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Black-White Differences in the Process of Educational Reproduction*

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Biographical information

Vida Maralani is Assistant Professor of Sociology at Yale University and works on a range of topics related to social stratification and demography. She studies educational stratification and inequality, intergenerational processes, social demography, and the pathways that link education and health. Her work examines the connections between education and demographic processes such as marriage, fertility, and mortality, especially with regards to the intergenerational effects of increases in women's education. She also studies why different subgroups acquire different levels of schooling, differences in age patterns of school entry and completion, and how educational inequalities persist or change. Another line of research examines the role that schooling plays in the production of health inequalities, and whether and how these pathways differ across groups.

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Abstract

Increases in women's schooling represent one of the most fundamental and wide-reaching socioeconomic changes of recent decades. But how much will future generations benefit from these gains in women's education? And will black and white Americans benefit equally? Using data from the PSID, this study combines a model of educational stratification with a demographic model of population renewal and uses simulations to examine differences in patterns of educational reproduction for black and white Americans. Results show that ignoring the intergenerational effects that accrue via differences in assortative mating, marital status, and differential fertility by race underestimates intergenerational effects for whites and overestimates them for blacks. Still, the benefits for children of increases in women's schooling in the parent generation are substantial, and are converging across cohorts for white and black Americans.

Introduction

Increases in women's schooling represent one of the most fundamental and wide-reaching socioeconomic changes of recent decades. In most developing countries girls have made large gains in primary and secondary schooling, while young women in many industrialized nations are pursuing post-secondary schooling in unprecedented proportions. Indeed, women now outpace men in rates of college completion in the United States, Canada, and much of Europe. In 2004, for example, women received 58% of all bachelor's degrees awarded in the U.S. and this advantage was even larger for some groups, such as black women, who earned 67% of college degrees received by African Americans (Buchmann and DiPrete 2006). Given the important role that educational attainment plays in processes of social, economic, and health stratification, these expansions in American women's schooling have attracted much attention both in the academic literature and in the popular press (Goldin 1992; Fonda and Berryman 2000; Marklein 2005; DiPrete and Buchmann 2006; Buchmann and DiPrete 2006). Few studies, however, have explored the implications of women's educational gains for intergenerational mobility and educational inequality in future generations. The intergenerational effects of women's schooling are particularly important because parents' education is an important determinant of children's outcomes (Blau and Duncan 1967, Mare 1981). Individuals with more schooling have children who obtain more schooling—a mechanism that transmits and multiplies the advantages of increased educational attainment across generations. Two important questions, then, remain unanswered. First, how much will future generations benefit from women's educational gains? And, second, will Americans of different race/ethnic backgrounds benefit equally?

The answers to these questions are not straightforward. Intergenerational effects involve a complex set of relationships that operate at both the family and population level, may be offsetting or reinforcing, and that differ in important ways for Americans of different race/ethnic backgrounds. Intergenerational effects accrue via two sets of pathways or mechanisms. The more familiar set, which has inspired much of the research in social stratification, describes associations at the family level between parent's statuses and children's statuses—for example, the correlation between parent's education and child's education (Blau and Duncan 1967; Jencks et al. 1972; Haveman and Wolfe 1994; Bowles, Gintis, and Groves 2005). The second set of intergenerational pathways, which is less studied but equally important, describes how the statuses of parents affect demographic processes such as marriage, fertility, and mortality that intervene between generations and *create* the very families within which statuses are transmitted (Duncan 1966; Preston 1974; Lam 1986; Mare 1996). Measuring the intergenerational effects of increases in women's schooling, for example, is complicated by the fact that the processes that create generations, such as marriage and childbearing, are endogenous to changes in women's schooling. That is, women with different levels of schooling have substantially different patterns of marriage and fertility. Given that schooling is usually completed early in life, increases in women's schooling quite likely change subsequent marriage and fertility choices as well. To measure the intergenerational effects of increasing women's schooling, one must consider both family level correlations in status and the intergenerational effects that accrue via changes in patterns of family formation (Mare and Maralani 2006, Maralani and Mare 2005). Consider a hyperbolic example, at least for the United States. If women with college degrees bore half as many children as women with only high school completed, then a large increase in college educated women such as the one we have experienced in the U.S. would greatly decrease the number of children born in the next generation who could benefit from having highly educated mothers. In this case, ignoring differential fertility by education would overstate the intergenerational effects of women's post-secondary gains despite the benefits suggested by the correlations between parent's and children's educational status.

Patterns of stratification and family formation differ by race/ethnicity and nativity status.[1] Past research shows that both sets of intergenerational mechanisms—the association of status within families and the population processes that create families—differ substantially for white and black Americans. Moreover, recent changes in patterns of family formation have only sharpened these differences. In recent decades American families have changed in important ways that are closely tied to women's education and race. For both white and black college educated women, the ages at which women marry and have children have increased across cohorts. College educated women in more recent cohorts do not forgo marriage and childbearing, rather they delay it. Women with less schooling, on the other hand, who postpone marriage and childbearing have relatively lower rates of marriage and fertility at older ages (Martin 2004; Rindfuss, Morgan, and Offutt 1996). There has also been substantial growth in the number of single parent families, primarily among women with less schooling and among African Americans (Ellwood and Jencks 2004). These divergent trends in single parenthood by education and race combined with changing levels and timing of marriage and fertility have transformed patterns of family formation across cohorts. Most studies of social mobility ignore these demographic processes and focus only on the associations between parents' statuses and children's statuses. This approach, however, is of diminishing value especially with regards to race/ethnic differences in educational reproduction. As family processes and educational attainment have become, on the one hand, more closely tied and, on the other hand, more differentiated across subgroups, understanding race/ethnic differences in educational reproduction requires considering both the direct transmission of family status and the population processes that transform one generation into the next. The demography of educational reproduction, and the role it plays in explaining

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[1] Because data on multiple generations of the sort analyzed below is quite limited for groups other than white and black Americans, I limit the remainder of the discussion and the empirical analysis to differences between

differences in transmission processes by race, has been largely ignored in the social stratification literature.

This study examines how increases in women's schooling combined with differences in patterns of family formation create differences in the process of educational reproduction for black and white Americans. Specifically, what is the total intergenerational effect of increases in women's schooling considering a more complete set of family and population level pathways? Do these effects differ for black and white Americans? Do differences in marriage and fertility patterns by race and education amplify or dampen the transmission of educational status, and if so, by how much? Finally, how have these patterns changed across birth cohorts? To answer these questions, I combine a model of educational stratification with a demographic model of population renewal and use a series of simulations to examine differences in patterns of educational reproduction for black and white Americans. I assess the implications of demographic trends such as delayed fertility and marriage, non-marital fertility, and race and cohort differences in these demographic mechanisms on patterns of intergenerational effects.

To preview the results, the process of educational reproduction differs in important ways for white and black Americans. Increases in women's schooling in the parent generation reduce the proportion of daughters with less than high school completed more for whites and increase the proportion of daughters with college completed more for blacks. Intergenerational effects increase across birth cohorts for both white and black Americans for daughters at the bottom of the education distribution. For daughters with college completed, intergenerational effects are constant across cohorts for whites and decrease across cohorts for black Americans. Overall, ignoring the intergenerational effects that accrue via population processes underestimates the intergenerational effects of increasing women's schooling for

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these groups. This lack of available data is unfortunate, however, because differences in processes of white Americans and overestimates them for black Americans. The combined effect of family level correlations and positive assortative mating explain much of the patterns for white families. In contrast, larger direct effects of mother's education on child's education and offsetting effects of differential fertility explain the patterns for black Americans. Overall, however, the benefits to children of increases in women's schooling in the parent generation are substantial, and converging across cohorts for white and black Americans.

How Generations Are Created and Statuses Transmitted

The intergenerational ties between the schooling of parents and children are a central concern in social stratification research. Much of this research shows that children of better educated parents get more schooling than the children of less educated parents (Jencks et al. 1972; Featherman and Hauser 1978; Mare 1981). Although these studies highlight the importance of the intergenerational transmission of educational status, few include the effect of changes in education on the components of the population renewal process when estimating intergenerational effects (for some exceptions see Mare 1996, Mare 1997, Maralani and Mare 2005, Mare and Maralani 2006). Yet patterns of family formation and family structure can benefit or impinge on children in numerous ways. Couples' choices about how many children to have determine the number of siblings with whom a child grows up. When in life individuals bear children determines whether their children have older or younger parents, the spacing of their children, and part of children's exposure to single parent households. Marriage decisions provide the other part of children's exposure to single parent households and determine the education of children's fathers (for marital births). Thus, these demographic mechanisms determine many family characteristics that research has shown to predict children's outcomes. Children who live with both parents, for example, obtain more schooling than those living with single mothers (McLanahan and Sandefur 1994). Children

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educational reproduction and mobility for other ethnic and immigrant groups are an important area of research.

with older parents also obtain more schooling (Mare and Tzeng 1989; Powell, Steelman, and Carini 2006) while children with more siblings, especially ones that are near in age, obtain less schooling on average (Blake 1989; Powell and Steelman 1993). Moreover, children of highly educated women are more likely to have a highly educated father, which amplifies the benefits to children (Mare and Maralani 2006).

But these family characteristics have different effects for black and white children. For example, relative to mother's schooling, father's schooling has a smaller effect on children's schooling for blacks, while for whites, father's schooling has a larger effect (Kane 1994). Similarly, the association between family size and children's schooling is weaker for blacks than for whites (Kuo and Hauser 1995). And the negative effect of non-intact families on children's schooling may be smaller for black children (Kuo and Hauser 1995; Hauser and Phang 1993; Haurin 1992; Dunifon and Kowaleski-Jones 2002). Race-ethnic differences in social mobility are a particularly important area of research because these differences represent a long-standing facet of inequality in the United States (Duncan 1967; Duncan 1968). Historically, blacks have experienced higher levels of downward mobility and much lower rates of upward income mobility than whites (Duncan 1968; Hout 1984; Hertz 2005). On average, black Americans begin life with lower levels of parental socioeconomic status, have lower average occupational standing, and are less able to convert their educational attainment to higher occupational status (Duncan 1967; Duncan 1968; Bielby, Hauser, and Featherman 1977; Featherman and Hauser 1976; Hout 1984). Thus, differences in patterns of intergenerational effects by race are an important and enduring part of the landscape of social stratification in the United States.

In addition to the family-level processes described above, differences in marriage and fertility by race operate at the population level as well. Education differences in total fertility, for example, are larger within rather than across race groups. Black women with 12 or fewer years of schooling have a higher total fertility rate (TFR) than their white counterparts, whereas black women with 13 or more years completed have a similar TFR to white women at this same level of schooling (Johnson 1979; Yang and Morgan 2003). This means that increasing women's schooling across these education thresholds would predict a larger drop in total fertility for black women than white women. Education differences in marital status are also much larger for black women. Black women at the top of the education distribution are more likely to be married than black women with less schooling. In contrast, differences in marital status by education are much smaller for white women (Elwood and Jencks 2004: figure 1.18). Once aggregated, these race differences in total fertility and marriage reweight the population differentially for black and white Americans. These changes in population composition are an important and often overlooked part of the intergenerational effects of parent's status.

This effort to measure both the family level effects of parents on children as well as those effects that accrue through population processes that are endogenous to parents' characteristics builds on two literatures. It brings together traditional status attainment research that focuses on intergenerational social mobility (Blau and Duncan 1967; Jencks et al. 1972; Featherman and Hauser 1978; Haveman and Wolfe 1994, Bowles et al. 2005) with formal demographic approaches of population projection that describe how groups sort and reproduce across generations (Mukherjee 1954; Matras 1961; Duncan 1966; Matras 1961; Preston 1974; Lam 1986; Preston and Campbell 1993; Mare 1996). I build on earlier work that developed new methods for estimating the effects of family socioeconomic background on educational attainment using models that account for marriage and fertility and data from Indonesia (Mare and Maralani 2006, Maralani and Mare 2005). The current paper extends this approach to the American context and incorporates the complex demographic patterns of this setting, including delayed marriage, never marrying, non-marital fertility and differences in these demographic patterns by race in assessing black-white differences in the intergenerational transmission of educational status. I also consider differences by birth cohort, address the concern that some mechanisms may be jointly determined, and check the robustness of the results to assumptions about the marriage market. A key conceptual and methodological contribution of the current study is to combine micro-level data with population projection methods in order to account for individual level correlations between different intergenerational pathways and unobserved heterogeneity at the individual or family level. The formal demographic studies referenced above did not address these issues or use this type of blended micro-macro approach.

Research Design

The research design combines a demographic model of how a generation of women produces a generation of offspring with a stratification model that describes the association between children's schooling and parent's schooling. This approach captures four mechanisms or pathways for intergenerational effects. Each mechanism is summarized by a statistical model. One pathway is the direct association between parents' schooling and children's schooling, which I call the transmission process. This corresponds to the conventional approach often used to assess the effect of parents' statuses on children's statuses. In this model, child's schooling is the dependent variable and mother's and father's schooling are key independent variables. Other covariates in the transmission model include number of siblings, exposure to single parent households, and mother's birth cohort. I also consider three additional mechanisms, which relate a woman's education to her marriage and fertility experiences: (i) conditional on her education, the probability that a woman will be married at each age from 15 to 62; (ii) conditional on her education, the education of her husband if she marries; and (iii) conditional on her own education, her marital status, and her husband's education if she is married, the probability of having a birth at each age from 15 to 44.

Each of these four mechanisms – transmission, marriage, assortative mating, and fertility – contributes to the total intergenerational effect of increases in women's schooling. Taken together, these mechanisms relate the education distribution of women in one generation to the education distribution of the next generation.[2] In addition to the family level effects discussed above, these demographic mechanisms also have population level effects by determining the number and types of families that are produced in the population from one generation to the next.

