Title

Racial and Temporal Differences in Fertility-Education Tradeoffs Reveal the Effect of Economic Opportunities on Optimum Family Size in the US

Author

Li, Sally

Publication Date

2023

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Racial and Temporal Differences in Fertility-Education Tradeoffs Reveal the Effect of Economic Opportunities on Optimum Family Size in the US

A thesis submitted in partial satisfaction of

the requirements for the degree Master of Arts

in Anthropology

by

Sally Li

2023

ABSTRACT OF THE THESIS

Racial and Temporal Differences in Fertility-Education Tradeoffs Reveal the Effect of Economic Opportunities on Optimum Family Size in the US

by

Sally Li

Master of Arts in Anthropology

University of California, Los Angeles, 2023

Professor Brooke A. Scelza, Chair

Contemporary trends in low fertility can in part be explained by increasing incentives to invest in offspring's embodied capital over offspring quantity in environments where education is a salient source of social mobility. However, studies on this subject often rely on homogenous populations, missing out on the opportunity to investigate how this relationship is impacted by structural factors that asymmetrically allocate economic opportunities between members of different groups. Using General Social Survey data from the US, I examine changes in the relationship between number of siblings and college attendance for White and Black respondents throughout the 1900s. Results showed that White individuals from larger families had a lower chance of completing at least four years of college education than individuals from smaller families, while the likelihood for Black individuals was more uniform across family sizes.

Though results were not significant for every cohort, racial difference was generally larger in cohorts born in the early 1900s and converged in the later part of the century. These results explain variations in the timing of demographic transitions within subpopulations of a nation and suggest that the benefits of decreasing family size on educational outcomes may be conditional on the specific economic opportunities afforded to a family.

The thesis of Sally Li is approved.

Harold Clark Barrett

Brian M. Wood

Brooke A. Scelza, Committee Chair

University of California, Los Angeles

2023

To my mom, for her endless support.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

INTRODUCTION

Because resource availability limits reproduction, we should expect to find a positive relationship between access to resources and number of surviving offspring across species. This pattern is observed in historical human societies (Nettle & Pollet, 2008, Clark & Hamilton, 2006) as well as in non-human primates (Harcourt, 1987), suggesting that the relationship played a role in past human evolution. However, the relationship between wealth and fertility in humans has largely been reversed in recent centuries, with wealth negatively impacting fertility. The effect was first observed in European cities and has become a global phenomenon in the past century, often being correlated with increases in national GDP (Vandenbroucke, 2016). Within countries, socioeconomic status and fitness also have an inverse relationship such that the wealthiest families are often the first to reduce their fertility (Vining, 1986). This decline of fertility within an increasingly wealthy world poses a perplexing problem for human behavioral ecologists; if individuals are evolved to maximize their fitness, we should expect increasing access to resources to lead to higher fertility, not lower.

Life history theory states that because parents have a limited number of resources to invest in their offspring, they face tradeoffs between the number of children they have and the amount that they can invest in each child, often referred to as a quantity-quality trade-off (Lack, 1947). Here, child quality should be understood to signify the potential of a child to contribute to the intergenerational fitness of their parent. This idea originated in David Lack's study of optimal clutch size in robins, where natural clutch sizes approximated reproductive optimums that, if exceeded, were likely to result in offspring death (Lack, 1947). Lack concluded that mothers lay only the number of eggs that she could sustain with the availability of resources she had, trading off additional reproductive opportunities with offspring survival. Extrapolating this

finding to other species, we should expect individuals of any species to adjust their reproduction in response to the optimum number of offspring that are afforded by a given environment. Observed offspring counts should therefore approximate overall fitness, rather than maximum fertility.

The extent to which this model can be used to approximate reproductive optimums in humans is unclear. Lawson and Borgerhoff Mulder (2016) point out that Lack's clutches were modeled as single reproductive events, whereas human families constitute multiple sequential reproductive events that are spaced out over years, and sometimes across multiple partners. Within the multi-year time frame between reproductive bouts, there are bound to be shifts in the availability of resources in an environment, and the functional ability of parents to access them. Therefore, understanding human reproductive variance requires additional consideration of tradeoffs between current and future reproduction, and somatic maintenance. Moreover, Lack uses offspring survival as a measure of quality and an approximation of fitness. Some studies do suggest that such tradeoffs may exist in human families as well. Meij et al. (2009) find evidence of a tradeoff between offspring quantity and offspring survival among families in Ghana under highly adverse conditions, where an offspring's chance of survival decreases with each additional sibling. Likewise, Hagen et al. (2006) found that Shuar children living in households with higher consumer-producer ratios were physically shorter and smaller, indicating diminished physical health. However, it is unclear how much child health can serve as a proxy for intergenerational fitness, especially in environments characterized by low child mortality. Human fitness depends not just on the survival of one's children, but on myriad factors that contribute to the continued reproduction of one's genetics through subsequent generations. In addition to health factors, measures of offspring quality should consider factors relating to social

success. Depending on the society, parental investment in offspring social success may require investing in their education, leaving behind heritable resources, or paying bride price or dowry to secure them a mate. Therefore, with respect to human reproduction, tradeoffs in offspring quantity should be measured against these factors as well.

Researchers consistently find that reducing fertility can bring benefits to offspring wealth, education, or occupational mobility (Anh et al., 1998, Kaplan et al., 1995, Goodman et al., 2012, Bavel et al., 2006, Eloundou-Enyegue & Williams, 2006). However, the idea that gains in offspring status can increase fitness through the improved reproductive success of subsequent generations fails to be supported by contemporary multigenerational analyses of fertility. Regardless of the child's later life status, parents who had more children ended up having more grandchildren, while parents who reduced their fertility had relatively fewer (Kaplan et al., 1995, Goodman et al., 2012). Given that investment in child quality in contemporary populations does not produce optimum fertility over generations, yet we continue to see decreases in fertility within these families, humans are probably not adjusting their reproductive behavior as a direct calculation of intergenerational fitness. Rather, as Borgerhoff Mulder (1998) suggests, reproductive behaviors observed today are probably the result of evolved psychological mechanisms that are sensitive to traits that served as proxies of fitness in the past. In this paper I will argue that a human reproductive psychology that is designed to maximize intergenerational resources through parental investment in offspring's status best explains discordant relationships between wealth and fitness in post-industrial environments. To illustrate this model of human reproduction, I highlight how racial exclusion in the United States contributes to differences in economic opportunities between White and Black individuals and use existing demographic data from the General Social Survey to evaluate how this structural inequality impacts the tradeoff

between fertility and offspring status among these groups across the 1900s. Finally, I discuss the results of my model and their contribution to literature on contemporary changes in human fertility.

Status, Competition, and Fitness

That today's reproductive patterns do not seem to yield adaptive results does not disqualify them as being shaped by forces of selection in the past. Behaviors are selected for the adaptive results they yield in the context they evolved in. Therefore, an evolutionary psychology approach seeks not to identify the most adaptive behavior in the present, but to understand the conditions of our evolutionary history that could have selected for the mechanisms that produce the patterns we see today (Buss, 2009). Given the opacity of one's offspring's future reproductive outcomes, it is likely that we have evolved psychological heuristics that approximate intergenerational fitness through other, observable proxy measures. A close relationship between status, resources, and fitness has been recognized in many nonindustrial human societies (von Rueden & Jaeggi, 2016). The same relationship is found in non-human primate species that live in multi-male, multi-female social groups (Majolo et al., 2012). Together these studies suggest that the status-resource-fitness link may have a long evolutionary history, supporting the possibility for the selection of psychological motivations for investing in one's children's status as a mechanism for achieving high fitness. Researchers have therefore proposed that rather than overall fitness, humans are sensitive to opportunities to optimize offspring status and adjust their fertility accordingly (Shenk et al., 2016, Alvergne & Lummaa, 2014). Through this view, family size varies as a function of the degree to which increased

parental investment in existing offspring confers real or perceived payoffs to their relative status, even if it fails to produce long term fitness benefits.

