.g., high school graduation)

Conceptual Framework



Theoretical Perspectives

- **Selection**—the education-mortality association is influenced by the characteristics of people who comprise the different levels of education (e.g., negative selection for declining prevalence of high school dropouts)
- **Human Capital**—continuous exposure to education lowers mortality risk by increasing cognitive function, sense of control, access to information, social ties, and problem solving skills
- **Credentialism**—degrees open up opportunities in the labor market that lead to more income and other societal rewards

All three may be operating simultaneously to define the functional form, and may vary over time and across social groups

Macro Societal Changes

The expansion of education in the U.S. population in the latter part of the 20th Century reflects:

- Increasing **social capacity for population health**—the stock of human capital, technological knowledge, and associated institutional resources that individuals have access to and may act on to garner health advantages (Easterlin 1996)
- **Technophysio evolution**—synergistic association between technological and physiological improvements over past 300 years (Fogel & Costa 1997)

Who is most likely to take advantage of dramatic growth in the social capacity for population health?

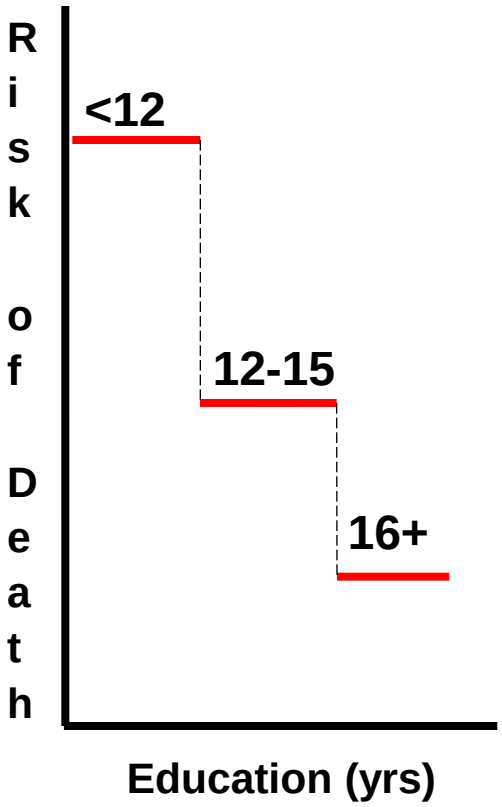
Kitagawa and Hauser (1973)

	Men		Women	
Education (yrs)	**25-64**	**65+**	**25-64**	**65+**
0-4	1.15	1.02	**1.60**	1.17
5-7	1.14	1.00	1.18	1.04
8	1.07	1.00	1.08	1.03
9-11	1.03	0.99	0.91	0.94
12	0.91		0.87	
13-15	0.85	0.98	0.82	**0.70**
16+	**0.70**		**0.78**	