The statistical models that describe the relationships between women's education and these pathways of intergenerational effects are estimated using individual level data and control for differences by age and cohort. I estimate each model separately by race. I use the parameter estimates generated by these models to calculate expected probabilities of marriage, fertility, and transmission of educational status. I use these estimates in a series of simulations that compare the combined or total effect of increases in women's schooling in the parent generation on the schooling of the next generation by race and cohort. The simulations also assess how differences in marriage and fertility patterns by race and cohort amplify or dampen the effects of increases in women's schooling across generations.

The simulations draw out nonlinearities and interactions within and across the intergenerational pathways that would otherwise be difficult to describe using the estimated parameters or predicted probabilities. More importantly, the simulations describe counterfactuals not available in any observed data. That is, these allow one to assess what women's marriage and fertility choices and the subsequent attainment of their children *might have been* had the women had a different level of schooling than they did in the observed data. For example, given a hypothetical increase in her schooling, the simulations allow a

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[2] For simplicity, I have omitted maternal and child mortality from the current analysis. Although black-white differences in infant mortality are an enduring dimension of inequality in the U.S., previous work suggests that the estimated intergenerational effects that accrue via differences in maternal and child survival are modest,

woman to marry a man with a different level of education than her observed husband's education, or have fewer or more children than in her observed brood. The simulations accomplish this by generating predicted life courses that allow for changes both in the associations between parents' education and children's education and in women's marriage and fertility "choices" for a given hypothetical increase in educational attainment.

Formal Model

To begin, assume that schooling is completed before marriage and or first birth and that women can marry whatever kind of men (at least with respect to education) that they or their families choose. For women and children, completed schooling is specified in four discrete but ordered categories: 0-11 years, 12 years, 13-15 years, and 16 or more years. For husbands, completed schooling has three discrete but ordered categories: 0-11 years, 12 years, 13 or more years.[3] Let C_j be the children in the offspring generation with education level j and W_i be the number of women in the mother generation with education level i. Let $r_{jka|i}$ be the number of children who attain education level j, with a father with education level k, born at mother's age a, per woman who has attained education level i. This can be thought of as an intergenerational transmission rate weighted by differential fertility and marriage. I set husbands'/fathers' education (k) equal to zero if a woman is not married. Thus, $i = 1, \ldots, 4$; $j = 1, \ldots, 4$; $k = 0, \ldots, 3$. Let age, a, range from 15 to 62 in single years. Then,

$$(1) \qquad C_j = \sum_{i=1}^{4} \sum_{k=0}^{3} \sum_{a=15}^{62} r_{jka|i} W_i \ .$$

Given the $r_{jka|i}$ one can compute the expected number of children of education level j born to a mother with education level i. If one knows the educational distribution of women at a

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even in a developing country where educational differences mortality are moderately high (Maralani and Mare 2005).

given point in time, then this equation can project the educational distribution of children in the next generation. One can also simulate the change in C_j if the distribution of W_i were modified or if the distribution of W_i differed by cohort or race.

Marriage, fertility, and intergenerational transmission affect the $r_{jka|i}$ as follows:

$$(2) \qquad r_{jka|i} = p^{H}_{k|ai} p^{F}_{kai} p^{T}_{j|kai},$$

where the components denote the following:

- $p^{H}_{k|ai}$ denotes the probability that a woman in the i^{th} education category has a husband in the k^{th} education category when she is age a. When k equals zero, this is the probability that she is unmarried. When k is greater than zero, this is the probability that she is married to a man in the given education category.
- p^{F}_{kai} denotes the probability that a woman in education category i who has a husband in category k (or who is unmarried if k=0) has a birth at each age a. p^{F}_{kai} is constrained to zero for ages 45 to 62. The model does not allow for multiple births.
- $p^{T}_{j|kai}$ denotes the probability that a child born to a woman in the i^{th} education category at age a with a man in the k^{th} education category (or unmarried if k=0) achieves the j^{th} level of schooling.

In this model only women's educational attainment is exogenous. The joint distribution of marital status, husband's schooling, fertility, and offspring's schooling is endogenously

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[3] In the data used for this analysis (described below), there are too few African American men with college education, especially in the older birth cohorts, to support the four category version of schooling used for women and children.

determined by women's schooling. I discuss this feature of the approach in more detail below.

The model specified above is highly flexible. It allows women to delay or forgo marriage and or fertility. Thus, a given change in women's schooling can change the relationships at the individual level as well as at the population level by changing the numbers and types of families that are produced. Specified in single years of age, the model allows age-specific variation in the likelihood of being married as well as marital and nonmarital fertility. It also distinguishes between the ages at which children's parents are married and those in which the mother is unmarried as a result of never marrying, divorce, or widowhood. In this way, the model allows for an accounting of the number of years children are expected to live in a two-parent household from birth through age 18, conditional on women's schooling.

The model also makes some simplifications. It does not include a formal treatment of divorce or remarriage, and does not distinguish between biological and step fathers. It ignores genetic ties between generations, maternal and child mortality, cohabitation, and uses a woman's completed education at all ages, rather than the education she actually had at each specific age (see Maralani and Mare 2005 for a formal treatment of mortality in the Indonesian context). While it is possible to include each of these complications in the approach described above, these are omitted here for the sake of simplicity. The current model captures the mechanisms most sensitive to changes in women's schooling and formalizes the changes that occur via both levels and timing through these mechanisms. Despite these simplifications, the current model goes far beyond a conventional model of intergenerational effects in specifying a more complete set of pathways between the statuses of parents and those of their children.

The model allows education to affect fertility, but in the U.S., the effect of fertility on schooling has also been of central concern. Although there is a continuing debate about whether or not fertility has a causal effect on completed schooling, there is nonetheless a large literature that focuses on the negative effects of early fertility on educational attainment (Rindfuss, Bumpass, and St. John 1980; Hofferth et al. 2001; see Hoffman 1998 for a review of the controversy). While the effects of fertility on schooling are important, the approach described here focuses only on the effect of changes in education on future fertility and marriage. The model assumes that women's completed education does not depend on their fertility.

In its simplest form, the model assumes a marriage market in which men's attainments are entirely endogenous to those of women, and women can marry men with whatever level of education they choose. This allows the men's education distribution to change freely in response to changes in the women's education distribution. This assumption may not hold, however, if the men's education does not keep pace with changes in women's schooling. If the women's educational distribution is systematically advantaged relative to men's distribution, as is currently the case in the United States, then the marriage market may be constrained in ways not captured by the model. Theories of constrained marriage markets have been especially important in discussions of African American family patterns (Wilson 1987). To examine the sensitivity of the results to assumptions about the marriage market, I also consider a constrained marriage market in which gains in women's schooling are not matched by similar gains in men's schooling. In this hypothetical marriage market, the male education distributions are constrained to the observed sample distributions for white and African American men.

Estimation Method

I estimate the components of equation (2) using three separate statistical models: one for marital status, one for assortative mating, and a joint model of fertility and educational transmission. The first two models estimate the first term in equation (2), $p^H_{k|ai}$, in two independent parts: a binary logit model predicting the probability of being married at each age, and conditional on being married, an ordered logit model predicting the probability of having a husband in each education category. The remaining two terms representing the fertility and transmission processes (p^F_{kai} and $p^T_{j|kai}$) are estimated jointly using a two-equation model with a woman-specific random intercept in each equation and an estimated covariance between the two random intercepts. The fertility equation is a binary logit model predicting the probability of a birth at each age (the birth may be marital or nonmarital). The children's schooling equation is an ordered logit model predicting the probability of having a child in each education category. Many sample women have observations in both the fertility and child schooling samples, and women with more than one eligible child have multiple observations in the child schooling sample. The fertility and child schooling equations are related in the following way (*a* indexes age, *w* indexes women, *m* indexes different children of the same woman, and μ_1 and μ_2 are woman-specific random factors):

$$(3) \qquad \text{Fertility}_{aw} = f(X'_{aw}\beta + \mu_{1w} + \omega_{aw}),$$

$$(4) \qquad \text{Child's Education}_{mw} = g(Z'_{mw}\gamma + \mu_{2w} + \eta_{mw}),$$

where $\mu_{1w} \sim N(0, \sigma_1^2)$, $\mu_{2w} \sim N(0, \sigma_2^2)$, with estimated correlation ρ; $\omega_{aw} \perp \eta_{mw} \perp \mu_{1w} \perp \mu_{2w}$; and $E(\omega_{aw}) = E(\eta_{mw}) = 0$. β and γ, which are vectors, and σ_1^2, σ_2^2, and ρ, which are the variances of the random factors and their correlation, are parameters to be estimated. Equations (3) and (4) are estimated simultaneously using maximum likelihood. This joint structure allows for separate woman-specific unobserved factors in the fertility and transmission processes and allows these to be correlated within individual women.[4] This joint random-effects structure begins to address two concerns. The first is that each woman may have constant but unobserved characteristics, for example, her temperament or motivation, which influence her family size and her children's outcomes. The second is that these characteristics may be correlated such that her fertility and children's outcomes are also correlated.[5]

Table 1 presents a summary of the statistical models used to compute the components of equation (2). I control for birth cohort and age in all models, and allow all parameters to vary by race in order to capture differences across groups in these demographic processes. These statistical models describe the relationship between women's schooling and various intergenerational mechanisms, and how these differ for black and white Americans. The goal is not to build a complete behavioral model for each mechanism. Rather, for each model, I use specifications that capture important interactions or nonlinearities and that reproduce the meaningful patterns present in the observed data as closely as possible.

I use predicted probabilities from these statistical models and actual or hypothetical values of observed characteristics of women and their husbands to compute an estimate of $r_{jka|i}$.

That is,

$$(5) \qquad \hat{r}_{jka|i} = \hat{p}^{H}_{ka|i}\hat{p}^{F}_{kai}\hat{p}^{T}_{j|kai},$$

where ^ denotes predicted values and all other notation is as defined above. Given the $\hat{r}_{jka|i}$ for each woman in the parent generation, the expected number of persons in the offspring

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[4] Models are estimated used GLLAMM, a Stata module for maximum likelihood estimation of Generalized Linear Latent and Mixed Models (StataCorp 2007; Rabe-Hesketh, Pickles, and Skrondal 2001) and aML version 2.0 (Lillard and Panis 1998).

[5] The concern that family size and children's outcomes may be correlated is well documented in the literature, and thus seems like the most obvious assumption to relax. With more assumptions and structure, one could also estimate a more complicated system that allows marriage to be correlated with either fertility or children's

generation who attain education level *j* is the sum over all women's and husbands' education categories and women's ages, or $\widehat{C}_j = \sum_i \sum_k \sum_a \hat{r}_{jka|i} W_i$. As discussed in further detail below, I compute the $\widehat{C}_j$ under several scenarios that vary given a hypothetical increase in women's schooling in the parent generation and which of the effects of women's education on marriage, fertility, and child's schooling (specified in the $\hat{r}_{jka|i}$) are allowed to operate in the simulation.

Identification

The random intercepts in equations (3) and (4) are identified using multiple observations on individuals. The fertility data include up to 30 woman-year observations over women's reproductive years with births distributed across these years. The transmission data include multiple children per woman for at least 75% of the women in the transmission sample. Further, all but a handful of women with children in the transmission sample also appear in the fertility sample. This means that the same women provide information for both the fertility and transmission process. This overlap identifies the correlation of the woman-specific random intercepts across the two equations. The joint model described by equations (3) and (4) has an added complication in that a transformation of the dependent variable in the fertility equation appears as a predictor in the transmission equation (number of siblings is total fertility minus one). In order to account for this dependence among the equations, the system requires an exclusion restriction. In the current model, age serves as an exclusion restriction between fertility and transmission—that is, woman's age is a predictor of fertility but not of children's schooling.

Data and Empirical Context

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schooling as well (Maralani and Mare 2008). For the sake of simplicity and tractability, I have not pursued that

The analysis uses the 1968 to 2003 public use waves of the Panel Study of Income Dynamics (PSID). The PSID is a longitudinal survey with a representative sample of U.S. individuals and their families. For the past three decades, the survey has followed original sample members and all new family members, tracking children from their families of origin to their new households. The survey includes extensive socioeconomic and demographic information and its multigenerational structure is well-suited to the types of models of intergenerational transmission presented above. I exclude the Latino and Immigrant samples from the analyses because these subsamples were observed for substantially fewer years than the original 1968 sample.

Although the PSID offers a unique opportunity to study intergenerational processes in the United States, the data are not without weaknesses. Two important shortcomings include high attrition in the first and second waves (14% and 11.5% respectively) and selective collection of family histories in order to reduce response burdens. As a result, the data include a moderately high amount of missing data, and a large number of people who flow into and out of the sample from one year to the next. Several studies confirm, however, that differential attrition in the PSID is small and that response rates are largely invariant across individual characteristics (Hill 1992). Once weighted, the data are generally representative of the original 1968 sampling population.

The analyses use observations from women ages 0 to 49 in the 1968 PSID household and their children. I divide women into three birth cohorts and control for cohort in all models. These cohorts include women born 1919-1938, 1939-1953, and 1954-1968, or alternatively, women ages 30-49, 15-29, and 0-14, respectively, in the first survey wave. When weighted, the sample is intended to represent female family members in U.S.

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here.

households in 1968.[6] Appendix Table A1 describes these cohorts in more detail. As expected, women's education has been increasing across cohorts for both whites and blacks and marriage and fertility levels have been declining.