Embodied capital is a useful construct that allows us to conceptualize the sorts of parental investments that are relevant to status. Embodied capital can be defined as "*a stock of attributes embodied in the soma of an organism which can be converted, either directly or, more commonly, in combination with other forms of capital, into fitness- enhancing commodities*" (Kaplan et al., 1995, p. 328). Some of the more commonly referenced embodied traits are physical formidability, skill, knowledge, and social alliances, all of which may be important components of someone's status. The types of embodied capital that best yield resource production and status depend on the subsistence style and cultural norms of one's society. Depending on the embodied trait in question, parents face varying degrees of resource allocation tradeoffs. For example, in small-scale, traditional subsistence societies, status may "*be achieved primarily on the basis of an individual's activities during their lifetime*" (Shenk et al., 2016, p.2). That is, there are more opportunities for individuals to increase their status by achieving prestige among their peers through displays of skill or good character. In such cases, parents can help their children by teaching them necessary skills or advocating for them in social situations, as seen in the Martu where the presence of a boy's father can accelerate his initiation into adulthood (Scelza, 2010). Holding aside the baseline resources needed to feed or clothe children, these additional investments are not characterized by being zero-sum; a parent can teach foraging skills to multiple children at the same time, or advocate for one child without necessarily taking anything away from another. Because these types of investments are not intrinsically depletable, we should predict fewer incentives to restrict fertility. In many industrialized and post-industrialized societies, in contrast, status is often determined by access to high income careers,

and the value of parental wealth in affecting this- specifically through investing in formal education- is perceived to be high. Because material wealth is a zero-sum resource, parents must make decisions about the amount they allocate to each child and should be more motivated to restrict fertility in order to appropriately allocate enough resources to all children. This idea has been proposed to explain the close association between market integration, education, and fertility decline (Colleran & Snopkowski, 2018, Lesthaeghe & Wilson 1986).

While this model of fertility variation fits well with observed patterns of fertility decline that follow the industrialization of societies, many studies have been unclear about why we should see fertility decline first in wealthy families within the same population. Why should some families be more motivated to reduce their fertility over others? In the following section I explore how variations in fertility decline are affected by the disproportionate distributions of opportunities for economic success within societies.

Structural Explanations for Intragroup Variations in Fertility

To explain variations in fertility patterns within populations, we need to understand how structural aspects of a society create individual differences in actual or perceived ability to convert parental investment into status gains. It is important to remember that populations are not uniform. Levels of inequality, degree of access to market economies, and the positioning of one's social or ethnic group within the society can all have important effects on how social mobility opportunities are distributed (Alvernge & Lummaa, 2014, Andrews & Leigh, 2009, Bertrand & Mullainathan, 2004). Therefore, while it does seem that reducing family size can have positive effects on offspring's status where parental investment is important, we should

expect this strategy to be most effective within subgroups who have best access to these status enhancing opportunities.

Firstly, geographic variations can affect an individual's access to market economies and resulting income opportunities. Development is first concentrated in urban centers, therefore families near these centers have greater access to high paying jobs. Alvergne and Lummaa (2014) show that across Mongolia, the value of education changes with market integration; in urban areas there are more opportunities to transform education into wealth due to having better access to high income labor markets. As a result, the wealth payoffs for women to invest in their own education over reproduction were greater in these areas, possibly explaining why fertility was lower in Mongolian cities. Similarly, one's incentive to invest in their children's education should depend on the relationship between education and wealth and be greater where this relationship is stronger. Because there are more opportunities for capital gains through education within cities than outside of them, it should be expected that urban families face a relatively larger tradeoff between investment in education and reproduction. Maralani (2008) shows that in urban regions of Indonesia, the relationship between number of siblings and an individual's total years of education went from positive to negative over a 30-year period corresponding to recent socioeconomic development. That this relationship is concentrated in urban areas, but not rural areas, suggests that dynamics in family resource allocation tradeoffs may depend on geographic access to education and labor market opportunities.

On a similar note, regional levels of income inequality can restrict opportunities for economic mobility, shifting the payoffs of trading fertility for parental investment. Andrews and Leigh (2009) compare Gini coefficients, a measure of income inequality, with changes in occupational wages between fathers and sons across 16 countries. They found that fathers and

sons in countries with higher income inequality were less likely to see positive differences in their occupational wages. Similarly, Shenk et al. (2016) use computer modeling to show that returns to status competition collapse under extreme levels of inequality due to high costs of social climbing. This may be because high inequality leads to social segregation by income, such that high income families have greater access to educational and social advantages, while low income families do not, and may also be exposed to higher concentrations of adverse peer effects (Burtless & Jencks, 2003, Durlauf, 1996). In support of this, Goodman et al. (2012) found that the socioeconomic benefits of fertility limitation are greatest among those who are already in high socioeconomic positions, and Lawson and Mace (2010) find that after the second child, wealthy- rather than poor- parents report expecting higher economic cost of having an additional child. Therefore, we can infer that high income families invest more in embodied capital precisely because there are more opportunities for them to benefit from doing so, while the same strategy may be less accessible for lower income families. This could explain why wealthy families are often the first to reduce family sizes. In agreement with this effect, Kremer and Chen (2002) find that the fertility difference between more educated and less educated is higher in countries with higher inequality.

Lastly, variations in the scope of influence that parents can have on their offspring's status can occur when societies are stratified by distinctions in social or cultural subgroups. Here, a person's identity, as encoded by certain cultural or phenotypic markers, can determine if and how a person can change their status. For example, caste systems can limit social mobility because they bind aspects of status to birth family characteristics. The impact of caste systems is best illustrated by the so-called paradox of fertility observed in Kerala, a state in India. Up until the 20th century, Kerala upheld rigid caste distinctions that prohibited lower castes from owning

property, relegating them to positions of slavery and servitude. However, in the 1900s, along with general improvements in the economy, social reforms that redistributed land ownership and made education available to all citizens preceded dramatic national fertility decline, especially in the lower classes. This outcome has been attributed to a diminished significance of one's caste distinction in determining their ability to improve their own socioeconomic positioning, therefore increasing the ability and incentive of parents from lower castes to invest more in the education and later life outcomes of their children (Pallikadavath & Wilson, 2005). Similar restrictions to social mobility can be found in multi-ethnic societies, where distinct ethnic or racial groups occupy different status levels, and these norms are enforced by discriminatory behaviors. Kaplan et al. (1995) observe that in New Mexico in the 1900s, Hispanic men had higher fertility than non-Hispanic white men. They propose that non-Hispanic white men face greater incentives to reduce their fertility because they have greater relative potential to capitalize on investments in education "*because of their relatively enriched home environment"* (Kaplan et al., 1995). This falls in line with the previously discussed idea that higher income families may have better access to resources that support education. However, this explanation assumes that Hispanic men who have similar income and educational backgrounds to their White counterparts should be equally able to affect their offspring's status. We must also consider aspects of status that are structurally "embodied" within racialized groups. That is, holding all other factors constant, those who present as members of minority groups may still face structural barriers to social mobility that others do not. A racialized social structure may create differences in reproductive patterns by disrupting the link between eduation and status for racialized groups. To further investigate the effect of racial stratification on reproductive strategy, I compare reproductive tradeoffs between Black and White individuals in the US throughout the 1900s.

Ecologies of Opportunity in the US

The United States underwent great social and economic change during the 1900s. The start of the century saw the effects of the massive economic change driven by the growing industrial economy that had emerged after the American Civil War. The growth of this economy meant an increase in market-based economic opportunities. Families from the countryside continued to move into cities to pursue wage labor opportunities created by the manufacturing economy, and by 1920, more Americans lived in cities than rural areas for the first time in history (Rauchway, 2009). At the same time, companies and factories needed to fill administrative and management roles, which increased demand for educated workers and expanded the ranks of the upper and middle class (Goldin & Katz, 1999). Aspirations to join this middle class, fueled by promises of a better and happier life, would be coined "The American Dream" in 1931 by James Trusklow Adams. This dream would go on to serve as a paradigm for success in the US, bringing with it ideologies that a better future could be earned through hard work and investment in education. However, amidst endeavors for brighter futures, the US still faced extreme racial inequality among its citizens. Black Americans did not have equal access to the newly created spheres of opportunity that came with industrialization. The ratification of the 13th amendment in 1865 had abolished slavery in the US, but practices that favored White people and limited Black people's choices persisted and were often enforced by the government. Jim Crow laws in the south legally prevented Black people from entering White spaces. These practices have important effects on the expected pathway between parental investment and child social status through the impact they have on Black access to educational institutions and economic spheres. For example, under segregation laws, Black communities were able to create their own schools and colleges, but they often received less funding, and could not accommodate

everyone who applied (Haynes, 2006). While the Civil Rights Act of 1964 prohibited discrimination based on color, race, religion, or sex, legally ending Jim Crow and other discriminatory laws, loopholes to this rule continued to advantage White people in many socioeconomic spheres.