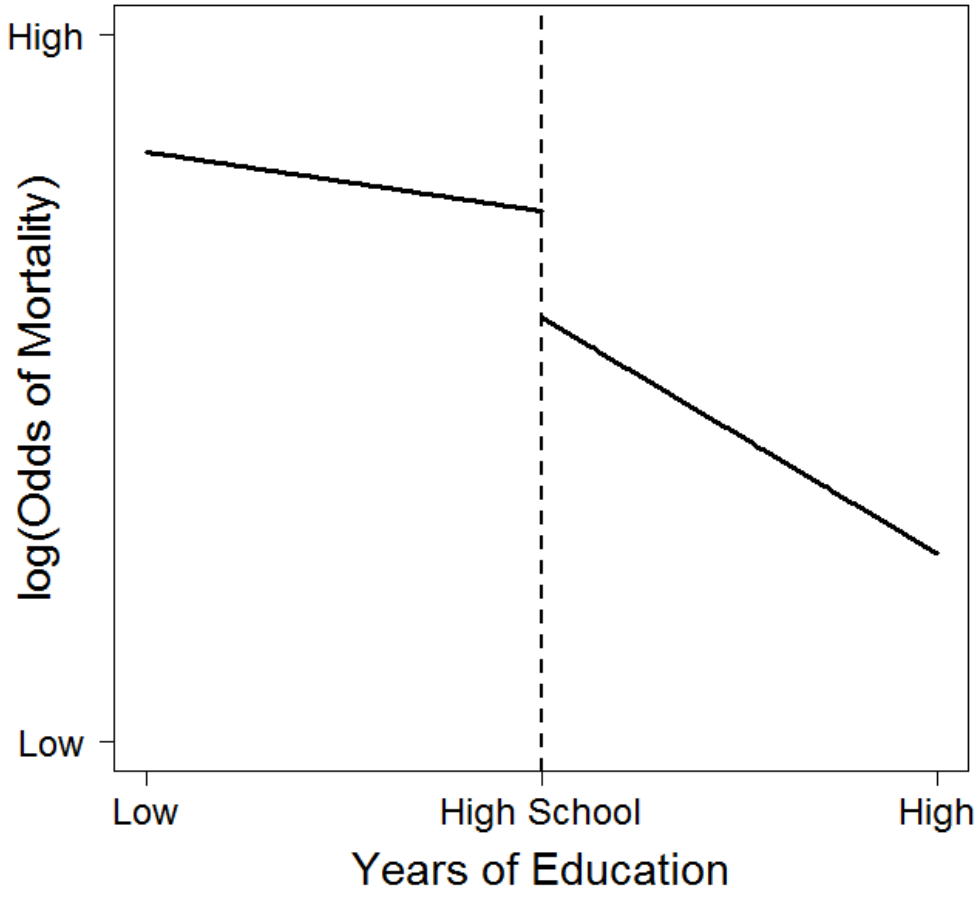
Sex- and age-specific standardized mortality ratios for white men and women by educational attainment, 1960

Backlund et al. (1999)

- Direct test of functional form among working-aged U.S. population centered on 1985
- Found that a three category measure (<12, 12-15, 16+) best predicted adult mortality risk → a credential pattern
- Model included a number of controls; hard to interpret



Montez, Hummer, and Hayward (2012)



- National Longitudinal Mortality Study, 1979-2001, treated as cross-section (centered on 1990)
- Examined group differences in functional form by gender, race, and age group
- Tested 13 different forms: linear only, credentials only (piecewise), and possible combinations

New Analysis of Functional Form

- NHIS-LMF data ranges from 1986-2006, which we split into two periods: 1986-1999 and 2000-2006
- Over 7.4 million person-years and 109,000 deaths
- Focus on NHWs and NHBs aged 45-84
- Evaluate same 13 functional forms as Montez et al. (2012), controlling only for age

(4) $$log\left(\frac{p}{1-p}\right) = b_0 Age + b_1 X_{lths} + b_2 X_{hs} + b_3 X_{sc+co}$$

(13) $$log\left(\frac{p}{1-p}\right) = a + b_0 Age + b_1 X_{ed} + b_2 X_{lths} + b_3 \left(X_{ed} \times X_{lths}\right)$$

- Choose optimal form based on smallest BIC

Figure 1: Log-odds coefficients of the risk of adult mortality by educational attainment, Non-Hispanic Whites 1986-2006 (optimal functional form)