I form four overlapping samples for estimating the statistical models. Many women contribute information to all four samples, and women observed in only some years or samples are included for the ages they are observed. Education is measured at age 25, and women who leave the survey before age 25 are excluded from the sample. Table 2 describes the educational attainment distributions and sample sizes of the women (and their husbands and children) used in estimating each statistical model. The most comprehensive sample is the one used for estimating the probability of being married from ages 15 to 62 (marital status sample). This sample includes 3,322 white and 2,734 black women. A woman is considered married at a given age if she reports being married at any point during the specified age. The assortative mating sample is a subset of the marital status sample, namely those women who ever married and for whom the PSID recorded husband's education. I use these samples to analyze the probability of being married at each age, and for those who marry and have valid education for their husbands, the probability of marrying a man in each educational category.[7]

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[6] When weighted, these sample cohorts are generally representative of women living in U.S. households in 1968 who were born during these year intervals. The 1939-1953 birth cohort may under-represent young adult members of 1968 households who were away at college if these individual were not reentered into the sample once they establish their own households, which the PSID design aimed to do.

[7] For women with multiple marriages (about 18% of women in the marriage sample), I use the education of the man to whom a woman was married for the longest time between her ages 15 and 44 (inclusive). If that man's education is missing, I use the education of the man from her next longest marriage. If an ever-married woman has no husbands who have ever resided in a PSID family, then husband's education is missing for that woman (8% of sample women). Each woman is assigned only one husband, and this husband is the same in both the fertility and transmission sample. The husband does not have to be the biological father of the woman's children, nor does he have to be present when the child is born. If, for example, a woman was married twice between ages 15 and 44, first for 3 years and then for 15, she is recorded as being married for 18 years but has only one husband's education for all married ages, that of the man from the 15-year marriage.

The fertility sample is a subset of the marital status sample with valid fertility histories. This sample includes 3,175 white and 2,297 black women.[8] The children's education (transmission) sample is a sample of children who ever resided in a PSID household and who were observed until at least age 25 to capture completed schooling. As with husbands, the PSID does not collect information on the education of children who have never resided in a PSID household. Although these children's births are captured in the fertility histories, their education is only observed if they resided in the household. Children's education is observed for approximately 81% of all the children listed in the fertility histories. Because few women in the youngest cohort are old enough to have children who are age 25 and older, I restrict the transmission sample to the children of women from the two older birth cohorts.

As shown in Table 2, about one fifth of the sample white women have 0-11 years of schooling, another two fifths have a high school degree, and one fifth have 13-15 years and 16 or more years, respectively. Black sample women are less advantaged educationally. About one third have 0-11 years of education, between 35 and 40% have only a high school degree and about one fifth have some college. Fewer than 10% of the black women in the sample(s) have a college degree or higher. Similarly, their husbands are more educationally disadvantaged than the husbands of white sample women. Overall, women in the marriage and fertility samples have a more advantaged educational distribution than those in the transmission sample because these former samples also include woman from the youngest birth cohort. For both whites and blacks, children have higher educational attainments than their parents, although white children obtain more schooling, on average, especially with regards to college completion.

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[8] If a woman has more than one birth at a given age, either because of twinning or births that are spaced less than a year apart, these are treated as having one birth at that age (1.4% of all births, N=182).

Table 3 summarizes the observed distributions of the four outcome variables by women's education. Marriage timing differs substantially by women's education for both whites and blacks. About 65% of white women in the lowest education category are married at age 20 compared to 17% of women in the highest education category. By age 30, however, differences between education groups narrow substantially. At this age, 87% of white women with 0-11 years of schooling are married compared to 78% of white women with college degrees. These patterns are similar for black sample women although the likelihood of being married is lower at all ages and across all education categories. Moreover, at age 30, the gap in the proportion married across education categories disappears for black women.

The distribution of husband's schooling shows positive assortative mating for both white and black Americans, although patterns differ between groups. White women are most likely to marry a man in the same education category whereas black women with 13 or more years tend to marry men with somewhat less schooling. As shown in Table 2, about 34% of black women have 13 or more years of schooling compared to only 25% of their husbands. Fertility declines monotonically with schooling for both whites and blacks. Average number of children ever born is about equal for white and black women with college degrees (about 1.8) while black women with fewer than 12 years of schooling have an average of 3.4 children compared to about 2.9 for similarly educated white women. Children's schooling shows two patterns. First, educational attainment has increased across generations. Second, children whose mothers have more schooling obtain high levels of schooling themselves. These patterns hold true for both groups.

Empirical Results

Education and Race Differences in Intergenerational Pathways

Appendix Tables A.2 to A.4 present parameter estimates from the multivariate statistical models described above, which correspond to the mechanisms included in the intergenerational model (marital status, assortative mating, fertility and transmission). I report robust standard errors for all models and correct for the clustering of multiple observations for the same woman. Figures 1 to 5 summarize the results of these models, and more importantly, the key patterns in the observed data. For each mechanism, I show results separately for the two oldest cohorts (1919-1938 and 1939-1953) to highlight changing patterns over time. The simulations use these two birth cohorts. For simplicity, I describe results only for daughters. There are no meaningful differences in the effects of women's schooling on children's schooling by sex of child.

Figure 1 shows the probability of being married at each age by women's education and race for the highest and lowest education categories. The predicted values for the other education groups fall within these bounds. The figure shows well-known differences in marriage levels by education and race. In both birth cohorts, white women with less than high school completed are more likely to be married at each age than their black counterparts. For women with a college degree in the 1919-1938 birth cohort, levels of marriage by race are similar until the mid 30s but higher for whites from age 35 onward. By the 1939 birth cohort, marriage levels have declined for both groups but more sharply for black women such that black college educated women have lower predicted probabilities of being married at each age relative to their white counterparts. But highly educated black women continue to have higher likelihoods of being married between ages 25 and 55 than black women with less than high school completed.[9]

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[9] Black-white differences in cohabitation are smaller than those for marriage, thus, the gaps shown here would be smaller if one considered both marital and cohabiting unions (Raley 1996). The current study ignores cohabitation because the data do not include complete cohabitation histories for all sample women.

Age patterns of marriage are similar across groups. For both black and white women with fewer than 12 years of schooling, the probability of being married rises quickly from age 15 to 20, then peaks and declines slowly. Women with a college degree, in contrast, are much less likely to be married before age 20. Instead, their probabilities of being married rise sharply in their 20s and peak at age 30. These age patterns by educational status are similar across cohorts, despite the decline in the overall likelihood of marriage across cohorts for both groups.

Figure 2 shows patterns of assortative mating by educational attainment. In both cohorts and for both groups, women with more schooling are more likely to marry men who have more schooling. White women are more likely to marry a man with more schooling than black women, and white women with college degrees are much more likely to marry a man with at least some college than are black women. Husbands in the black sample have a more disadvantaged education distribution than wives, which means that opportunities for marrying men with high levels of schooling are more limited for black women in these cohorts. These differences are particularly sharp in the 1919-1938 birth cohort where white women with a college degree have a predicted probability of having a husband with at least some college of about 0.77 compared to 0.26 for black women. Differences narrow in the 1939-1953 birth cohort but are still substantial (.84 versus 0.50). These patterns are similar for women with 13-15 years of schooling as well.

Figure 3 shows age-specific patterns of marital fertility by education for white and black women. Figure 4 shows corresponding patterns for nonmarital fertility. Predicted probabilities of having a marital birth are moderately higher for whites than for blacks across each education group.[10] Age patterns of fertility are similar across groups. For women with 0-

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[10] Although Figure 3 shows predicted probabilities of marital fertility for the full age range, very few women with a college degree are actually married and having births between ages 15 to 20. These estimates are out of sample predictions that should be interpreted with caution.

11 years of schooling, the likelihood of having a marital birth peaks in the early 20s and declines steadily thereafter. For women with 16 or more years of schooling, the likelihood of having a marital birth peaks at later ages. In the 1919-1938 cohort, white women with 13 to 15 years of schooling have the highest predicted probability of having a marital birth at age 25 and those with college degrees have the highest likelihood around age 30. Across both cohorts from age 29 to 44, college educated white women have the highest predicted probabilities of having a birth at each age. Black women show similar patterns except that the probability of having a birth peaks earlier for college educated women and education differences in the probability of having a birth after age 30 are less pronounced. Also, black women with 13 or more years of schooling have lower predicted probabilities of marital fertility in their 30s than their white counterparts. For both whites and blacks, the overall likelihood of having a marital birth at each age declines for college educated women across birth cohorts. For women with less than high school completed, the likelihood of having a marital birth increases across birth cohorts before age 21, but decreases from ages 21 onward.

In contrast to marital fertility, black women have substantially higher predicted probabilities of nonmarital fertility than whites across different education groups. Age patterns of nonmarital fertility differ across education groups in roughly the same ways as age patterns of marital fertility. For both white and black women in the 1919 birth cohort, the probability of having a nonmarital birth peaks at age 20 for women with 12 or fewer years of schooling and at later ages for those with more schooling. However, those in the lowest education category have the highest likelihood of this type of birth at all ages for both groups. Cohort changes in nonmarital fertility are small for whites but moderately large for black Americans. Relative to the 1919 cohort, black women in the 1939-1953 cohort have higher predicted probabilities of having a nomarital birth at earlier ages and lower likelihoods at ages 25 and older.

Figure 5 shows the relationship between mother's and daughter's education. For both blacks and whites, women with more schooling are more likely to have daughters who complete more schooling. This is especially true for college educated black women whose daughters are more likely than daughters of similarly educated white women to complete college themselves. Black women with some college completed also have higher likelihoods of having daughters with more rather than less schooling relative to their white counterparts. Among women with 12 or fewer years of schooling, white women are more likely to have daughters who complete college than similarly educated black women. For black women, these relationships are stable across cohorts. For white women, *conditional on mother's education*, daughters have lower predicted probabilities of completing at least some college in the 1939 cohort relative to the 1919 cohort. That is, the marginal effect of women's schooling differs across cohorts.[11] For whites, women's education increased across cohorts but children's schooling did not increase as fast as these gains in mother's schooling would have predicted. This translates to a negative coefficient of cohort for whites once mother's schooling is controlled.

Figure 5 holds father's schooling fixed at high school completed. Although not shown here, having a father with more schooling has a larger marginal effect on children's schooling for white families. Among whites, having a father with high school completed versus less than high school increases the predicted probability of having a daughter who completes college by about 0.11. Having a father with some college versus high school completed increases daughters' predicted probabilities of completing college by 0.24. For black families, in contrast, the corresponding changes are 0.04 and 0.08. Highly educated fathers benefit

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[11] The model does not specify an interaction between women's schooling and birth cohort, and this interaction term is not significant if included. However, the model's nonlinear form means that, when transformed, predicted probabilities within categories of women's education differ across cohorts.

both white and black children but the predicted marginal effects are substantially larger in white families.

Two additional aspects of the joint fertility and transmission model that deserve explanation are the estimated variances of the latent factors and their correlations (shown at the end of Appendix Table A.5). All the estimated variances are statistically significant. Although the estimated covariances of the latent factors are not estimated precisely for either whites or blacks, the point estimates are quite different from each other. For blacks, the estimated covariance is nearly zero. This suggests that once the appropriate set of covariates is controlled in the model, the women-specific random errors of the fertility and transmission processes are uncorrelated. The point estimate for whites, in contrast, is fairly large and corresponds to a correlation between the women-specific errors in fertility and transmission of about 0.5. These estimated correlations depend greatly on the covariates included in the models, especially ones related to endogenous family processes. The correlation changes, for example, if number of years lived in a two parent family or number of siblings is omitted from the transmission model.

Taken together, these results show that key components of the intergenerational process differ substantially by women's education and race groups. At the family level, these relationships might suggest higher direct transmission of educational status for highly educated black women relative to their white counterparts. Indeed, if the analysis had no demographic component, we might conclude that having a college educated mother was associated with larger intergenerational gains for black Americans. But as the simulations below will show, the correlations between parent's schooling and children's schooling are just one component of a more complex set of intergenerational pathways. Conventional estimates of intergenerational effects usually ignore these demographic mechanisms and how they differ across groups. A more complete assessment of the intergenerational effects of women's schooling depends on the interplay of all the processes described above. The following section incorporates all these mechanisms in estimating the intergenerational effect of increasing women's schooling for white and black Americans.

Combining Pathways of Intergenerational Effects

I assess the effects of increasing women's education on the education of the next generation through a series of micro simulations. The simulations allow a change in women's schooling to change both marriage and fertility patterns and transmission probabilities across generations. The simulations use predicted probabilities, which correspond to the components of equation (2), calculated using the parameter estimates shown in Appendix Tables A.2-A.5 and described in Figures 1-5. Each simulation has two parts: (i) a hypothetical change in women's schooling, and (ii) a particular set of pathways that are included in assessing intergenerational effects. Each simulation is carried out separately for whites and blacks and for each of the two older birth cohorts (1919-1938 and 1939-1953) using the women from the marriage sample (see Appendix Table A.1 for each starting sample size and baseline education distribution). I inflate these starting samples by a factor of ten to reduce random noise in the simulations. For each simulation, I impose a hypothetical change to the women's education distribution by drawing at random without replacement a subsample equal to 5% of the women and increasing their education to a higher level. For example, to estimate the effect of moving 5% of the 1919-1938 white sample women from less than high school to 12 years of schooling, I move a random draw of 560 women ((1126*10) * .05) from the 0-11 years education category to the 12 years category. The other 95% of the women retain all their original values. The choice of moving 5% of sample women is somewhat arbitrary. The goal is to choose a level that is large enough to see population level results but still realistic in its scale. As a point of reference, Head Start, a national federally-funded early childhood intervention program that promotes school readiness, is approximately of this scale.