Ideally, the discriminatory experiences faced by Black individuals in the US would be confined to historical descriptions of American society. In reality, many of these effects can still be observed in the present day. The income gap between White and Black individuals remains large, as do differences in employment, education, and health (Harris, 2022). Strategic drawings of district boundaries and informal exclusion of housing in White neighborhoods prevent Black people from accessing high quality public services such as schooling, which hampers their access to higher education (Gilbert et al., 2022). Moreover, individuals who were able to overcome educational barriers still face biases in hiring. Bertrand and Mullainathan (2004) show that even in the 21st century, employers favor resumes with White sounding names over Black ones. Therefore, the monetary investment in higher education may confer fewer guaranteed benefits for Black people. Black individuals that did enter privileged education and economic settings were not free of obstacles either. Access to high income professional spaces may not confer the same social advantages for people of color, because these spaces are often White dominated. When people of color seek entrance into these spaces, it may be harder for them to form social alliances with other members, and they may even be deliberately excluded from doing so. Therefore, despite overall economic changes in the US, barriers for Black families to improve their status, such as lack of governmental funding for education, exclusion from employment opportunities, and discrimination in White spaces, are exogenous to the impact of parental investment on their children's later life status. Given this, I predict: *(1) The relationship between*

family size and educational attainment will be weaker for Black respondents than White respondents. (2) This difference will decrease throughout time following a decreased tolerance for racial discrimination in entrance to educational and economic spheres.

METHODS

Data

I use data from the General Social Survey collected by the National Opinion Research Center (NORC). Data collection for this project started in 1972 and is ongoing, with new samples added every 1-2 years. The most recent year of data collection was 2022. In each year of data collection, a new sample of up to a few thousand adult participants are recruited through a process of random selection that aims to select individuals across the US from a mix of geographic areas and community types (ie. rural, suburban, and urban). Participation in the study is voluntary and consists of a 90 minute in-person interview conducted by researchers from the University of Chicago. Interviewers ask about demographic and economic variables of the respondents, as well as their parents and their partners, and various questions about health, behavior, and social and political opinions. The entire database comprises 68,846 individuals. For this study I used data from 41,444 individuals sampled between 1972 and 2021. Individuals were selected from the total sample to be included in this study based on being older than 25, and the availability of the variables of interest, described below.

Variables

Offspring education is my outcome of interest. I coded this as a binary variable, differentiating between individuals who did or did not complete four years of college. The data are derived from interview questions that ask: "*What is the highest grade in elementary school or*

high school that you finished and got credit for?" and "*Did you complete one or more years of college for credit--not including schooling such as business college, technical or vocational school? IF YES: How many years did you complete?*" (GSS, 2022). I choose four years of college to represent those who have completed the standard number of years to receive a bachelor's degree. I use only individuals aged 25 and older to exclude those that may still be in the process of schooling assuming a semi-direct pathway from high school to college.

Sibship size is represented through the respondents' self-reported number of siblings. The survey question associated with this variable is "*How many brothers and sisters did you have? Please count those born alive, but no longer living, as well as those alive now. Also include stepbrothers and stepsisters, and children adopted by your parents*" (GSS, 2022). This question was included in the survey every year it was conducted. Respondents in this sample that had missing answers for this question (N=3) were taken out of the sample. This self-reported measure of sibship size provides a proxy measure for tradeoffs in parental investment relevant to the respondent's childhood and education.

Birth cohort is calculated by subtracting the respondent's reported age at the time of survey from the survey year, which are both variables reported by the GSS. Individuals are grouped by birth year into 9 cohorts, each spanning a decade. The first cohort is born between 1905 and1915 and the last are born between 1986 and 1995. Finally, because I use only individuals who were at least 25 at the time of sampling, individuals sampled by the GSS between 18-24 years old (N = 4,806) are excluded from the sample.

Parental socioeconomic status is represented in this study by the highest year of school completed by the respondent's father. This is a numerical count extracted from interview questions that ask the respondent: "*What is the highest grade in elementary school or high*

school that your father finished and got credit for?" and "*Did he complete one or more years of college for credit--not including schooling such as business college, technical or vocational school? IF YES: How many years did he complete?*" (GSS, 2022). I chose fathers' education over other variables represented in the survey, such as father's income, because it is less likely to be time dependent. Because each respondent is sampled at different points in their lives, their fathers may be at different stages of their career and receive different levels of income as a result. Fathers' education is therefore more likely to represent an overarching economic "strategy" of the household, regardless of time of interview.

Race is reported by the respondent. In this model I use only White (1) and Black (2) racial groups because early years of the GSS represent race as White, Black, or other. I exclude those in the "other" category (N= 3,999) because the nature of the model requires understanding the effect of specific racialized experiences, something that cannot be generalized for a category of "other".

Sex is reported by the respondent.

Statistical Analysis

To compare historical changes in the relationship between sibship size (main effect) on the probability of having a college degree or higher for both White and Black groups (interaction effect), I ran the data for each cohort (N=9) through a multivariate Bayesian logistic regression model. I include fathers' education and sex as control variables. Varying intercepts were estimated for race and sex. Measures of fathers' education and sibship size were standardized by subtracting from each value the population average and then dividing by the sample's standard deviation. The standardized values were calculated prior to splitting the sample by cohort, and

therefore represent data scaled to the entire dataset rather than individual cohorts. The models were fitted in R using the "rethinking" package (McElreath, 2021). Models were run with 4 chains, 4 cores, and 2000 iterations. The corresponding mathematical equation for the model is as below:

$$Logit(\lambda) = \beta_E * Fathers\ education + \beta_F\ Number\ of\ siblings + \beta_S\ Sex + \beta_R\ Race + \beta_{RF}\ Race*Number\ of\ siblings$$

RESULTS

Cohort and fathers' education had the strongest association with education.

In my sample, 48.6% of individuals over 25 years old are coded as having completed four years of college education. Across the sample, this was the second most common reported years of education completed, following a high school diploma (Figure 1). Figure 2 compares rates of college completion between my sample and the US census (US Department of Education, 1993). Yearly rates of college completion from my sample were more variable and on average higher than values reported in the US census. However, my data does agree with the general upward trend in college completion as reported by the census. Across cohorts, I find that the percent of respondents that have a college degree increased over time for both Black and White cohorts except for individuals in birth cohorts between 1946 and 1965, where it decreased by 1% for White groups (Table 1). The observed decrease may be an artifact of grouping subjects into 10-year cohorts, as the same pattern is not seen in census data.

Aside from cohort level changes, the probability of completing four years of college education by age 25 was best predicted by fathers' education. Standardized father's education had a significant overall positive effect on educational attainment for all cohorts. Leaving all other variables unchanged, for one standard deviation increase in fathers' education, the

probability of the respondent having completed four years of college went up by 71 - 96%. (By cohort: $\beta = 0.91$, 100% >0; $\beta = 0.73$, 100% >0; $\beta = 0.71$, 100% >0; $\beta = 0.76$, 100% >0; $\beta = 0.8$, 100% >0; $\beta = 0.94$, 100% >0; $\beta = 0.96$, 100% >0$\beta = 0.86$, 100% >0; $\beta = 0.92$, 100% >0).This is in line with expectations that families who have educated parents are more likely to have the ability or motivation to invest in the education of their own children (Goodman et al., 2012, Kaplan et al., 1995).