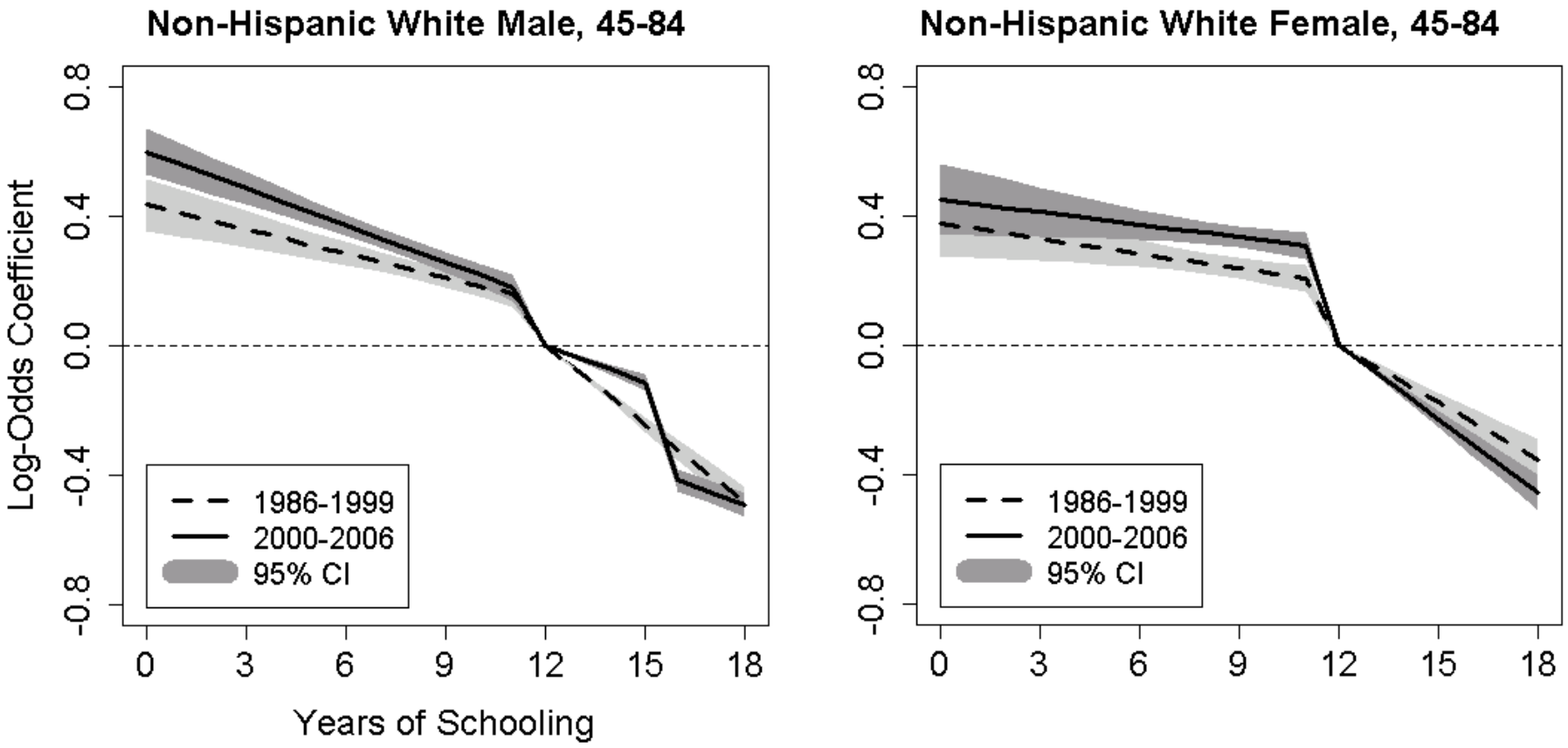
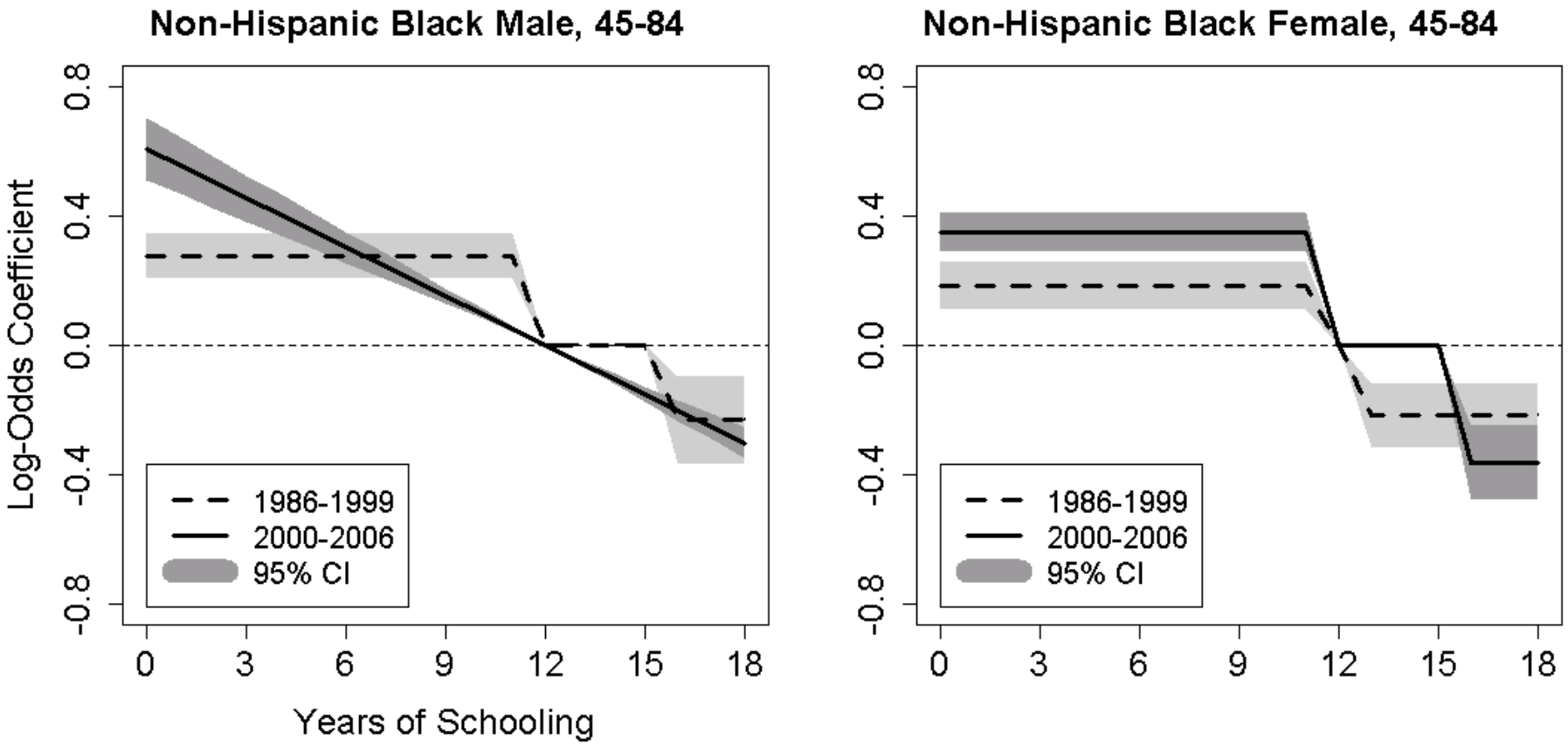