The simulations are conducted at the individual level. For each woman, I use predicted probabilities from the statistical models to draw marriage, fertility, and transmission statuses at each age. The simulations account for the unobserved heterogeneity components predicted by the joint model of fertility and transmission by drawing individual random components for each sample woman. These draws are held fixed even when a woman's education and the other endogenous processes are allowed to change. These components allow for correlation between a woman's predicted fertility probabilities and her children's predicted schooling.

I combine these estimates to simulate a life course for each woman. I then aggregate across women and children and compute the number of children born in each educational category in the subsequent generation. I form a ratio of the simulated offspring educational distribution to the baseline distribution predicted by the sample women's observed schooling to see how a given hypothetical change in women's schooling increases or decreases the proportion of children in each schooling level, relative to making no changes in women's schooling. Using the ratio of the proportions of daughters in each education category is only one of several options for characterizing the "effect" of a given change in women's schooling. I use this approach to emphasize the change in the relative shape of the distribution, rather than changes in levels in each education category. Although the simulations alter the schooling of exactly 5% of sample women, the size of the proportional changes in each education category varies greatly depending on the starting number of women and daughters in each category. I describe each component of the simulations in more detail below.[12]

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[12] Moving 5% of the total sample is not the same as moving 5% of women in a given *educational category*. For perturbations at the top of the educational distribution, upgrading the schooling of a number equal to 5% of the sample is a near doubling of the number of women in that education category, especially for the 1919-1938 cohort.

Changes in Women's Education Distribution. I simulate the effect of increases in women's schooling by computing the expected offspring education distribution for each of five actual or hypothetical distributions of women's educational attainment: (i) the education distribution of the sample women, as observed; (ii) move 5% of sample women from 0-11 years to 12 years completed; (iii) move 5% of sample women from 12 years to 13-15 years completed; (iv) move 5% of sample women from 13-15 years to 16 or more years completed; and (v) move 5% of sample women from 0-11 years to 16 or more years completed. I then compare the distribution of children's schooling predicted by each perturbed women's education distribution (ii to v) to the distribution of children's schooling predicted by the observed women's education distribution (i). Perturbations (ii) to (iv) shift women's schooling at one particular school transition. Perturbation (v) is akin to shifting the entire education distribution upward.

Combinations of Mechanisms. In order to assess the role of marriage and fertility in the intergenerational transmission of status, and to see how these effects differ for black and white families, the simulations are carried out for various combinations of the demographic mechanisms included in equation (2). In much of the existing stratification literature, estimates of the intergenerational effect of mothers' schooling on offspring's schooling are based on the observed conditional joint distribution of parents' and offspring's schooling. This does not allow changes in women's schooling to alter their marriage or fertility experiences. In terms of the components of equation (2), this suggests that changes in women's schooling will only affect children's schooling through the transmission process—or, the direct individual level effect of mother's schooling on child's schooling. Given an increase in women's schooling, children gain the benefit of having more educated mothers, but they retain their observed values for father's schooling, number of siblings, and the number of years spent living with two parents between birth and age 18. These characteristics are not allowed to change despite the upgrading of women's education. The population level effects are also suppressed. Women cannot change when or whom they marry, forgo marriage or fertility, or change how many children they produce. As a point of comparison, I show these results in the combination labeled *"Transmission Only."* I report two versions of the *"Transmission Only"* combination: one using parameters from an independent model of transmission (this most closely resembles the conventional approach in the literature), and another from the joint random effects model with fertility shown in equations (3) and (4).

The other mechanisms in equation (2) modify conventional estimates by taking account of the fertility or marriage processes. For example, the "*Transmission, Fertility, Marriage"* combination allows for family level changes in mother's education, father's education, number of siblings, and the number of years a child lives with two parents from age zero to 18, women's and husband's education in fertility, plus population level effects of differential fertility, childlessness and never marrying. In contrast, the *"Transmission, Marriage"* combination allows pathways through marriage but not fertility. This allows for changes in mother's and father's education in transmission but no changes through fertility levels or timing at either family level or the population level. The *"Transmission-Fertility"* combination allows for changes in mother's education in transmission and fertility, number of siblings, the part that fertility timing that contributes to number of years lived with two parents, plus population level effects of differential fertility and childlessness. This combination holds husband's/father's education fixed at the observed levels.[13]

Assumptions about Marriage Markets. In its simplest form, the model described in equations (1) and (2) assumes a simple marriage market. Men's attainments can increase along with women's attainments, and women can marry whatever man they choose, at least

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[13] Many other combinations are possible. For example, one could allow husband's education to change but not marital status, or fertility timing to change but not fertility levels. I report on 4 combinations below but the full set simulation results are available upon request.

with regards to education. To check the sensitivity of the results to these assumptions, I estimate a set of simulations in which men's schooling is constrained to the observed sample men's schooling distribution and this distribution is not allowed to change when women's schooling is perturbed.[14] When women's schooling increases, this creates a relative shortage of highly educated men in the marriage market. In this case, the simulation implements a queue. The education categories are ordered from highest to lowest, and within each education level, women are ordered at random. Women with the highest education level get "first pick" of the highly educated men and these husbands are distributed without replacement. Once all of the highly educated men are matched, the remaining women who would otherwise marry a highly educated man must instead take a husband from the next lower education level. If no men remain available at that level either, women must draw from the next lower education category. This queue proceeds from the highest education level to the lowest level until all the women who desire husbands are matched. Although this constrained market is an extreme case, it nonetheless provides a lower bound for the effect of marriage in the presence of highly unmatched educational marriage markets and high educational assortative mating.

Disentangling Differences in Composition from Differences in Effects. Black-white differences in the intergenerational effects of improvements to women's education occur for two reasons. First, because the two groups have different baseline educational distributions, a given perturbation results in different proportional changes in the relative numbers of women in the different education categories. Second, the relationship between women's schooling and the components of the intergenerational process differs between groups. Black Americans have much higher rates of non-marriage and nonmarital fertility, and lower levels

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[14] To be precise, the men's schooling distribution is constrained to that predicted by drawing from the predicted assortative mating probabilities using the women's baseline education distribution. This produces a distribution that is very close to but not necessarily identical to that of the actual observed sample husbands.

of predicted marital fertility by women's schooling. They also have higher predicted probabilities of having college educated children given highly educated mothers.

In order to assess the relative contribution of each of these parts to the overall pattern of racial differences in intergenerational effects, I also estimate simulation results for a third sample of women: the black sample women with their education standardized to the education distribution of white women. Standardizing the black women's education distribution produces a more favorable baseline education distribution for husbands as well. In simulations where the marriage market is constrained, the husbands' schooling distribution is constrained to this more favorable baseline. Although this does not provide a full formal decomposition of the relative contributions of levels versus effects, it begins to disentangle differences between blacks and whites in the effects of women's schooling on the marriage, fertility, and transmission processes from differences in the relative distribution of women in the different education categories.

Results. Appendix Tables A.5 to A.7 show the simulation results for the combinations of mechanisms estimated for daughters for the two older birth cohorts. Tables A.5 and A.6 show results for white and black women using their observed starting education distributions. Table A.7 shows results for the black sample with each cohort's education distribution standardized to the corresponding white distribution. Table 4 summarizes the main findings for two perturbations to women's schooling: one that moves 5% of the women from less than high school to high school completed, and one that shifts up the whole education distribution by moving 5% of the women less than high schooling to 16 or more years completed. Table 4 shows the estimated effects for only the lowest and highest categories of daughter's education (<12 years and 16+ years). The top panel shows results for the 1939-1953 birth cohort and the bottom panel shows results for the 1919-1938 cohort. The combinations of pathways shown in rows 1 to 6 are identical to those described in rows 7 to 12. The results shown in rows 1 and 7 include the full set of pathways (the preferred and most complete model). The results in rows 2 and 8 ignore the effects that accrue via changes in levels and timing of fertility. The results in rows 3 and 9 ignore the effects that accrue via changes in marriage timing and assortative mating. The results in rows 4 and 10 ignore the effects that accrue via both marriage and fertility, but use parameters from the joint model of transmission and fertility. The results in rows 5 and 11 ignore all demographic mechanisms, and use parameters from an independent model of transmission not estimated jointly with fertility. This replicates a conventional stratification model that ignores any endogenous or correlated demographic mechanisms.[15] The results shown in rows 6 and 12 include all pathways but under the assumption that women face a constrained marriage market. For ease of exposition, I first discuss the results for the 1939-1953 cohort, then highlight key differences between the cohorts.

Columns 1 and 2 show results for whites for a simulation that moves 5% of sample women from less than high school to high school completed. In the 1939-1953 birth cohort, this shift in white women's schooling predicts a 10% decrease in the proportion of girls with less than high school completed and about a 4% increase in the proportion of girls with college completed (row 1). This perturbation to women's schooling represents a moderate shift in this cohort's education distribution. It reduces the number of white women at the very bottom of the education distribution, and therefore the proportion of daughters produced with low levels of schooling, but it does not move women into educational categories that contribute many daughters to the top of the children's education distribution. The different combinations of pathways (rows 2-5) suggest that differences in fertility and marriage patterns between these women's education groups (less than high school and high school completed) do not play a large role in estimates of intergenerational effects. Ignoring the

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[15] This reference model is an independent ordered logit with the covariates shown in Table 1 under

effects that accrue through marriage and fertility would understate the expected intergenerational results by a small amount. Constraining the marriage market does not change the results of the full model (row 6).

Columns 3 and 4 show results for a more drastic change to white women's schooling. In this simulation, 5% of the sample white women are moved from the lowest education category into the highest education category. In the 1939-1953 cohort, this represents a 21% increase in the number of women with college degrees and a 37% decrease in the number of women less than 12 years completed. Not surprisingly, improvements are larger at both the bottom and top of the daughters' schooling distribution. Every combination of mechanisms leads to larger reductions in the proportion of daughters with 0-11 years of schooling. The reduction is largest for the combination that allows changes through both transmission and marriage but ignores the effects that accrue through reductions in fertility levels (17% reduction, row 2). In this combination, women continue to produce as many children as predicted by their observed rather than upgraded educational level. This creates more children who go on to gain the benefits of parents with more schooling compared to the full model, which allows for reductions in fertility levels. These positive effects at the population level of higher fertility are offset at the family level by having more siblings, which in these data predicts less schooling. But the population level effects swamp these family level effects, and the predicted intergenerational effects are quite large. Ignoring all demographic pathways (row 5) predicts a 12% reduction in daughters at the bottom of the education distribution. Allowing effects via all pathways (row 1) predicts a 15% reduction in daughters with 0-11 years of schooling.

This shift in women's schooling also has larger effects for daughters with college completed (column 4). Women with college completed are very likely to produce daughters

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"Transmission" (model parameters not shown).

who complete college, and this simulation moves women to that education category. Combinations that ignore the benefits that accrue to children through marriage processes produce the smallest effects (rows 3, 4, 5). For white women, positive assortative mating is an important pathway through which marriage benefits children's schooling. This simulation moves women into an education category that greatly improves their husband's predicted schooling, and predicts the most favorable expected distribution of father's schooling. As expected, constraining the marriage market attenuates the results in this simulation, especially for girls at the bottom of the education distribution. But the results of the full model are still substantial even when the men's education distribution is held fixed at the observed level.

Overall, these patterns are similar for both cohorts of white women. The main substantive difference is that intergenerational effects increase across cohorts for daughters with less than high school completed (row 7). Differences across these white cohorts are produced by widening gaps in differential fertility, upward shifts in the women's baseline education distribution, and changing transmission probabilities within women's education categories (shown in Figure 5). Constraining the marriage market attenuates results less for the older cohort because men still have quite a bit more schooling than women in this cohort. As the men's and women's education distributions converge in more recent cohorts, assumptions about the marriage market become more relevant. For both cohorts of white women, ignoring the demographic pathways would result in an underestimate of intergenerational effects, primarily because positive assortative mating amplifies the intergenerational effects of increasing women's schooling. This general finding is robust to assumptions about the marriage market.

Columns 5 and 6 show results for black women. For these women, moving 5% of the 1939-1953 cohort from less than high school to high school completed produces modest effects for girls at the bottom of the education distribution and very small effects for those at the top of the distribution. The contribution of the different demographic mechanisms is also quite small. This shift in women's schooling represents a quite modest improvement to this cohort's education distribution. Many black women remain in the lower education categories despite the shift. Moreover, unlike white women, black women with high school completed have similar predicted probabilities of having daughters in the lower education categories as women with only 0-11 years completed (see Figure 5). Taken together, this means that this particular perturbation to black women' schooling does not translate to meaningful improvements for the daughter's education distribution for this cohort.

In contrast, moving women from the bottom of the education distribution to the very top predicts much larger improvements to the education distribution of daughters (columns 7 and 8). The full model (row 1) predicts an 8% reduction in the proportion of daughters with less than high school completed and an 11% increase in the proportion who complete college. Ignoring positive assortative mating and changes in marital status would understate the intergenerational effects (row 3). Ignoring the offsetting effects of differential fertility levels, however, would overstate the intergenerational effects by 5 percentage points at bottom and 9 percentage points at the top the daughters' education distribution (row 2). Recall the graphs in Figures 3 and 4. In this cohort, college educated black women had substantially lower predicted fertility than women in the lowest education category. That relationship is ignored here, and these women are predicted to bear more children than they probably would. A conventional model that ignores any endogenous or correlated demographic mechanisms (row 5) would overestimate the intergenerational effects of increases to women's schooling for black women for this cohort by about 7 percentage points. For this cohort of black women, the amplifying effects of changes in marital patterns are offset by the dampening effects of differential fertility. This occurs for three reasons. First, father's education has a weaker effect for blacks than whites. Second, the benefits that come from the increased likelihood of being married, and therefore, the number of years children live with both parents or from having fewer siblings (positive family level effects) do not make up for the population level differences in fertility. Third, differential fertility by education is larger for black women than for white women. Because assortative mating has a smaller effect for black women, constraining the marriage market has only a small effect on the results for this group (row 6).