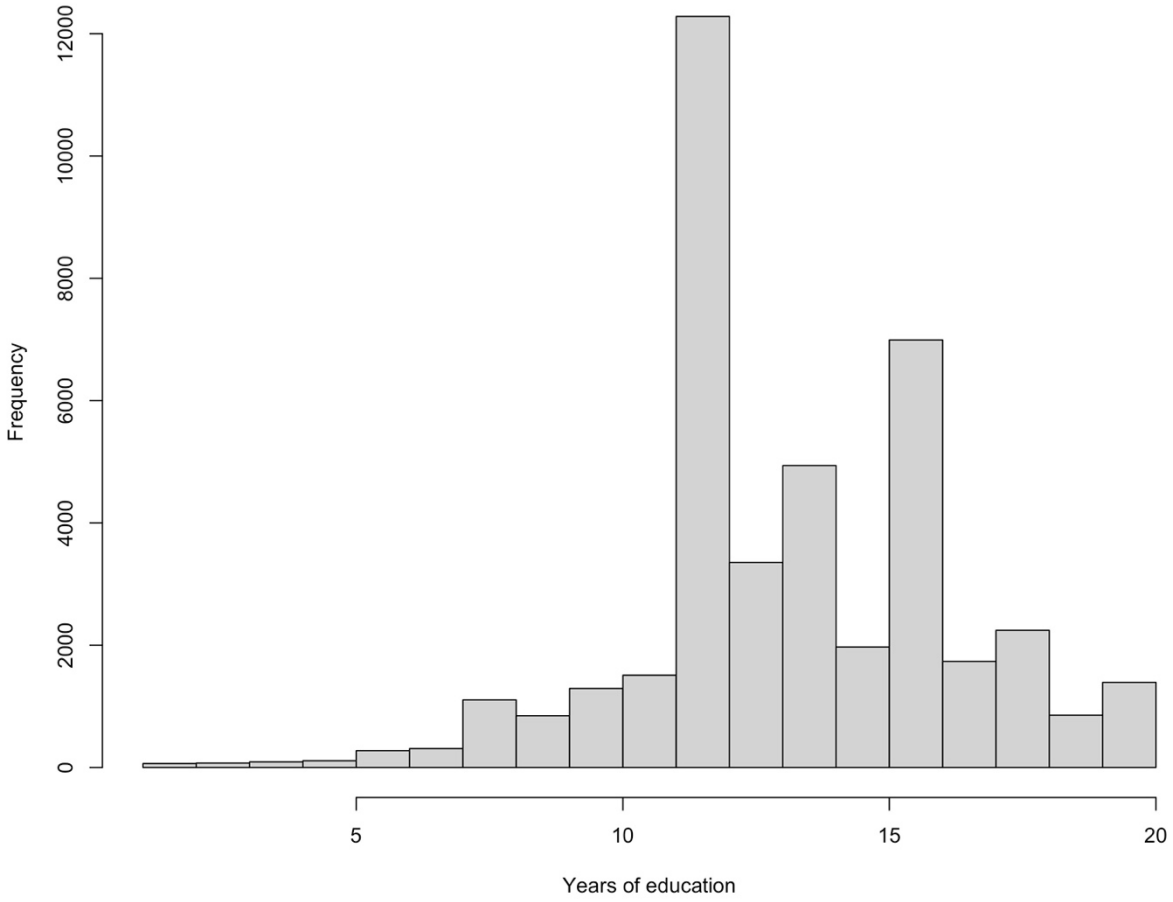

Figure 1: *Respondent's education across cohorts. Depicts years of school completion measured across all cohorts.*

Figure 2: *Percent of persons 25 years old and over completing four years of college.*

Cohort	Birth Year	Total Respondents in Cohort		Average Years of Education		% Completed 4 Years of College		Average fathers' Education		Average Family Size	
		White	Black	White	Black	White	Black	White	Black	White	Black
1	1906-1915	1628	131	11.4	9.1	12.6	5.3	8.4	6.3	4.5	6.5
2	1916-1925	2957	272	12.3	10.2	16.8	8.1	8.8	7.2	4.1	6.0
3	1926-1935	3765	458	13.0	11.8	24.4	15.5	9.2	7.9	3.7	6.0
4	1936-1945	5754	740	13.6	13.0	29.5	22.7	10.2	8.8	3.3	5.9
5	1946-1955	8164	1292	14.2	13.6	36.5	28.3	11.5	9.6	3.3	5.5
6	1956-1965	6696	1297	14.1	13.8	35.5	30.1	12.4	10.9	3.3	5.1
7	1966-1975	3516	1040	14.5	13.9	41.9	33.8	13.0	11.8	2.8	4.1
8	1976-1985	2034	678	14.7	14.1	46.4	38.6	13.3	12.0	2.7	3.6
9	1986-1995	766	256	14.9	14.5	50.7	43.4	13.7	12.9	2.6	3.3

Table 1: *Descriptive level analysis of education variables and sibship size across race and birth cohort.*

The relationship between sibship size and education differed by race.

Overall, respondents had a mean of 3.6 siblings, with the maximum number of siblings being 37, as reported by one respondent. In my sample 5.3% of all respondents reported having no siblings and 50.7% of respondents report having 2 or fewer siblings. There was a general decrease in sibship size across birth cohorts for both Black and White groups, which follows general patterns of fertility decline in the US. Black groups had higher average sibship size in early cohorts, but by cohort 9 the two groups showed similar average sibship size (Table 1, Figure 3).

Overall, one's standardized number of siblings had a negative effect on the chances of completing four years of college for all race and cohort groups, though this effect was not significant in all groupings (Figure 4). This finding is in line with other studies that have found a negative relationship between number of siblings and educational attainment (Anh et al., 1998, Kaplan et al., 1995, Eloundou-Enyegue & Williams, 2006). In support of my first prediction, the negative relationship between sibship size and education was greater for White people compared to Black people in all cohorts except for the last one. For example, for individuals born between 1946 and 1955, one standard deviation increase in sibship size had an average 32% negative effect on the probability of completing four years of college for White individuals, but only a 15% average negative effect on Black individuals.