Figure 2: Log-odds coefficients of the risk of adult mortality by educational attainment, Non-Hispanic Blacks 1986-2006 (optimal functional form)



Summary and Implications

- Shallow declines in mortality risk < 12 years (perhaps a little steeper for some groups post 2000 than previously)
- Clear credential effect at 12 years for all groups → HS degrees matter in important way (1/8 of young adults still without degree)
- Each additional year of education after 12 is associated with lower mortality risk (no apparent floor—with the exception of AA women)
- Mortality among the most highly educated is low and becoming even lower. "Weaker selection" at the high levels does not appear to have a large effect

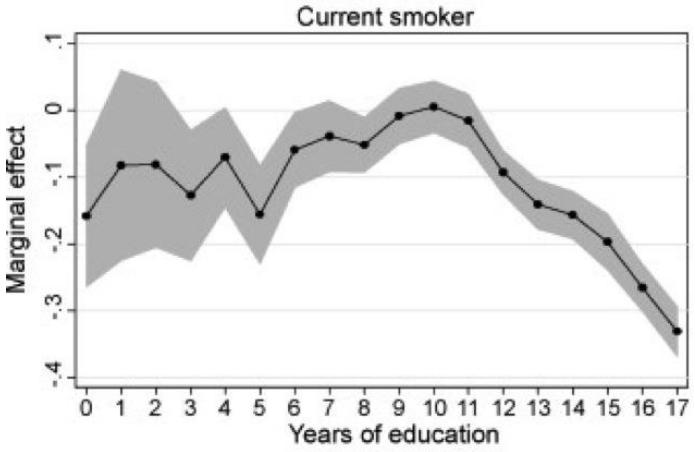
Discussion (1)