As was the case for whites, intergenerational effects increase across cohorts for daughters with less than high school completed for black families. For daughters with college completed, in contrast, intergenerational effects decrease across cohorts for blacks, whereas these remained constant for whites. These cohort differences are produced by changing fertility patterns by education status and upward shifts in the black women's education distribution. Unlike for whites, the family level relationships between women's schooling and children's schooling (shown in Figure 5) do not differ across cohorts for blacks. Instead, changes in marriage and fertility patterns by education and population composition account for most of the cohort differences in the intergenerational effects for black Americans.

Columns 9 to 12 show the results for the black sample women, but with their education standardized to the white women's education distribution. This begins to disentangle the relative contribution of differences in baseline education distributions versus differences in the effects of women's schooling on the different intergenerational pathways for explaining black-white differences in intergenerational effects. Once standardized, the proportion of black women in the bottom education category of the 1939-1953 cohort is nearly halved (13.8% versus 25.1%) and the proportion in the highest category more than doubles (24.5% versus 11.1%). In the full model (row 1), standardizing the black women's education distribution produces larger reductions in the proportion of daughters with less than 12 years completed than those predicted for the observed black sample. This estimate is much closer to that for whites than the observed black sample. This result appears in both perturbations to women's schooling (columns 9 and 11). Thus, black-white differences in patterns of intergenerational effects for daughters at the bottom of the education distribution are largely driven by the fact that the black women in this cohort have a more disadvantaged baseline education distribution than their white counterparts. As black and white women's educational distributions continue to converge, patterns of educational reproduction at the bottom of the education distribution should also converge.

Standardization does not have much of an effect for the proportion of daughters in the highest education category (columns 10 and 12). These estimated effects are quite similar for white and black women, regardless of black women's baseline education distribution. The pattern of the results across combinations, however, is similar to that for the observed black sample, suggesting that these depend on the associations of women's schooling and the various intergenerational pathways rather than the underlying education distributions. Assumptions about the marriage market do not change the pattern of results for this standardized sample. Differences across birth cohorts are similar to the patterns for the observed black sample.

Summary and Conclusion

The intergenerational effects of increases in women's schooling accrue through several mechanisms. In addition to the direct benefits to children of having a mother with more schooling, increasing women's schooling changes patterns of family formation in ways that also influence the schooling of children. Some of these effects are at the family level, including changes in the number of siblings a child has, the education of her father, or the number of years she lives in a two-parent family. Other effects are at the population level. Given an increase in schooling, some women will change their timing and levels of marriage and fertility while other may forgo marriage or fertility altogether. These changes alter the numbers and types of children that are created at the population level and inform the distribution of schooling across generations. The analyses described above capture all these mechanisms and provide a more complete assessment of the intergenerational effects of increasing women's schooling for white and black Americans.

In the United States, patterns of family formation and structure differ greatly by women's education and race. Moreover, the effects of family characteristics on children's schooling differ for white and black children. The results reported above show that a conventional stratification model that ignores these endogenous demographic processes would underestimate the predicted intergenerational effects of increasing women's schooling for white Americans and overestimate these for black Americans. Ignoring these demographic pathways produces estimated intergenerational effects for daughters at the top of education distribution that are three times larger for black families than white families. A model that includes a more complete set of intergenerational pathways shows that the gap in predicted effects is in fact smaller, and that differences in effects are converging across birth cohorts. For both white and black Americans, the intergenerational benefits of increasing women's schooling increases across birth cohorts for daughters with less than high school completed. In contrast, for daughters with college completed, the benefits of increasing women's schooling are constant across cohorts for whites and decrease across cohorts for blacks. Estimates across cohorts are converging as black and white women's education distributions are converging and the offsetting effects of differential fertility have become amplified for black women.

For white women, positive assortative mating amplifies the benefits of increases in women's educational attainment. Increases in fathers' schooling predict substantial additional gains in children's schooling above and beyond those predicted by increasing mothers' schooling. The effects of fathers' education are not as large for black children. Instead, black children with college educated mothers get a large boost to their predicted schooling at the family level. But highly educated black women have lower fertility than black women with less schooling. While at the family level reductions in fertility translate to fewer siblings (a positive family level effect), at the population level reductions in fertility reduce the number of children produced overall who go on to benefit from having highly educated mothers. These population level effects of differential fertility attenuate the benefits accrued at the family level. This offset produced by differential fertility is larger for black Americans because differences in fertility by education are larger for black versus white women.

The simulations show that women's starting education distribution and where in the distribution women's schooling increases have important implications for the magnitude of intergenerational effects and where in the children's' education distribution these benefits accrue. If the women's starting education distribution is particularly disadvantaged, there are few women at the highest categories. Moving women into these education categories, therefore, results in large changes in the offspring generation both because this amounts to a drastic improvement to women's schooling and because these women are most likely to produce children who will obtain high levels of schooling. Simulations using the black sample women with their baseline education distributions standardized to that of white women clarify this point. For the 1939-1953 cohort, the predicted intergenerational effects for this standardized group are closer to those estimated for white women than that of the observed black sample. For the 1919-1938 cohort, the results are at an intermediate level between those for the observed white and black samples.

Simulating the marriage market in a detailed way is a complex task that requires a two-sex model rather than the one-sex model employed here as well as computing the market's equilibrium. Although that task is beyond the scope of this paper, the analyses above check the robustness of the results to assumptions about the marriage market by asking how these might change under the extreme assumption that men's schooling does not improve at all for a given increase in women's schooling. Constraining the marriage market in this way attenuates results more for whites than for blacks, but generally reproduces the pattern of results found in the unconstrained marriage market.

This study combines micro-level data analysis with a demographic model that accounts for how groups sort and reproduce. This micro-macro blended approach specifies complicated relationships at the individual or family level but in a demographically informed way. Although most studies in the stratification literature abstract from these complications, intergenerational effects are closely tied to demographic behavior. In those cases in which demography and social status are interrelated, as is the case with patterns of family formation, race, and educational attainment, ignoring demographic pathways can greatly bias our assessment of intergenerational effects. This is particularly true for understanding black-white differences in educational reproduction. This micro-macro approach, therefore, is a useful complement to standard approaches for studying race differences in mobility. The analyses above quantify just how much estimates of intergenerational effects can differ when we ignore family processes such as marriage and fertility that create the families in which statuses are transmitted.

The analyses described above use a complex model of intergenerational effects but the model also makes important simplifications that should temper our interpretation of the results. These simplifications include ignoring genetic ties between parents and children, ignoring differential mortality, and assuming that the marriage process is independent of the fertility and transmission processes. Ignoring genetic ties between parents and children is likely to overstate the estimated family-level effect of mother's education on child's education (transmission process). The results above, however, suggest that even in the absence of any direct effect of women's schooling on children's schooling, the intergenerational effects of increasing women's schooling are unlikely to be zero because these accrue through many different pathways. Ignoring differential mortality is likely to underestimate the benefits of increasing women's schooling. If differential mortality differs by race, then this omission misses another way in which intergenerational pathways differ for white and black Americans. If the random effects structure used to relate the fertility and transmission processes is misspecified, then the model may not adequately account for the correlated nature of these mechanisms. Finally, all simulation studies ultimately assume that the parameters used are correct and causal, despite judicious caution in the language used to interpret the results. Simulations offer a way to consider counterfactuals not available in the observed data at the risk of using parameters that might be incorrect. The estimated parameters used above reproduce the patterns present in the observed data. Nonetheless, they are potentially biased estimates of the "true" causal parameters and should be interpreted with caution.

Despite these simplifications, the analyses show important features of educational transmission across generations, the intervening role of demographic processes, and how these processes differ for black and white Americans. By comparing results across groups and cohorts, the analyses provide a richer description of intergenerational processes and a more dynamic and complete view of the process of educational stratification. The approach also assesses the effect of recent demographic shifts such as delayed fertility timing, non marital fertility, and delayed and or forgone marriage on intergenerational effects. Overall, the results show that gains in women's schooling such as those we have experienced in the United States bode well for improving the education of future generations for both white and black Americans.

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Table 1. Summary of Statistical Models Used in Analyses, PSID 1968-2003

Mechanism	Model	Dependent Variable	Specification
Marital Status	Binary Logit	Married (yes/no) in single years, ages 15 to 62	Woman's Education Age Birth Cohort Woman's Education * Age, Cohort * Age, Age in 4 piece spline (knots at 20, 30, 40)
Assortative Mating	Ordered Logit	Husband's education in categories: 0-11, 12, 13+	Woman's Education Birth Cohort
Fertility	Binary Logit estimated jointly with Transmission	Probability have birth at each age from 15 to 44	Woman's Education Age Birth Cohort Husband's Education Data Source dummy Women's Education*Age Cohort*Age Age in 4 piece spline (knots at 20, 25, 30) Random intercept with variance σ_1^2
Transmission (Child's Education)	Ordered Logit estimated jointly with Fertility	Child's education in categories: 0-11, 12, 13-15, 16+	Woman's Education Birth Cohort Husband's Education Number of Siblings Child Sex No. years lived in 2 parent family from ages 0-18 Random intercept with variance σ_2^2 Correlation ρ (σ_1^2, σ_2^2)

Notes: The Fertility and Transmission models are estimated jointly using a two-equation model with random intercepts in each equation that may be correlated. See the text for details. All models are estimated separately for whites and blacks. Birth cohorts are 1919-38, 1939-53, and 1954-68.

Table 2. Educational Attainment Distributions of Samples Used in Estimation of Statistical Models (Percent), PSID 1968-2003

	Marital Status	Assortative Mating		Fertility		Child's Education		
Educational Attainment	Woman	Woman	Husband	Woman	Husband	Woman	Husband	Children
Whites								
Less than high school (0-11 yrs)	17.0	16.6	21.7	16.3	20.0	18.7	25.2	8.7
High school only (12 yrs)	41.5	42.7	33.9	41.5	31.2	48.1	35.1	34.2
Some college (13-15 yrs)	20.3	20.4	18.6	20.4	17.1	18.8	15.6	25.5
Completed College (16 plus yrs)	21.1	20.4	25.8	21.7	23.8	14.4	23.6	31.6
No Husband					7.9		0.6	
Total	99.9	100.1	100.0	99.9	100.0	100.0	100.1	100.0
# Observations	3,322	2,941		3,175		1,138		2,937
Blacks								
Less than high school (0-11 yrs)	32.7	31.6	37.3	30.1	25.5	38.2	44.7	13.7
High school only (12 yrs)	38.1	34.8	37.9	38.4	26.4	41.9	28.4	42.9
Some college (13-15 yrs)	20.9	23.6	17.7	22.4	12.5	12.4	9.8	30.5
Completed College (16 plus yrs)	8.3	10.0	7.2	9.1	5.1	7.5	4.9	12.9
No Husband					30.4		12.3	
Total	100.0	100.0	100.1	100.0	99.9	100.0	100.1	100.0
# Observations	2,734	1,588		2,297		607		1,844

Notes: Totals do not sum to 100 due to rounding. Data are weighted to adjust for sample design. Husband is defined as the man to whom a woman was married for longest period between ages 15 and 44.

Table 3. Distribution of Outcomes by Women's Educational Attainment, PSID 1968-2003

	Married at age 20	Married at age 30	Husband's Education (%)			Children Ever Born	Children's Education (%)			
			0-11	12	13 +		0-11	12	13-15	16+
Whites										
Woman's Education:										
0-11 years	64.5	87.2	58.7	31.5	9.8	2.9	24.0	46.9	19.5	9.7
12 years	54.5	87.9	22.5	48.2	29.3	2.5	5.8	38.4	27.5	28.4
13-15 years	40.2	84.1	8.9	25.9	65.2	2.3	3.1	23.2	30.1	43.6
16+ years	17.1	77.6	2.7	13.9	83.5	1.8	1.0	12.0	21.9	65.1
Blacks										
Woman's Education:										
0-11 years	43.7	62.5	68.3	23.7	8.0	3.3	20.3	47.1	24.9	7.7
12 years	36.3	59.1	29.1	49.3	21.6	2.4	8.1	44.0	38.4	9.5
13-15 years	33.5	63.4	18.0	39.9	42.1	2.2	5.7	30.5	40.6	23.2
16+ years	16.6	62.4	13.2	38.0	48.9	1.7	1.6	18.4	14.6	65.4

Notes: Data are weighted to adjust for sample design. Marriage and fertility estimates are based on women observed to age 40 or older. A woman is considered married at a given age if she reports being married at any point during the specified age. Husband is defined as the man to whom a woman was married for the longest period between ages 15 and 44.