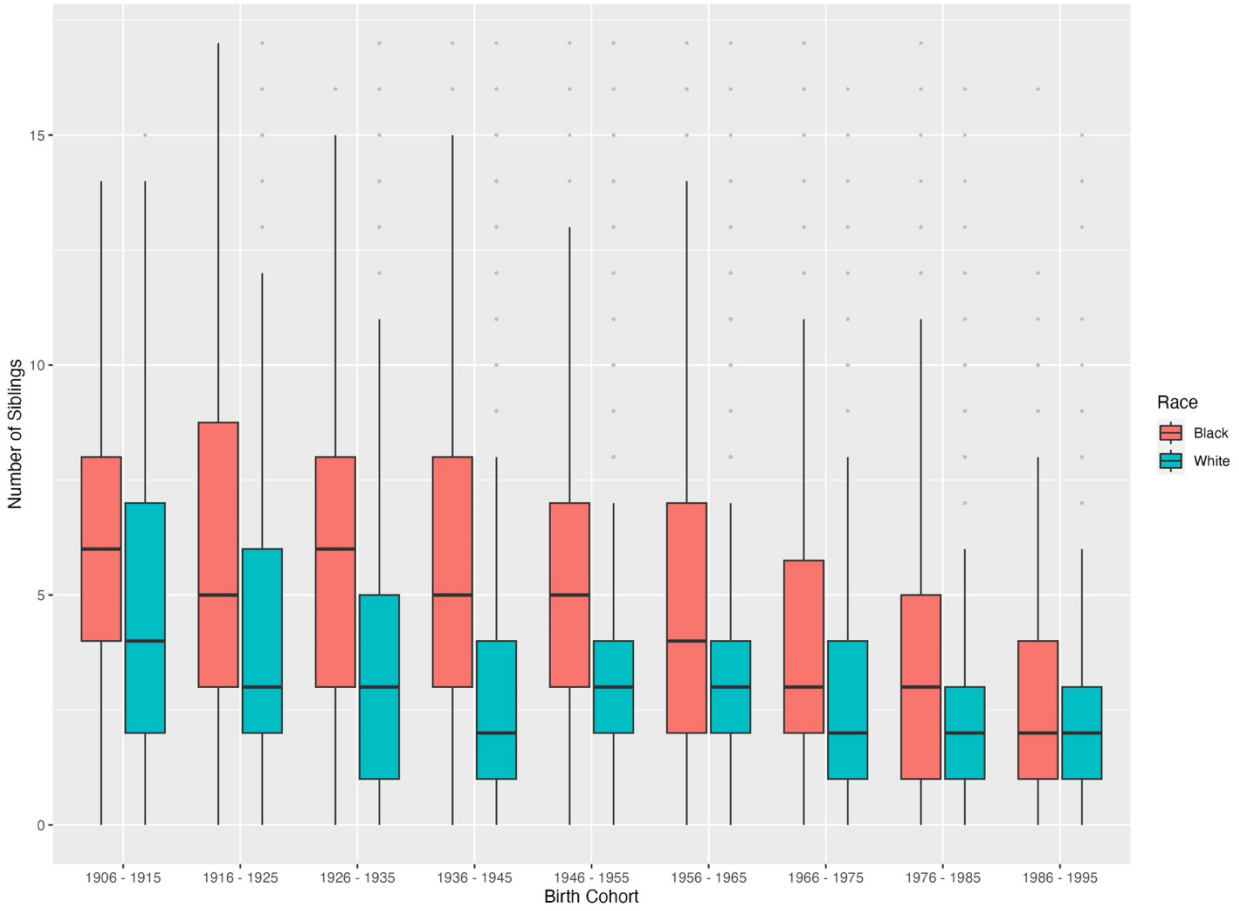

Figure 3: *Number of siblings by cohort and race.*

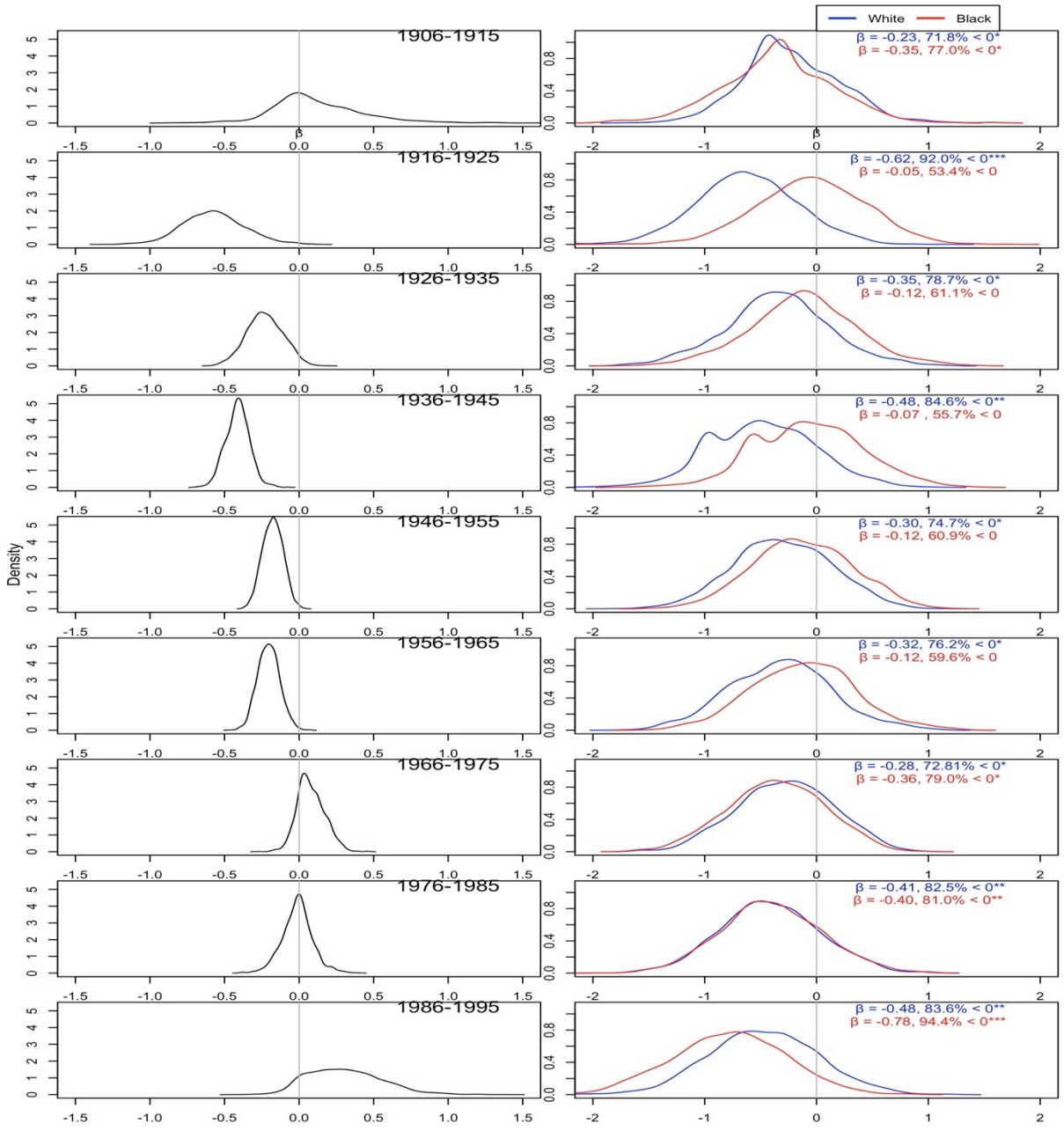

Figure 4: *Posterior densities of the interaction effect of race and sibship size on education. Left: Black line is rendered by subtracting Black posterior densities from White posterior densities, depicting the difference in effect of sibship size on education between the two groups for each cohort. The central x=0 line here represents no difference between Black and White groups, while values to the left of this line represent a greater negative effect in White groups than in Black groups. Right: Red line depicts densities for Black groups only and blue line depicts densities for White groups only. The central line on x=0 represents no effect of sibship size on education, while values to the left of this line represent negative effects. Annotations show mean β and the percent of β values that are less than 0: * 70% β <0. ** 80% β <0. *** 90% β <0.*

Racial differences in the sibship-education relationship converged with time.

My second prediction that the relationship between sibship size and education would converge for Black and White people over time was also seen in the data. Figure 5 compares the relationship between sibship size and respondents' standardized years of education as derived from the raw data. While White groups have a more negative relationship in earlier cohorts, the regression lines look the same for cohorts born after 1966. The same pattern is demonstrated in Figure 6, which depicts estimated probabilities of college completion derived from running the trained models with simulated data. Also demonstrated in this figure is that while Black individuals born between 1916 and 1965 have lower chances of completing four years of college in smaller families compared to White individuals with the same number of siblings, Black individuals with more siblings have higher simulated probability of completing four years of college than White individuals with the same family size. Interpretations for these results are discussed in the following section.