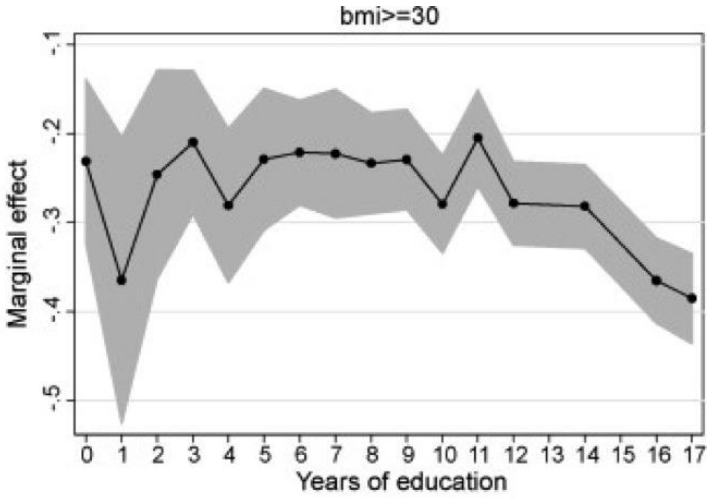
1960 →	1980s →	1990-2000s
Modest educational gradient in mortality (but not for non-whites!)	Credentialist model clearly established	Emergence of combined credentialist-human capital form

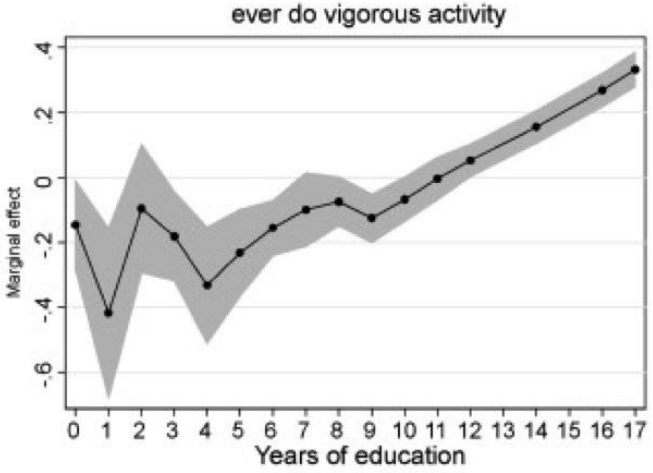
Changes in functional form reflect changes in the larger social environment that may have brought new mechanisms into play, operating at *different* parts of the educational distribution

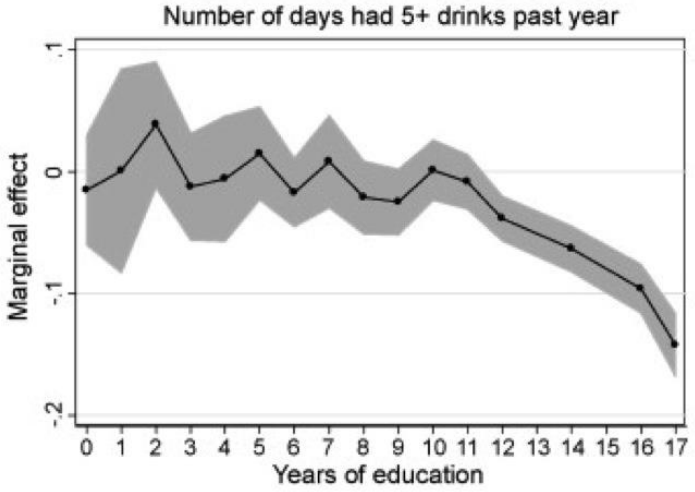
Discussion (2)