Table 4. Ratio of Simulated to Baseline Daughters' Education Distribution for Selected Changes in Women's Education and Combinations of Mechanisms, PSID 1968-2003

	Whites				Blacks				Blacks Standardized to White Education Distribution			
	Simulation: < 12 → 12		Simulation: < 12 → 16+		Simulation: < 12 → 12		Simulation: < 12 → 16+		Simulation: < 12 → 12		Simulation: < 12 → 16+	
	Daughters' Education				Daughter's Education				Daughter's Education			
	< 12	16+	< 12	16+	< 12	16+	< 12	16+	< 12	16+	< 12	16+
Combinations:					Women Born 1939-1953							
1. Transmission, Fertility, & Marriage	0.90	1.04	0.85	1.10	0.96	1.02	0.92	1.11	0.92	1.01	0.87	1.10
2. Transmission & Marriage	0.90	1.02	0.83	1.10	0.94	1.02	0.87	1.20	0.94	1.02	0.86	1.15
3. Transmission & Fertility	0.92	1.03	0.85	1.06	0.94	1.01	0.90	1.07	0.97	1.02	0.90	1.07
4. Transmission, Joint Model	0.92	1.01	0.86	1.05	0.96	1.01	0.88	1.16	0.95	1.01	0.86	1.12
5. Transmission , Independent Model	0.93	1.02	0.88	1.06	0.96	1.01	0.89	1.18	0.96	1.01	0.87	1.14
6. Transmission, Fertility, & Marriage (Constrained Marriage Market)	0.91	1.04	0.91	1.08	0.94	1.02	0.93	1.09	0.92	1.01	0.94	1.11
					Women Born 1919-1938							
7. Transmission, Fertility, & Marriage	0.92	1.03	0.94	1.10	1.02	1.06	0.99	1.17	0.98	1.02	0.93	1.14
8. Transmission & Marriage	0.93	1.03	0.89	1.10	0.97	1.03	0.94	1.21	0.96	1.02	0.91	1.18
9. Transmission & Fertility	0.93	1.04	0.91	1.07	1.01	1.04	0.97	1.14	0.98	1.05	0.92	1.14
10. Transmission, Joint Model	0.95	1.02	0.90	1.05	0.98	1.02	0.94	1.20	0.97	1.01	0.91	1.16
11. Transmission, Independent Model	0.95	1.02	0.91	1.06	0.98	1.02	0.94	1.22	0.97	1.01	0.92	1.20
12. Transmission, Fertility, & Marriage (Constrained Marriage Market)	0.93	1.04	0.97	1.07	0.99	1.03	0.96	1.18	0.94	1.04	0.96	1.13

NOTES: Simulations move a number equal to 5% of sample women from one education category to another one. See text for description of different combinations and specifics of the constrained marriage market.

Figure 1. Predicted Probability of Being Married by Age, Women's Education, Race, and Birth Cohort Based on Model Shown in Appendix Table A.2, PSID 1968-2003

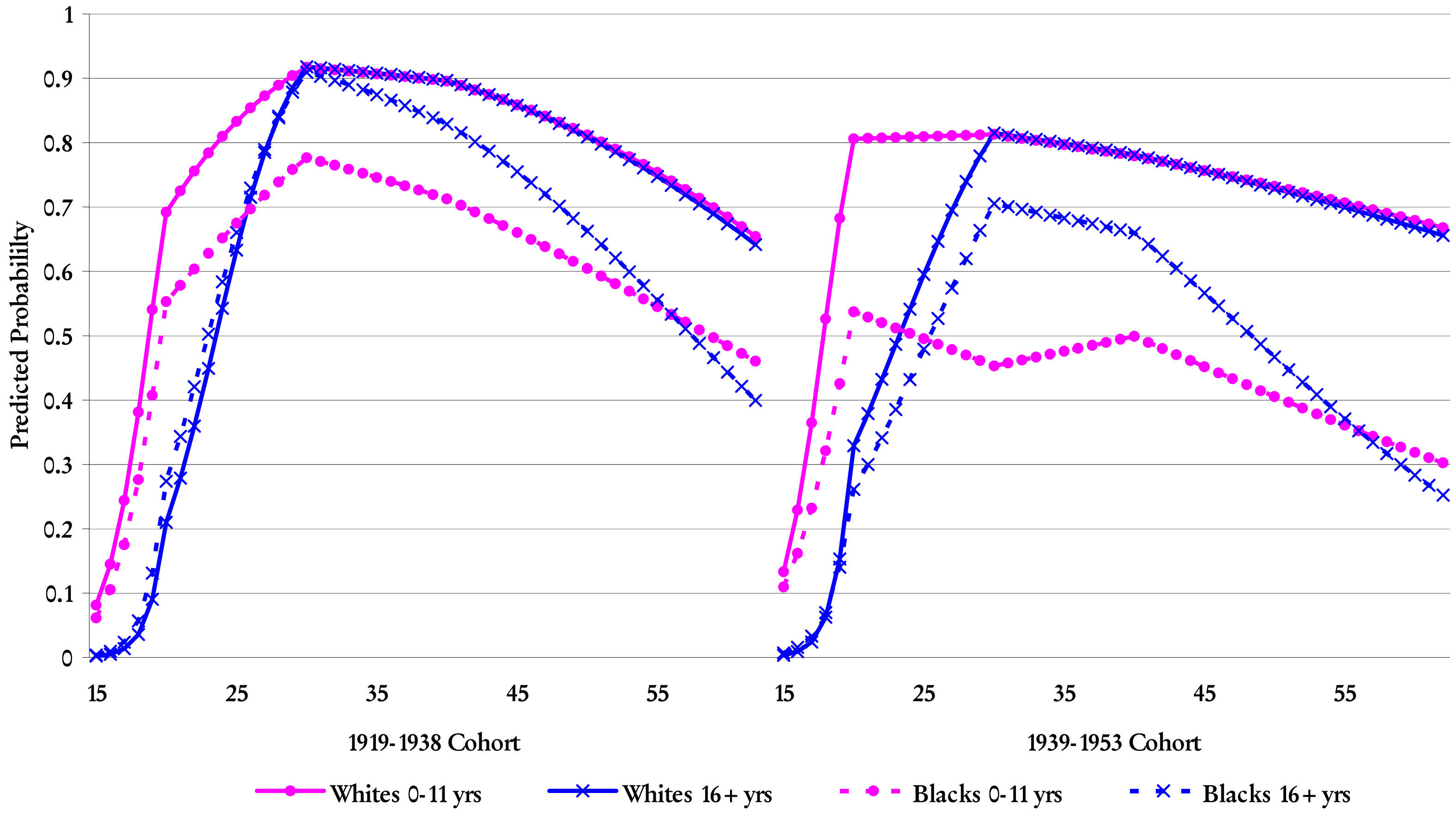


Figure 2. Husband's Predicted Education Given Wife's Education by Race and Birth Cohort Based on Model Shown in Appendix Table A.3, PSID 1968-2003

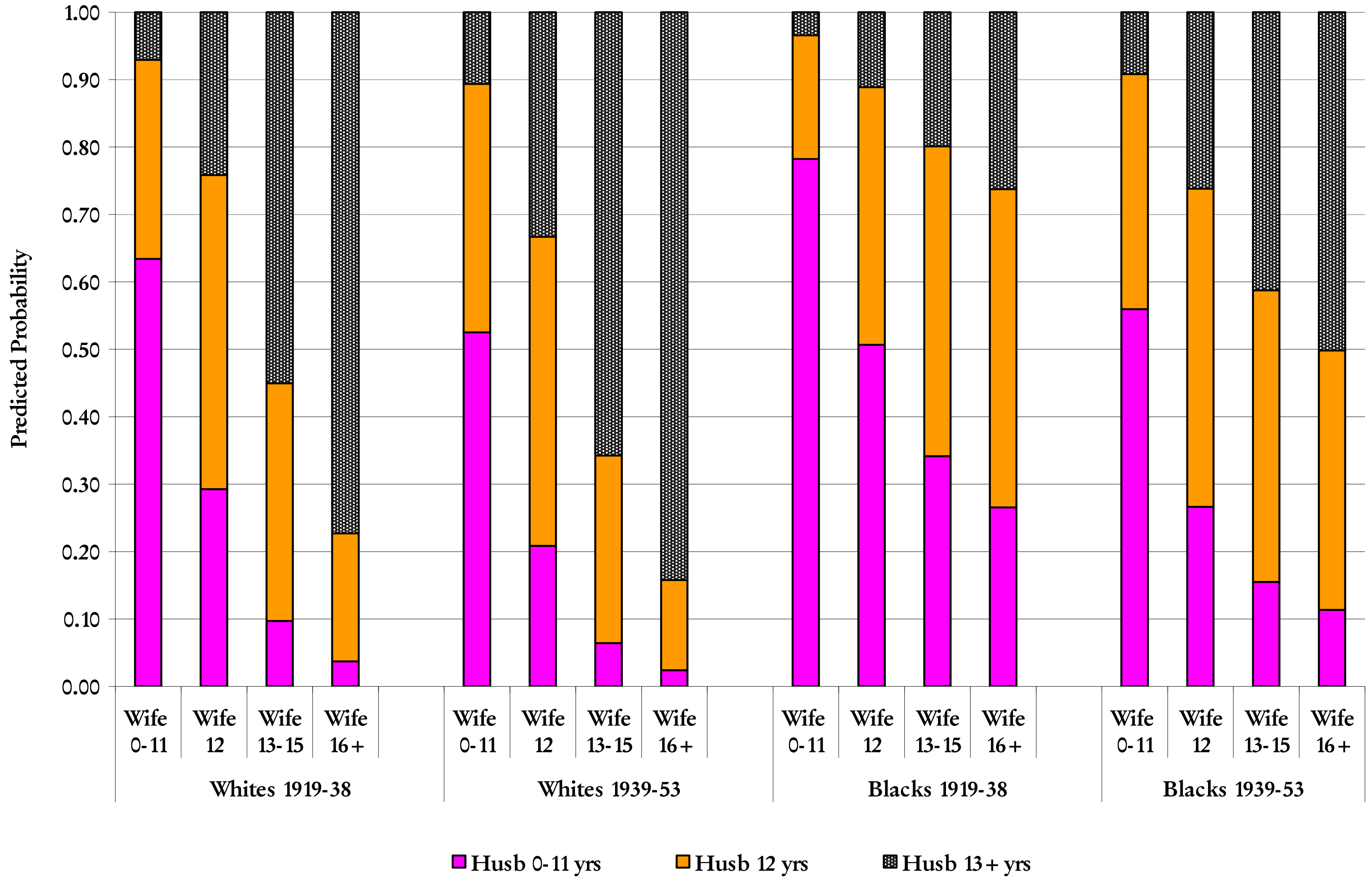


Figure 3. Predicted Probability of Having a Marital Birth by Age, Women's Education, Race, and Birth Cohort Based on a Joint Model of Fertility and Children's Education Shown in Appendix Table A.4 (Husband's Education = 12 years), PSID 1968-2003

Figure 4. Predicted Probability of Having a Nonmarital Birth by Age, Women's Education, Race, and Birth Cohort Based on a Joint Model of Fertility and Children's Education Shown in Appendix Table A.4, PSID 1968-2003