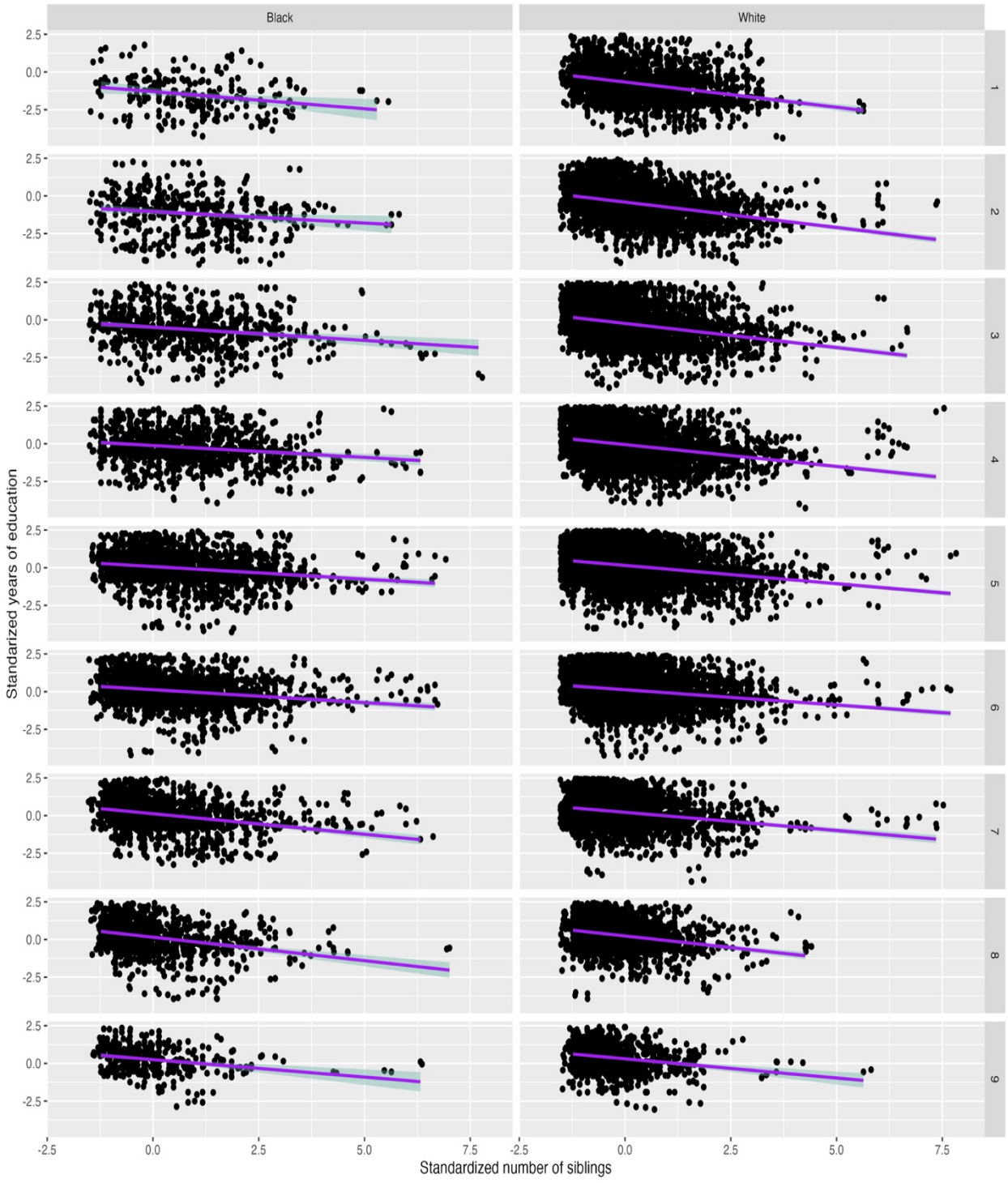

Figure 5: *The relationship between sibship size and years of education by race and birth cohort. A linear regression line is fit through data for each group.*

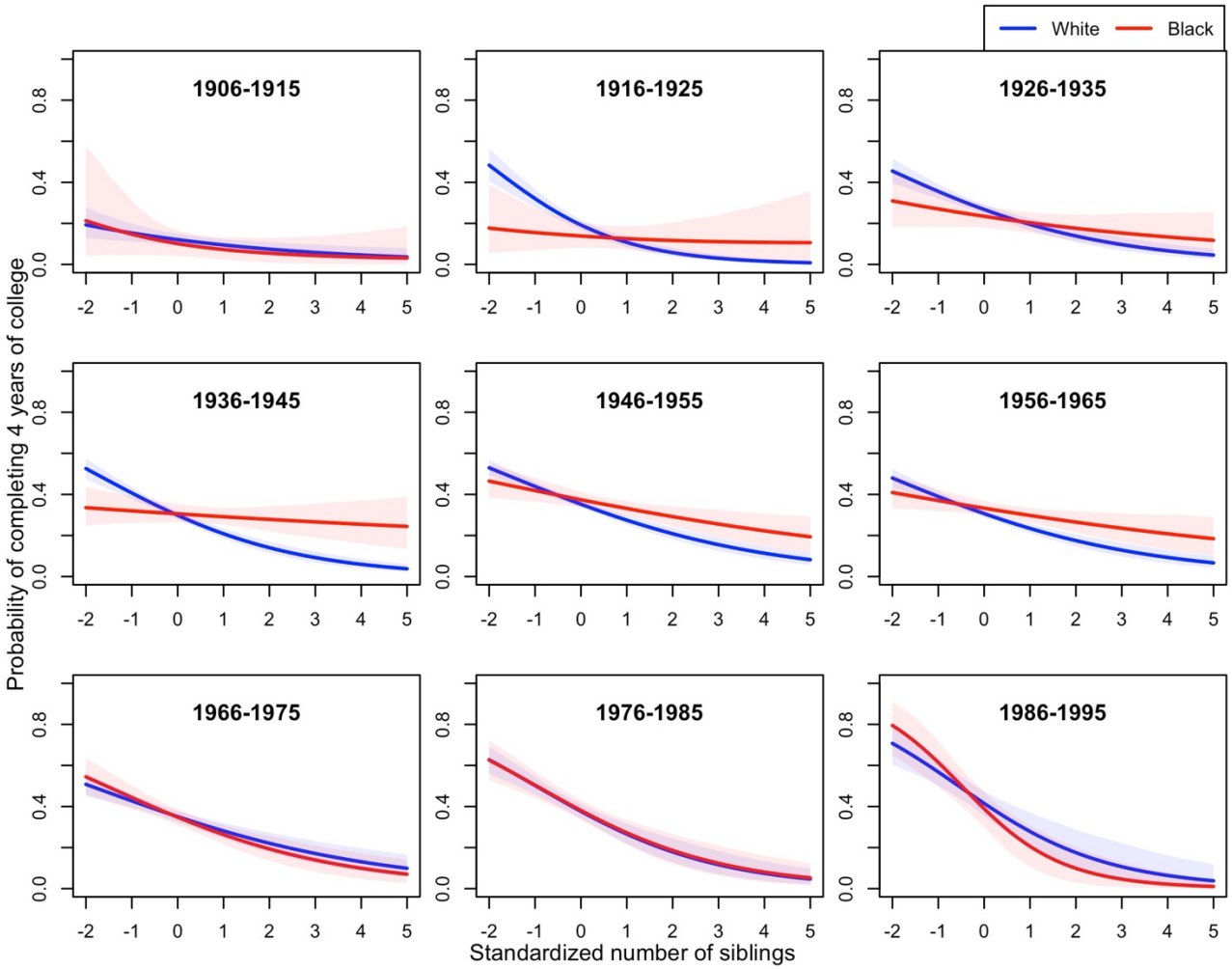

Figure 6: *Simulated effect of sibship size on education by race and birth cohort. Simulated male individuals (N=2000) with fathers of average education for their cohort level are run through the trained model with varying sibship sizes for each race and cohort group. The plot depicts the predicted probabilities for each circumstance.*

DISCUSSION

While analyses of the demographic transition across nations tend to support the general trend that decreases in fertility correspond with a shift to an industrialized economy, looking at patterns of fertility decline within nations allows us to better understand how variations in this relationship materializes across different individuals. The results of my study demonstrate that

the relationship between sibship size and educational attainment varies between racial groups in the 1900s and suggests that this variation may be responsive to the landscape of economic opportunities afforded to the individual. In post-industrial societies, parents can affect their children's status by investing in their education, which can confer greater access to high income jobs. However, fixed characteristics of an individual can be embodied in ways that negatively affect this pathway, such as when racial distinctions preclude individuals from accessing relevant resources or institutions. In these cases, the ability of parents to improve their children's status may be reduced, muting the benefit of trading off offspring quantity for offspring status and therefore the incentive to reduce fertility. A model of human reproduction that considers these distinctions could explain variations in the timings of fertility decline both within and across populations. While nationwide economic development will have downstream effects on all individuals, not everyone will have equal access to opportunities to increase status, thereby creating variations in optimum reproductive strategies.

One surprising result seen in the counterfactual data was that Black individuals born in larger families between 1916 and 1965 showed a higher probability of having completed four years of college than White individuals with the same family size. This result calls for an investigation of the possible benefits of having a larger family in an industrial economy. Mithun (1973) observes how, in a predominantly Black community in the metropolitan US, actions of mutual aid between family and community members are normalized. She notes that "*friends call upon one another to borrow small household items, food, and/or money, or to watch a child for a short time. Small children help carry groceries, run errands, babysit, and offer to assist in immediate chores which need to be done… Families take in other families on a temporary emergency basis"* (p. 28). It has been proposed that cultural norms that prescribe greater

community or extended family support for childcare may weaken the negative relationship between family size and education (Ahn et al, 1998, Shavit & Peirce, 1991). Shavit and Peirce (1991) find that in Israel, while greater sibship size has a negative effect on education in Ashkenazi and Oriental Jews, for Moslem Arabs who put greater emphasis on extended family support, large sibships are associated with benefits in education. Moreover, children from smaller Arab families were disadvantaged in their education, possibly because in cultures where community connections are important sources of reproductive support, those with weaker connections will have fewer children in the first place. This study sheds light on the importance of identifying from where resources are obtained and between whom resources must be divided. The distribution of resources in large families may not be as straightforward as tradeoff models predict. Instead of sibling competition being zero-sum as assumed in standard behavioral ecology models, family members might work together and allocate roles to increase the total pot of family resources. For example, Hackman and Kramer (2021) show that in a Maya community living in a mixed economic structure, where resources can come from traditional subsistence practices and participation in market economies, larger families have greater livelihood diversity, which can increase their household income and provide resilience to environmental or economic scarcity. These findings illustrate the problems with assuming homogeneous reproductive strategies across groups and ignoring the importance of cooperation within families and communities.