- Multiple mechanisms arising from educational attainment are now influencing adult mortality in the U.S.
  - Step reduction at 12 → labor market opportunities
  - Dose-response after 12 years points to the combination of mechanisms to produce low mortality among those with advanced education
- What happened in American society that made it possible for the emergence of the credentialist-HC functional form?
  - Surgeon General's Report on smoking, availability of medical technology and information, economic returns to a bachelor's degree (especially for women), assortative mating…
- Cutler & Lleras-Muney's (2010) work points to a bundle of resources currently available to very highly educated persons

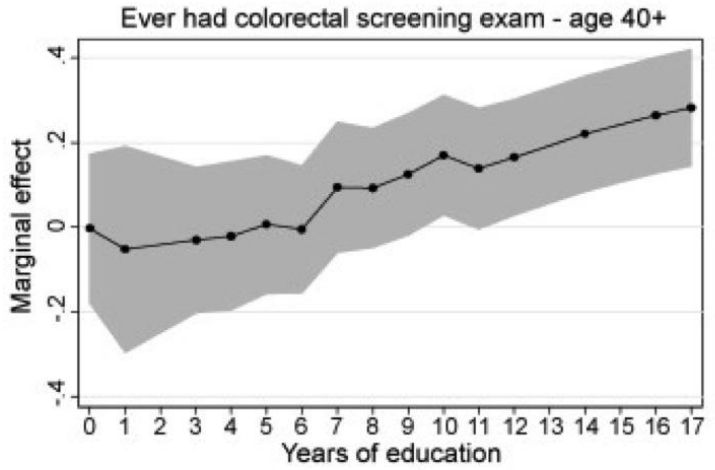


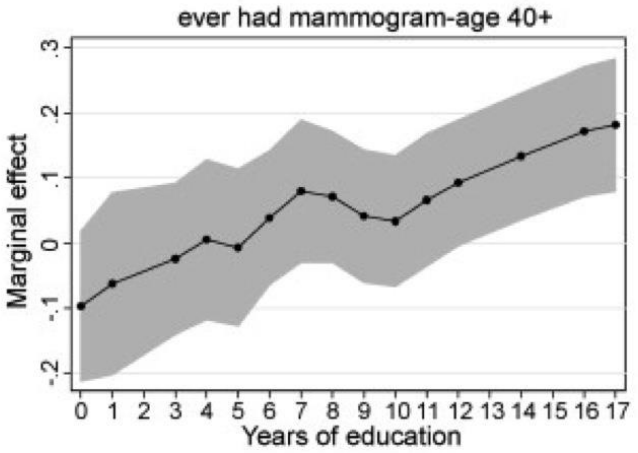


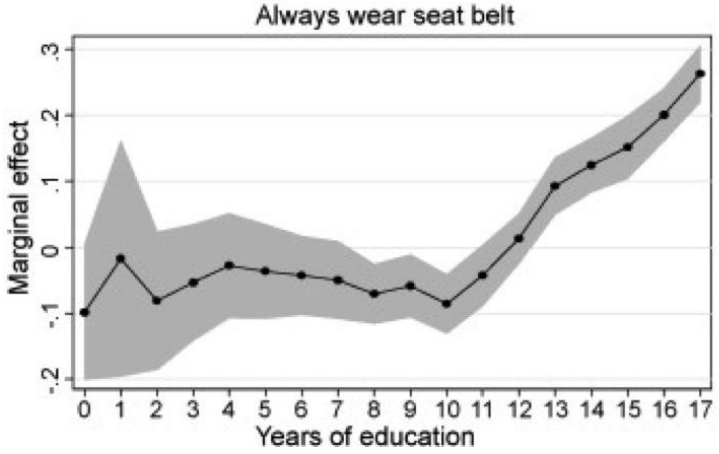


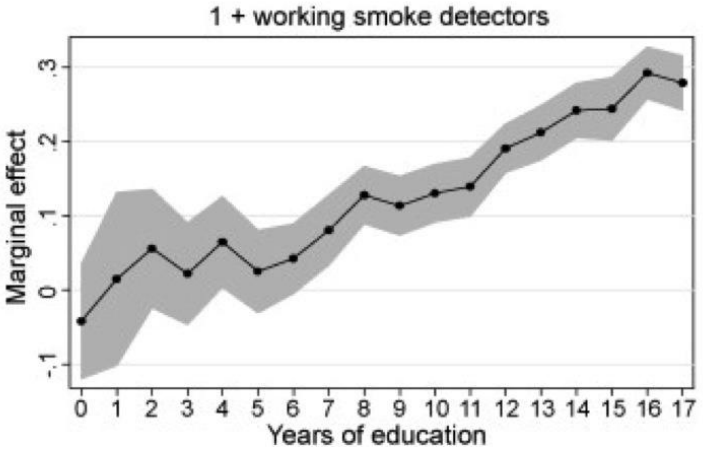


Source: Cutler, D. and Lleras-Muney, A. 2010. “Understanding differences in health behaviors by education.” *JHE* 29:1-28.









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Final Thoughts

- In our framework, there is no inherent causal association between educational attainment and adult mortality
- Instead, specific historical and social contexts make it possible for educational attainment—perhaps in different parts of the educational distribution and for different social groups—to have a causal effect on mortality
- Current “causal” associations likely to be highly dependent on exogenous conditions that allow education to garner resources and deploy them

Thanks!
Comments? Questions?

Sample size and number of deaths by race, sex, and educational attainment (National Health Interview Survey Linked Mortality Files, 1986-2006)

		Non-Hispanic Whites				Non-Hispanic Blacks			