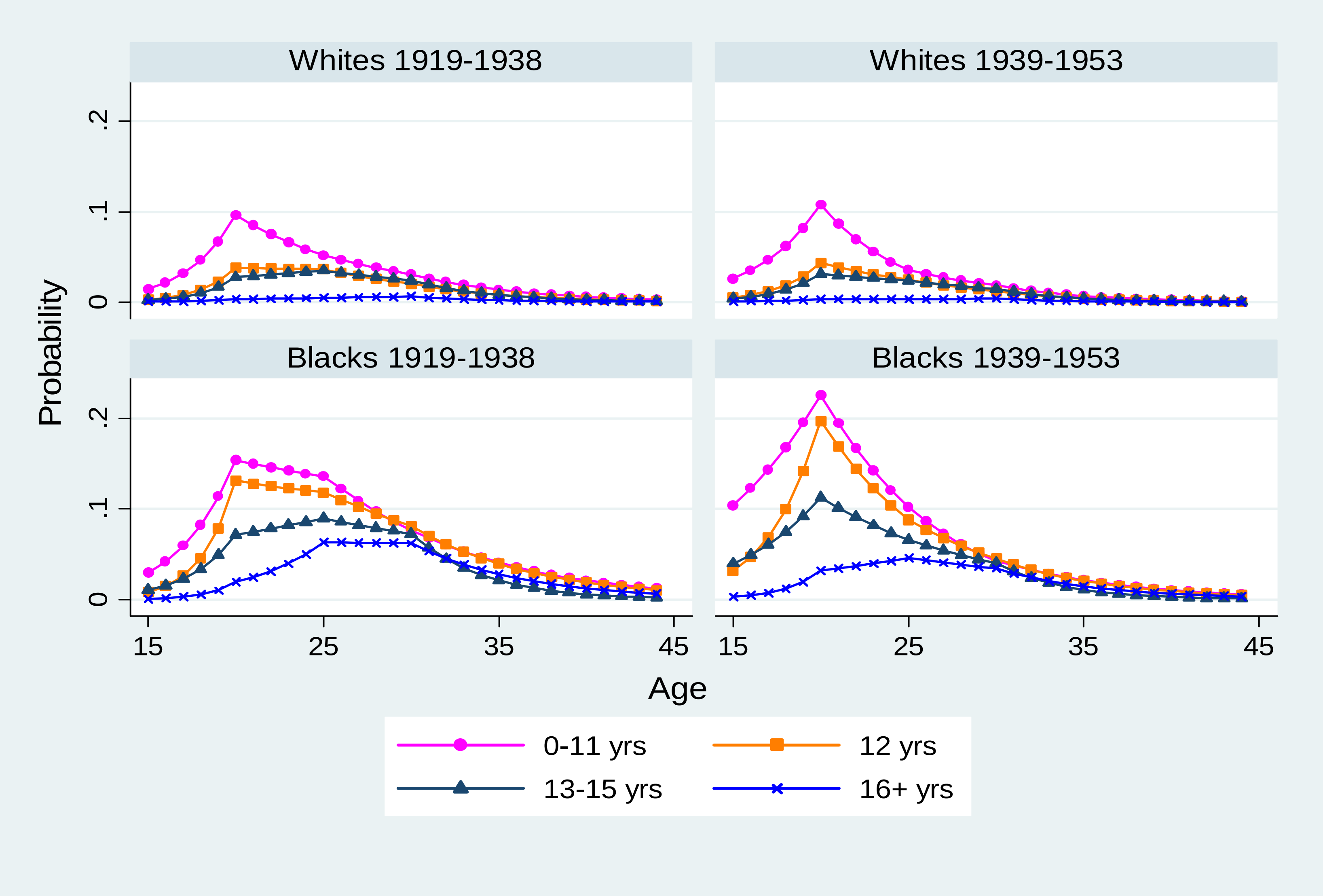
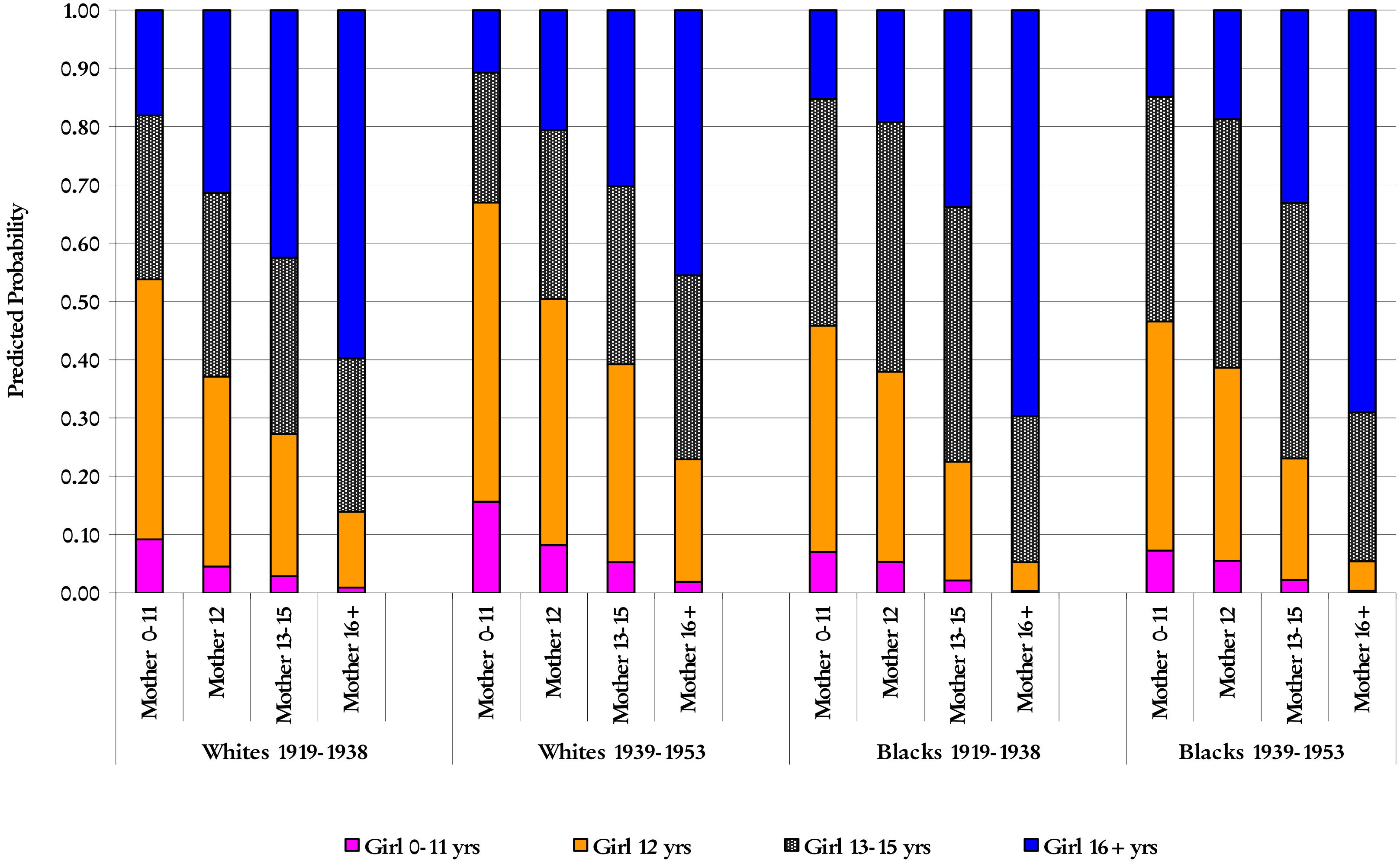


Figure 5. Daughter's Predicted Education Given Mother's Education by Race and Birth Cohort Based on a Joint Model of Fertility and Children's Education Shown in Appendix Table A.4 (Father's ed.=12 yrs; Siblings=2; No. yrs lived with 2 parents=19 yrs; Mom age at birth=25), PSID 1968-2003



Appendix Table A.1. Cohort Summaries, PSID 1968-2003

	Cohort 1	Cohort 2	Cohort 3
Birth Year	1919-1938	1939-1953	1954-1968
Age in 1968	30-49	15-29	0-14
Age in 2003	65-84	50-64	35-49
Whites			
Education (%)			
0-11 years	28.0	13.8	8.7
12 years	47.8	40.5	35.9
13-15 years	12.6	21.2	27.7
16 plus years	11.7	24.5	27.8
# Women in Marriage Sample	1126	1111	1085
# Children ever born	2.8	2.2	1.9
Blacks			
Education (%)			
0-11 years	55.4	25.1	21.1
12 years	29.8	44.0	39.9
13-15 years	9.9	19.8	30.2
16 plus years	4.8	11.1	8.8
# Women in Marriage Sample	727	816	1191
# Children ever born	3.1	2.5	2.2

Notes: Data are weighted to adjust for oversampling and attrition.

Appendix Table A.2. Parameter Estimates for Binary Logit Model Predicting Marital Status, PSID 1968-2003

Dependent variable: Married (0/1)

	Whites			Blacks		
	β	SE	*z*	*β*	SE	*z*
Age (spline)						
15-20	1.012	0.04	26.4	0.744	0.08	9.2
20-30	0.249	0.02	15.3	0.163	0.03	6.4
30-40	-0.057	0.01	-3.8	-0.113	0.02	-4.8
40 plus	-0.054	0.01	-7.0	-0.032	0.02	-1.9
Woman's Education (ref. = 12 years)						
0-11 years	7.696	0.76	10.1	3.245	1.51	2.1
13-15 years	-1.390	1.11	-1.3	-3.720	1.97	-1.9
16 plus years	-1.201	1.76	-0.7	-4.482	3.14	-1.4
Woman's Ed 1 * Age (spline)						
Woman's Ed 1 * Age 1	-0.365	0.04	-8.9	-0.156	0.08	-2.0
Woman's Ed 1 * Age 2	-0.089	0.02	-5.0	-0.060	0.02	-2.5
Woman's Ed 1 * Age 3	0.032	0.02	1.7	0.079	0.02	3.6
Woman's Ed 1 * Age 4	-0.015	0.01	-1.3	-0.016	0.02	-0.9
Woman's Ed 3 * Age (spline)						
Woman's Ed 3 * Age 1	0.039	0.06	0.7	0.206	0.10	2.0
Woman's Ed 3 * Age 2	0.057	0.02	3.3	0.013	0.03	0.5
Woman's Ed 3 * Age 3	-0.024	0.02	-1.3	0.023	0.03	0.8
Woman's Ed 3 * Age 4	-0.001	0.01	-0.1	-0.017	0.03	-0.7
Woman's Ed 4 * Age (spline)						
Woman's Ed 4 * Age 1	-0.027	0.09	-0.3	0.171	0.16	1.1
Woman's Ed 4 * Age 2	0.125	0.02	7.5	0.165	0.04	4.0
Woman's Ed 4 * Age 3	0.032	0.02	2.0	0.039	0.04	1.0
Woman's Ed 4 * Age 4	-0.018	0.01	-1.5	-0.058	0.04	-1.6
Cohort						
(ref. = 1919-1938)						
1939-1953	0.360	0.81	0.5	2.720	1.57	1.7
1954-1968	2.082	0.83	2.5	0.987	1.54	0.6
Cohort 2 * Age (spline)						
Cohort 2 * Age 1	0.013	0.04	0.3	-0.139	0.08	-1.7
Cohort 2 * Age 2	-0.155	0.02	-8.7	-0.137	0.03	-5.1
Cohort 2 * Age 3	0.005	0.02	0.3	0.052	0.02	2.1
Cohort 2 * Age 4	0.043	0.01	4.4	0.011	0.02	0.6
Cohort 3 * Age (spline)						
Cohort 3 * Age 1	-0.122	0.04	-2.8	-0.119	0.08	-1.5
Cohort 3 * Age 2	-0.112	0.02	-6.3	-0.090	0.03	-3.2
Cohort 3 * Age 3	0.059	0.02	3.4	0.057	0.03	2.2
Cohort 3 * Age 4	0.048	0.03	1.8	0.096	0.03	2.8
Constant	-19.822	0.74	-26.9	-14.793	1.57	-9.4
# Observations (person years)		112881			82181	
Log Likelihood		-51776			-47805	

Notes: Data are weighted to adjust for sample design. Standard errors are adjusted for clustering.

Appendix Table A3. Parameter Estimates for Model Predicting Husband and Education (Ordered Logit), PSID 1968-2003

Dependent variable: Husband's Education (0-11 yrs, 12 yrs, 13 plus yrs)

	Whites			Blacks		
	β	SE	*z*	*β*	SE	*z*
Woman's Education						
(ref. = 12 years)						
0-11 years	-1.434	0.11	-13.0	-1.252	0.24	-5.1
13-15 years	1.346	0.11	12.3	0.684	0.23	3.0
16 plus years	2.369	0.13	18.3	1.044	0.34	3.1
Cohort						
(ref. = 1919-1938)						
Born 1939-1953	0.449	0.09	4.7	1.040	0.29	3.6
Born 1954-1968	0.546	0.10	5.6	1.226	0.29	4.2
Cut Points						
Cut 1	-0.884	0.08		0.027	0.28	
Cut 2	1.144	0.08		2.077	0.32	
# Observations	2941			1588		
Log Likelihood		-2558			-1481	

Notes: Data are weighted to adjust for sample design. Standard errors are adjusted for clustering.

Appendix Table A4. Parameter Estimates for Model of Predicting Fertility (Binary Logit) and Children's Schooling (Ordered Logit) Using Two-Equation Random Effects Model of Fertility and Children's Schooling, PSID 1968-2003

	Whites			Blacks		
Dependent variable: Birth (0/1)	*β*	SE	*z*	*β*	SE	*z*
Age (spline)						
1. 15-20	0.532	0.05	9.8	0.586	0.09	6.4
2. 20-25	-0.014	0.02	-0.7	-0.029	0.07	-0.5
3. 25-30	-0.123	0.02	-6.9	-0.090	0.05	-1.7
4. 30 plus	-0.193	0.01	-15.1	-0.158	0.03	-5.2
Woman's Education (ref. = 12 years)						
0-11 years	3.121	1.06	2.9	4.630	1.25	3.7
13-15 years	0.058	1.51	0.0	3.405	1.75	1.9
16 plus years	2.278	2.25	1.0	-3.017	2.77	-1.1
Woman's Ed 1 * Age (spline)						
Woman's Ed 1 * Age 1	-0.133	0.05	-2.5	-0.219	0.07	-3.3
Woman's Ed 1 * Age 2	-0.127	0.03	-4.7	-0.005	0.06	-0.1
Woman's Ed 1 * Age 3	0.010	0.03	0.3	-0.049	0.05	-1.0
Woman's Ed 1 * Age 4	0.021	0.02	1.0	0.015	0.03	0.5
Woman's Ed 3 * Age (spline)						
Woman's Ed 3 * Age 1	-0.018	0.08	-0.2	-0.185	0.09	-2.1
Woman's Ed 3 * Age 2	0.060	0.03	2.0	0.075	0.06	1.3
Woman's Ed 3 * Age 3	0.042	0.03	1.6	0.040	0.06	0.7
Woman's Ed 3 * Age 4	-0.028	0.02	-1.3	-0.107	0.04	-2.5
Woman's Ed 4 * Age (spline)						
Woman's Ed 4 * Age 1	-0.153	0.11	-1.3	0.081	0.14	0.6
Woman's Ed 4 * Age 2	0.104	0.04	2.4	0.277	0.10	2.8
Woman's Ed 4 * Age 3	0.177	0.03	6.2	0.082	0.09	0.9
Woman's Ed 4 * Age 4	-0.021	0.02	-1.2	-0.012	0.04	-0.3

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Appendix Table A4. Parameter Estimates for Model of Predicting Fertility (Binary Logit) and Children's Schooling (Ordered Logit) Using Two-Equation Random Effects Model of Fertility and Children's Schooling, PSID 1968-2003, Continued

Dependent variable: Birth (0/1) *continued*	Whites *β*	SE	*z*	Blacks *β*	SE	*z*
Husband's Education						
(ref. = 12 years)						
No husband	-2.160	0.12	-17.5	-0.401	0.13	-3.1
0-11 years	0.090	0.04	2.0	0.273	0.12	2.3
13 plus years	0.083	0.04	2.2	0.161	0.11	1.4
Cohort						
(ref. = 1919-1938)						
Born 1939-1953	1.984	0.98	2.0	3.962	1.58	2.5
Born 1954-1968	4.649	1.01	4.6	5.693	1.48	3.8
Cohort 2 * Age (spline)						
Cohort 2 * Age 1	-0.093	0.05	-1.8	-0.173	0.08	-2.0
Cohort 2 * Age 2	-0.106	0.02	-4.3	-0.169	0.06	-2.7
Cohort 2 * Age 3	-0.024	0.02	-1.0	-0.059	0.06	-1.0
Cohort 2 * Age 4	-0.035	0.02	-1.9	-0.009	0.03	-0.3
Cohort 3 * Age (spline)						
Cohort 3 * Age 1	-0.239	0.05	-4.5	-0.279	0.08	-3.5
Cohort 3 * Age 2	-0.071	0.03	-2.5	-0.075	0.06	-1.2
Cohort 3 * Age 3	0.036	0.02	1.5	-0.031	0.05	-0.6
Cohort 3 * Age 4	-0.010	0.02	-0.6	-0.036	0.04	-1.0
Data Source (binary)	-1.078	0.07	-14.6	-1.396	0.14	-10.0
Woman's Ed * No Husband						
Woman's Ed 1 * No Husb	0.639	0.18	3.5	0.060	0.18	0.3
Woman's Ed 3 * No Husb	-0.056	0.20	-0.3	-0.429	0.22	-2.0
Woman's Ed 4 * No Husb	-1.829	0.31	-5.9	-0.715	0.43	-1.7
Constant (Fertility Equation)	-11.679	1.06	-11.0	-13.125	1.74	-7.5