I have hypothesized that parents are adjusting their fertility as a reaction to the perceived benefit of investing in a child's education. However, the proximate mechanisms through which aspects of the environment can be translated to individual behavior are still unclear. If reproductive decision making involves knowing how beneficial investments in each child's

embodied capital is to their later status, how do parents intuit this relationship from their surroundings? Social learning and culture allow humans to approximate adaptive behaviors in novel situations and have played important roles in our evolutionary history (Henrich & McElreath, 2003). Henrich and McElreath (2003) propose that individuals have context biases that predispose them to learn from people who display certain characteristics. Personal attributes such as high prestige or sharing similar traits with a learner can make others more likely to learn from them. Prestige bias has commonly been invoked to explain the spread of low fertility from social elite to other members of society. If high status families are the first to reduce family sizes, then others will be responsive to this and copy their behavior with the intention of attaining similar status distinctions (Colleran, 2016). While this may be true, my data illustrates that individuals living in the same geographic space may face different environmental constraints. Therefore, it should be important that people identify the appropriate models to copy with respect to these constraints. Studies show that children are more likely to copy models who share the same sex and language as them over models who differ (Taylor, 2013, Shutts et al., 2009). People should direct social learning towards models with shared identity markers when aspects of an individual's identity determine important differences in their interaction with the ecology. This process could serve as a proximate mechanism for between group differences in average fertility and could possibly explain convergences in reproductive behavior in recent years; as successful models of social mobility through investment in education emerge in Black individuals, more Black people should adopt this strategy. Moreover, if ecological realities between races become less distinct, people may be more willing to copy people of other races. My data supports the notion that pathways to economic success are not universal; structural circumstances interact with individual level characteristics to produce a variety of optimal

strategies for different group members. These results emphasize that initiatives to increase motivations for family planning or investment in education should be sensitive to the variations in tangible benefits available to subgroups.

Methodological Limitations and Further Investigations

This work has several limitations which call for further investigations. For one, I use fathers' education as a proxy for the relative status of the family and the number of resources a family can allocate to its children. One problem with using fathers' education as a proxy for income is that the relationship between education, status, and income is not always consistent across individuals. Additionally, I choose to use father's education instead of mother's education or a composite of both to avoid confounding effects that may result from single earning families where fathers have significantly higher earning potential than mothers, which may be more likely to be observed in higher income families. This decision comes with the tradeoff of potentially misrepresenting the socioeconomic status of families where mothers contribute significantly more income than fathers or in split families where fathers may not be involved in the finances of the child.

Another limitation of my model is that it does not account for variation in household compositions. The variable reported in the General Social Survey for number of siblings does not specify the relatedness between siblings (ie, full, half, step, or adoptive) nor the age differences between siblings. As a result, a few known effects may be hidden in the analysis. One of these effects is that individuals reporting a larger number of siblings may be disproportionately represented by those who have many half and step siblings from their parents' remarriage. For example, someone who reports having 20 siblings may only be coresident with 3 of them.

Therefore, we do not know how much competition for parental resources occurred between each sibling. If individuals who have a large number of siblings are individuals with more half siblings, but less full siblings, there might be a false correlation between sibling number and education. Similarly, there is a chance that individuals are not sharing parental resources with some siblings due to large age gaps such that siblings are already adults during the time of the individual's childhood, or the individual has finished school by the time the sibling is born. This may be true especially for, but not limited to, the case of step siblings and half siblings, which further contributes to the ambiguity of using sibship size as a measure of competition. Additionally, individuals who have adult siblings during childhood could potentially see benefits in education if adult siblings are able to invest time or money into their younger siblings. Jokela et al. (2010) find that in the US, Black men show larger increases in fertility from serial monogamy than White men. If this distinction means that individuals in Black families are more likely to have half and step siblings than in White families, then this effect may be an important confounder of the observed differences in sibship size-education relationships between Black and White families. Future studies would greatly benefit by having more fine-grained data on the actual household compositions of the surveyed individuals to tease out the degree of competition for resources that exists within each household.

Finally, the GSS data does not specify the geographic location of its participants. Therefore, while my study uses race and year groups as proxies for understanding the interaction between individual and environment, it fails to account for variations in geographic space. An individual's resident location is expected to be important on multiple factors. The opportunities for high paying jobs are concentrated in cities, and even within cities, there may be variation within communities. On a larger scale, living in the North versus the South should have

important effects on the relationship between education and later life opportunities for earlier cohorts because industrial enterprise proliferated in the Northern states, and because being in the North versus the South has considerable consequences for the opportunities afforded to Black people due to segregation laws. Future studies could investigate how this historical distinction affected the value of investing in education for different groups.

CONCLUSION

The causes of declining fertility rates across nations have been widely debated among social scientists. Evolutionary anthropologists seek to explain how our past may have shaped our psychology in ways that produce the relationships between current environments and patterns of behavior. Reduced fertility does not seem to be a strategy that produces adaptive results today, but rather a consequence of the human propensity to pursue opportunities to improve the status of their children when possible. Economic development following industrialization cedes ecological conditions characterized by a heightened importance of education on status and opportunities for social mobility, favoring reduced family size in exchange for maximum investments to children's embodied capital. However, a more detailed understanding of this process requires us to incorporate structural factors that unequally allocate status enhancement potentials within populations. I have shown that in the US, the tradeoff between family size and children's education is different for Black and White individuals and corresponds with patterns of racial discrimination that persisted in history. This effect could explain why on average Black families decreased their family sizes later than white families in the US. This study shows the importance of historical and cultural phenomenon on understanding behavioral patterns, even when taking evolutionary viewpoints.

REFERENCES

Adams, James Truslow. The Epic of America. NYC, NY: Cornwall Press, 1931. Print.

Alvergne, A. and Lumma, V. (2014). Ecological variation in wealth-fertility relationships in Mongolia: The 'central theoretical problem of sociobiology' not a problem after all? *Proc. R. Soc. B*. 281: 20141733. doi: 10.1098/rspb.2014.1733

Andrews, D. and Leigh, A. (2009). More inequality, less social mobility. *Applied Economics Letters,* 16(15): 1489-1492. doi:10.1080/13504850701720197

Anh, T. S, Knodel, J., Lam, D., and Friedman, J. (1998). Family size and children's education in Vietnam. *Demography,* 35(1): 57-70. doi:10.2307/3004027

Bavel, J. V. (2006). The effect of fertility limitation on intergenerational social mobility: The quality-quantity trade-off during the demographic transition. *J. biosoc. Sci,* 38: 553-569. doi: 10.1017/S0021932005026994

Bentley, G., Goldberg, T., and Jasienska, G. (1993). The fertility of agricultural and non-agricultural traditional societies. *Population Studies,* 47: 269-281. https://www.jstor.org/stable/2174730

Bertrand, M. and Mullainathan, S. (2004). Are Emily and Greg more employable than Lakisha and Jamal? A field experiment on labor market discrimination. *American Economic Review, 94*(4): 991-1013. doi: 10.1257/00028280420002561

Borgerhoff Mulder, M. (1998). The demographic transition: are we any closer to an evolutionary explanation? *Trends in Ecology & Evolution,* 13(7): 266-270. doi: S0169-5347(98)01357-3

Burtless, G. and Jencks, C. (2003) American inequality and its consequences, in Agenda for the Nation (Eds) H. Aaron, J. M. Lindsay, and P. S. Nivola, Brookings, Washington DC, pp. 61–108.