	Education	Deaths	N	%N	PY	Deaths	N	%N	PY
Males	0-11	16,617	46,563	15.5	522,934	4,997	13,622	31.0	147,690
	12	17,508	104,701	34.9	1,051,808	2,471	16,035	36.4	146,444
	13-15	7,749	63,603	21.2	602,159	1,019	8,656	19.7	73,151
	16+	8,037	85,302	28.4	868,146	588	5,688	12.9	51,603
	Total	**49,911**	**300,169**	**100.0**	**3,045,047**	**9,075**	**44,001**	**100.0**	**418,888**
Females	0-11	13,771	46,334	14.4	598,219	4,915	17,707	28.7	210,051
	12	17,591	133,062	41.3	1,489,013	2,748	23,341	37.8	229,393
	13-15	6,226	73,897	22.9	718,670	1,002	12,933	20.9	109,562
	16+	3,882	68,884	21.4	667,748	561	7,821	12.7	72,772
	Total	**41,470**	**322,177**	**100.0**	**3,473,650**	**9,226**	**61,802**	**100.0**	**621,778**

Ranking of functional forms of the association between educational attainment and U.S. adult mortality

	1986-1999				2000-2006			
Model	NHW Male	NHW Female	NHB Male	NHB Female	NHW Male	NHW Female	NHB Male	NHB Female
1. Semi-Nonparametric	11	12	13	13	11	12	13	13
2. Continuous (ed)	10	10	4	3	9	10	1	10
Step Changes with Zero Slopes								
3. lths+hs, sc+co	13	13	12	7	13	13	12	12
4. lths, hs, sc+co	12	9	2	1	12	9	11	5
5. lths, hs+sc, co	8	7	1	2	8	7	5	1
6. lths, hs, sc, co	7	3	7	5	7	2	9	3
Step Changes with Constant, Nonzero Slopes								
7. ed, lths+hs, sc+co	3	4	8	10	4	4	7	6
8. ed, lths, hs, sc+co	9	6	6	6	10	8	6	8
9. ed, lths, hs+sc, co	2	2	5	8	1	3	3	2
10. ed, lths, hs, sc, co	4	5	9	11	5	5	8	7
Step Changes with Varying Slopes								
11. ed, lths+hs, sc+co, ed x (lths+hs), ed x (sc+co)	6	11	10	9	6	11	4	11
12. ed, lths, hs+co, ed x lths, ed x (hs+sc), ed x co	5	8	11	12	3	6	10	9
13. ed, lths, ed x lths	1	1	3	4	2	1	2	4

* All models are unadjusted for sampling weights and design; Top ranking models are in color.
** NHW = non-Hispanic white; NHB = non-Hispanic black.