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Appendix Table A4. Parameter Estimates for Model of Predicting Fertility (Binary Logit) and Children’s Schooling (Ordered Logit) Using Two-Equation Random Effects Model of Fertility and Children’s Schooling, PSID 1968-2003, Continued

	Whites			Blacks		
Dependent variable: Child's Education (0-11 yrs, 12 yrs, 13-15 yrs, 16 plus yrs) *continued*	*β*	SE	*z*	*β*	SE	*z*
Woman's Education						
(ref. = 12 years)						
0-11 years	-0.923	0.18	-5.2	-0.548	0.29	-1.9
13-15 years	0.605	0.17	3.6	0.816	0.42	2.0
16 plus years	1.356	0.20	6.9	2.765	0.97	2.9
Husband's Education						
(ref. = 12 years)						
No husband	-1.241	0.74	-1.7	-0.239	0.39	-0.6
0-11 years	-0.572	0.16	-3.7	-0.236	0.34	-0.7
13 plus years	1.259	0.16	8.1	0.503	0.45	1.1
Number of siblings	-0.379	0.09	-4.1	-0.102	0.15	-0.7
No. yrs lived with 2 parents ages 0-18						
(ref. = 19 yrs)						
0-10 yrs	-0.595	0.29	-2.1	-0.944	0.30	-3.1
11-18 yrs	-0.499	0.17	-3.0	-0.264	0.25	-1.1
Child is Female	0.160	0.09	1.8	0.598	0.17	3.6
Mother’s Cohort						
1. Born 1919-1938 (ref.)						
2. Born 1939-1953	-0.727	0.14	-5.3	-0.036	0.26	-0.1
Cut Points						
Cut 1	-4.426	0.27	-16.6	-3.093	0.42	-7.3
Cut 2	-1.327	0.24	-5.5	-0.252	0.41	-0.6
Cut 3	0.413	0.24	1.7	2.063	0.44	4.7
σ_1^2 (variance of random intercept, fertility)	0.047	0.02		0.339	0.06	
σ_2^2 (variance of random intercept, child’s education)	1.760	0.22		1.194	0.32	
Covariance σ_1^2, σ_2^2	0.148	0.10		-0.038	0.29	
ρ (correlation of intercepts)	0.514			-0.059		
# level one units (both fertility and transmission)	87,896			58,686		
# level two units (women)	3,178			2,305		
Joint Log Likelihood	-482,904			-67,469		

Notes: Fertility observations are person years. Data are weighted to adjust for sample design. Standard errors are adjusted for clustering.

Appendix Table A5. Ratios of Simulated to Observed Daughters' Education Distributions for a Given Change in Women's Schooling for White Women by Birth Cohort, PSID 1968-2003

	Whites 1919-1938				Whites 1939-1953			
	Daughters' Education				Daughters' Education			
	0-11 yrs	12 yrs	13-15 yrs	16+ yrs	0-11 yrs	12 yrs	13-15 yrs	16+ yrs
Simulation	Transmission, Fertility, & Marriage							
0-11 to 12 yrs	0.92	0.99	1.01	1.03	0.90	0.98	1.02	1.04
12 yrs to 13-15 yrs	0.99	0.98	1.01	1.02	0.94	0.99	1.01	1.02
13-15 yrs to 16+ yrs	0.98	1.00	1.00	1.01	0.97	0.98	1.01	1.03
0-11 yrs to 16+ yrs	0.94	0.95	1.00	1.10	0.85	0.95	1.03	1.10
	Transmission & Marriage							
0-11 to 12 yrs	0.93	0.99	1.02	1.03	0.90	0.99	1.03	1.02
12 yrs to 13-15 yrs	0.98	0.99	0.99	1.03	0.97	0.98	1.02	1.02
13-15 yrs to 16+ yrs	0.99	0.99	0.99	1.04	0.99	0.98	0.99	1.03
0-11 yrs to 16+ yrs	0.89	0.96	1.02	1.10	0.83	0.95	1.03	1.10
	Transmission & Fertility							
0-11 to 12 yrs	0.93	1.00	0.99	1.04	0.92	0.99	1.02	1.03
12 yrs to 13-15 yrs	0.98	0.99	0.99	1.03	0.97	0.98	1.03	1.01
13-15 yrs to 16+ yrs	1.00	1.00	0.96	1.04	0.99	0.98	1.02	1.01
0-11 yrs to 16+ yrs	0.91	0.97	1.01	1.07	0.85	0.95	1.07	1.06
	Transmission Only (Joint Model)							
0-11 to 12 yrs	0.95	1.00	1.01	1.02	0.92	1.00	1.02	1.01
12 yrs to 13-15 yrs	0.98	0.99	1.00	1.02	0.98	0.99	1.01	1.01
13-15 yrs to 16+ yrs	0.99	0.99	0.99	1.03	0.99	0.99	0.99	1.02
0-11 yrs to 16+ yrs	0.90	0.98	1.02	1.05	0.86	0.98	1.03	1.05
	Transmission Only (Independent Model)							
0-11 to 12 yrs	0.95	0.99	1.02	1.02	0.93	0.99	1.02	1.02
12 yrs to 13-15 yrs	0.99	0.99	1.00	1.02	0.99	0.99	1.00	1.01
13-15 yrs to 16+ yrs	1.00	0.99	0.99	1.03	0.99	0.98	1.00	1.03
0-11 yrs to 16+ yrs	0.91	0.97	1.03	1.06	0.88	0.96	1.04	1.06
	Transmission, Fertility, & Marriage (Constrained Market)							
0-11 to 12 yrs	0.93	1.00	0.99	1.04	0.91	0.98	1.02	1.04
12 yrs to 13-15 yrs	1.00	0.98	0.98	1.04	0.98	0.99	0.99	1.03
13-15 yrs to 16+ yrs	1.02	0.99	0.98	1.02	1.02	0.97	0.99	1.04
0-11 yrs to 16+ yrs	0.97	0.97	0.98	1.07	0.91	0.97	0.99	1.08

Appendix Table A6. Ratios of Simulated to Observed Daughters' Education Distributions for a Given Change in Women's Schooling for Black Women by Birth Cohort, PSID 1968-2003

	Blacks 1919-1938				Blacks 1939-1953			
	Daughters' Education				Daughters' Education			
	0-11 yrs	12 yrs	13-15 yrs	16+ yrs	0-11 yrs	12 yrs	13-15 yrs	16+ yrs
Simulation	Transmission, Fertility, & Marriage							
0-11 to 12 yrs	1.02	0.99	0.98	1.06	0.96	0.98	1.03	1.02
12 yrs to 13-15 yrs	1.01	0.98	1.00	1.06	0.96	0.99	1.01	1.02
13-15 yrs to 16+ yrs	0.99	0.99	0.97	1.11	0.98	1.00	0.97	1.07
0-11 yrs to 16+ yrs	0.99	0.96	0.99	1.17	0.92	0.95	1.04	1.11
	Transmission & Marriage							
0-11 to 12 yrs	0.97	0.99	1.01	1.03	0.94	0.99	1.02	1.02
12 yrs to 13-15 yrs	0.99	0.98	1.01	1.04	0.97	0.98	1.02	1.03
13-15 yrs to 16+ yrs	0.99	0.98	0.97	1.13	0.99	0.97	0.98	1.11
0-11 yrs to 16+ yrs	0.94	0.95	1.00	1.21	0.87	0.93	1.02	1.20
	Transmission & Fertility							
0-11 to 12 yrs	1.01	0.99	0.99	1.04	0.94	1.00	1.02	1.01
12 yrs to 13-15 yrs	1.02	0.98	1.00	1.05	0.97	0.99	1.02	0.99
13-15 yrs to 16+ yrs	1.00	0.99	0.98	1.10	0.98	0.99	0.99	1.05
0-11 yrs to 16+ yrs	0.97	0.96	1.00	1.14	0.90	0.96	1.04	1.07
	Transmission Only (Joint Model)							
0-11 to 12 yrs	0.98	1.00	1.00	1.02	0.96	0.99	1.01	1.01
12 yrs to 13-15 yrs	0.99	0.99	1.01	1.04	0.97	0.99	1.02	1.02
13-15 yrs to 16+ yrs	0.99	0.98	0.97	1.13	0.99	0.97	0.98	1.11
0-11 yrs to 16+ yrs	0.94	0.95	1.00	1.20	0.88	0.94	1.03	1.16
	Transmission Only (Independent Model)							
0-11 to 12 yrs	0.98	1.00	1.01	1.02	0.96	0.99	1.01	1.01
12 yrs to 13-15 yrs	0.98	0.99	1.01	1.03	0.98	0.99	1.01	1.02
13-15 yrs to 16+ yrs	0.98	0.98	0.99	1.11	0.99	0.98	0.99	1.09
0-11 yrs to 16+ yrs	0.94	0.96	1.01	1.22	0.89	0.94	1.03	1.18
	Transmission, Fertility, & Marriage (Constrained Market)							
0-11 to 12 yrs	0.99	1.00	1.00	1.03	0.94	1.00	1.01	1.02
12 yrs to 13-15 yrs	1.00	0.98	1.00	1.06	0.99	0.98	1.02	1.00
13-15 yrs to 16+ yrs	0.98	0.99	0.98	1.11	0.99	1.00	0.98	1.05
0-11 yrs to 16+ yrs	0.96	0.98	0.97	1.18	0.93	0.96	1.02	1.09

Appendix Table A7. Ratios of Simulated to Observed Daughters' Education Distributions for a Given Change in Women's Schooling for Black Women with Education Standardized to White Women's Education Distribution by Birth Cohort, PSID 1968-2003

	Blacks 1919-1938				Blacks 1939-1953			
	Daughters' Education				Daughters' Education			
	0-11 yrs	12 yrs	13-15 yrs	16+ yrs	0-11 yrs	12 yrs	13-15 yrs	16+ yrs
Simulation	Transmission, Fertility, & Marriage							
0-11 to 12 yrs	0.98	0.97	1.03	1.02	0.92	0.99	1.03	1.01
12 yrs to 13-15 yrs	1.01	0.97	1.00	1.04	0.96	0.98	1.02	1.03
13-15 yrs to 16+ yrs	0.99	0.99	0.97	1.08	1.01	0.98	0.99	1.04
0-11 yrs to 16+ yrs	0.93	0.93	1.03	1.14	0.87	0.95	1.02	1.10
	Transmission & Marriage							
0-11 to 12 yrs	0.96	0.99	1.01	1.02	0.94	0.99	1.01	1.02
12 yrs to 13-15 yrs	0.98	0.99	1.00	1.03	0.96	0.98	1.02	1.03
13-15 yrs to 16+ yrs	0.99	0.98	0.98	1.09	0.98	0.97	0.98	1.07
0-11 yrs to 16+ yrs	0.91	0.94	1.00	1.18	0.86	0.92	1.01	1.15
	Transmission & Fertility							
0-11 to 12 yrs	0.98	0.98	1.00	1.05	0.97	0.96	1.04	1.02
12 yrs to 13-15 yrs	0.98	0.99	0.99	1.04	0.99	0.96	1.05	0.99
13-15 yrs to 16+ yrs	1.02	0.96	0.99	1.09	0.99	0.98	1.00	1.04
0-11 yrs to 16+ yrs	0.92	0.95	1.00	1.14	0.90	0.93	1.05	1.07
	Transmission Only (Joint Model)							
0-11 to 12 yrs	0.97	0.99	1.01	1.01	0.95	1.00	1.01	1.01
12 yrs to 13-15 yrs	0.99	0.99	1.00	1.03	0.97	0.98	1.02	1.02
13-15 yrs to 16+ yrs	0.99	0.98	0.99	1.09	0.98	0.97	0.99	1.07
0-11 yrs to 16+ yrs	0.91	0.94	1.00	1.16	0.86	0.93	1.03	1.12
	Transmission Only (Independent Model)							
0-11 to 12 yrs	0.97	0.99	1.02	1.01	0.96	0.99	1.01	1.01
12 yrs to 13-15 yrs	0.98	0.99	1.01	1.03	0.97	0.98	1.01	1.03
13-15 yrs to 16+ yrs	0.98	0.98	0.98	1.10	0.98	0.98	0.98	1.08
0-11 yrs to 16+ yrs	0.92	0.93	1.01	1.20	0.87	0.93	1.02	1.14
	Transmission, Fertility, & Marriage (Constrained Market)							
0-11 to 12 yrs	0.94	1.01	0.98	1.04	0.92	0.98	1.03	1.01
12 yrs to 13-15 yrs	1.06	0.96	1.01	1.04	0.93	0.98	1.02	1.01
13-15 yrs to 16+ yrs	1.04	0.98	0.97	1.08	1.02	0.99	0.98	1.04
0-11 yrs to 16+ yrs	0.96	0.96	0.99	1.13	0.94	0.96	0.99	1.11