Buss, D. M. (2009). Evolutionary Psychology: a new paradigm for psychological science. *Psychological Inquiry,* 6(1):1-30. doi:10.1207/s15327965pli0601_1

Clark, G. and Hamilton, G. (2006). Survival of the richest: the Malthusian mechanism in pre-industrial England. *The Journal of Economic History,* 66(3): 707-736. doi: 100.1017/S0022050706000301

Colleran, H. (2016). The cultural evolution of fertility decline. *Phil. Trans. R. Soc. B*, 371: 20150152. doi:10.1098/rstb.2015.0152

Colleran, H. and Snopkowski, K. (2018). Variation in wealth and educational drivers of fertility decline in 45 countries. *Population Ecology,* 60:155169. doi:10.1007/s10144-018-0626-5

NORC. (2021). *General Social Surveys, 1972-2021* [Data set]. NORC at the University of Chicago. Data retrieved July 2022 from gssdataexplorer.norc.org.

Durlauf, S. (1996) A theory of persistent income inequality, *Journal of Economic Growth*, 1: 75–93. https://www.jstor.org/stable/40215882

Eloundou-Enyegue, P. M. and Williams, L. B. (2006). Family size and schooling in sub-Saharan Africa settings: A reexamination. *Demography,* 43(1): 25-52. doi: 10.1353/dem.2006.00002

Gilbert, K. L., Ransome, Y. Dean, L. T., DeCaille, J. and Kawachi, I. (2022). Social capital, black social mobility, and health disparities. *Annu. Rev. Public Health,* 43: 173-91. Doi: 10.1146/annurev-publhealth-052020-112623

Goldin, C. and Katz, L. (1999). Education and income in the early 20th century: evidence from the prairies. *Journal of Economic History,* 60(3): 7882-818. doi: 10.1017/S0022050700000334

Goodman, A., Ilona, K., and Lawson, D. W. (2012). Low fertility increases descendant socioeconomic position but reduces long-term fitness in a modern post-industrial society. *Proc. R. Soc.,* 279: 4342-4351. doi: 10.1098/rspb.2012.1415

Guyer, B., Freedman, M. A., Strobino, D. M., and Sondik, E. J. (2000). Annual summary of vital statistics: trends in the health of Americans during the 20th century. *Pediatrics,* 106(6): 1307-1317. doi:10.1542/peds.106.61307

Hackman, J. V. and Kramer, K. L. (2021). Balancing fertility and livelihood diversity in mixed economies. *PLoS ONE,* 16(6): e0253535. doi:10.1371/journal.pone.0253535

Hagen, E. H., Barrett, H. C., and Price, M. E. (2006). Do human parents face a quantity-quality tradeoff?: Evidence from a Shuar community. *American Journal of Physical Anthropology,* 130: 405-418. doi: 10.1002/sjpa.20272

Harcourt, A. H. (1987). Dominance and fertility among female primates. *J. Zoo., Lond.,* 213: 471-487. doi:10.1111/j.1469-7998.1987.tb03721

Harris, B. (2022). *Racial inequality in the United States*. U.S. Department of the Treasury. https://home.treasury.gov/news/featured-stories/racial-inequality-in-the-united-states

Haynes, B. (2006). Black undergraduates in higher education: an historical perspective. *African Americans: Struggle for Recognition in the Academy,* 17(2): 8-21.

Henrich, J. and McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology,* 12:123-135. doi: 10.1002/evan.10110

Jokela, M., Rotkirch, A., Rickard, I. J., Pettay, J., and Lummaa, V. (2010). Serial monogamy increases reproductive success in men but not in women. *Behavioral Ecology,* 21(5): 906-912. doi: 10.1093/beheco/arq078

Kaplan, H. S., Lancaster, J. B., Johndon, S. E., and Bock, J. A. (1995). Does observed fertility maximize fitness among New Mexican men? A test of an optimality model and the new theory of parental investment in the embodied capital of offspring. *Human Nature, 6*(4): 325-360. doi: 10.1007/BF02734205

Keister, L. A. (2004). Race, family structure, and wealth: the effect of childhood family on adult asset ownership. *Sociological Perspectives, 47*(2): 161-187. doi:10.1525/sop.2004.47.2.161

Kremer, M. and Chen, D. L. (2002). Income distribution dynamics with endogenous fertility. *J. Econ. Growth,* 7: 277-258. doi: 10.1023/A:1020154031908

Lack, D. (1947). The significant of clutch-size. *Ibis,* 89: 302-352. doi: 10.111/j.1474-919X.1947.tb04155.x

Lawson, D. W. And Borderhoff Mulder, M. (2016). The offspring quantity-quality trade-off and human fertility variation. *Phil. Trans. R. Soc. B* 371: 2015014. doi: 10.1098/rstb.2015.0145

Lesthaeghe, R., and Wilson, C. (1986). Modes of production secularization and the pace of the fertility decline in Western Europe 1870-1930, in *The Decline of Fertility in Europe* (Coale, A.J. and Watkins, S.C., eds) pp 261-292, Princton University Press. doi: 10.1515/9781400886692-011

Majolo, B., Lehmann, J., de Bortoli, V. A., Schino, G. (2012). Fitness-related benefits of dominance in primates. *Am. J. Phys. Anthropol,* 147: 652-660. doi: 10.1002/ajpa.22031

Maralani, V. (2008). The changing relationship between family size and educational attainment over the course of socioeconomic development: evidence from Indonesia. *Demography,* 43(3):693-717. doi:10.1353/dem.0.0013

McElreath, R. (2021). rethinking: statistical rethinking book package, R package version 2.21

Meij, J. J., Van Bodegom, D., Ziem, J. B… and R. G. J. Westendorp. (2009). Quality-quantity trade-off of human offspring under adverse environmental conditions. *J. Evol. Biol,* 22: 1014-1023. doi:10.1111/j.1420-9101.2009.01713.x

Mithun, J. S. (1973). Cooperation and solidarity as survival necessities in a Black urban community. *Urban Anthropology, 2(1), 025–034. http://www.jstor.org/stable/40552636*

Nettle, D. and Pollet, T. V. (2008). Natural selection on male wealth in humans. *The American Naturalist,* 175(5): 658-666. doi: 10.1086/591690

Pallikadavath, S. and Wilson, C. (2005). A paradox within a paradox: schedules caste fertility in Kerala. *Economic and Political Weekly,* 40(28): 3085-3093. http://www.jstor.org/stable/4416878.

Rauchway, E. (2009). An economic history of the United States 1900–1950. In A Companion to the Modern American Novel 1900–1950, J.T. Matthews (Ed.). doi:10.1002/9781444310726.ch1

Scelza, B. A. (2010). Fathers' presence speeds the social and reproductive careers of sons. *Current Anthropology, 51*(2), 295–303. Doi:10.1086/651051

Shavit, Y. and Pierce, J. L. (1991). Sibship size and educational attainment in nuclear and extended families: Jews in Israel. *American Sociological Review,* 56(3): 321-330. doi:10.2307/2096107

Shenk, M. K., Kaplan, H. S., and Hooper, P. L. (2016). Status competition, inequality, and fertility: Implications for the demographic transition. *Phil. Trans. R. Soc. B,* 375:20150150. doi:10.1098/rstb.2015.0150

Shutts, K., Kinzler, K. D., McKee, C. B., and Spelke, E. S. (2009). Sensitivity to communicative relevance tells young children what to imitate. *Developmental Science,* 12(6): 1013-1019. doi: 10.111/j.1467-7687.2009.00861.x

Taylor, M. G. (2013). Gender influences on children's selective trust of adult testimony. *Journal of Experimental Child Psychology,* 115(4): 672-690. doi:10.1016/j.jecp.2013.04.003

U.S. Department of Education. (1993). *120 Years of American education: A statistical portrait*. Center for education statistics.

Vandenbroucke, G. (2016). *The link between fertility and income*. Federal Reserve Bank of St. Louis. https://www.stlouisfed.org/on-the-economy/2016/december/link-fertility-income

Vining, D. R. (1986). Social versus reproductive success: the central theoretical problem of human sociobiology. *Behav. Brian Sci,* 9: 167-187. doi: 10.1017/S0140525X00021968

Von Rueden, C. R. & Jaeggie, A. V. (2016). Men's status and reproductive success in 33 nonindustrial societies: Effects of subsistence, marriage system, and reproductive strategy. *PNAS*, 113(39): 10834-10829. doi: 10.1073/pnas.1606800113