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WHAT EXPLAINS THE GROWING GENDER EDUCATION GAP? THE EFFECTS OF PARENTAL BACKGROUND, THE LABOR MARKET AND THE MARRIAGE MARKET ON

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Abstract

In the 1960 cohort, American men and women graduated from college at the same rate, and this was true for Whites, Blacks and Hispanics. But in more recent cohorts, women graduate at much higher rates than men. To understand the emerging gender education gap, we formulate and estimate a model of individual and family decision-making where education, labor supply, marriage and fertility are all endogenous. Assuming preferences that are common across ethnic groups and fixed over cohorts, our model explains differences in all endogenous variables by gender/ethnicity for the '60-'80 cohorts based on three exogenous factors: family background, labor market and marriage market constraints. Changes in parental background are a key factor driving the growing gender education gap: Women with college educated mothers get greater utility from college, and are much more likely to graduate themselves. The marriage market also contributes: Women's chance of getting marriage offers at older ages has increased, enabling them to defer marriage. The labor market is the largest factor: Improvement in women's labor market return to college in recent cohorts accounts for 50% of the increase in their graduation rate. But the labor market returns to college are still greater for men. Women go to college more because their overall return is greater, after factoring in marriage market returns and their greater utility from college attendance. We predict the recent large increases in women's graduation rates will cause their children's graduation rates to increase further. But growth in the aggregate graduation rate will slow substantially, due to significant increases in the share of Hispanics – a group with a low graduation rate – in recent birth cohorts.

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What Explains the Growing Gender Education Gap?

The Effects of Parental Background, the Labor Market and the Marriage Market on College Attainment

by

Zvi Eckstein*, Michael Keane** and Osnat Lifshitz*

November 16, 2023

Abstract: In the 1960 cohort, American men and women graduated from college at the same rate, and this was true for Whites, Blacks and Hispanics. But in more recent cohorts, women graduate at much higher rates than men. To understand the emerging gender education gap, we formulate and estimate a model of individual and family decision-making where education, labor supply, marriage and fertility are all endogenous. Assuming preferences that are *common* across ethnic groups and *fixed* over cohorts, our model explains differences in all endogenous variables by gender/ethnicity for the ‘60-‘80 cohorts based on three exogenous factors: family background, labor market and marriage market constraints. Changes in parental background are a key factor driving the growing gender education gap: Women with college educated mothers get greater utility from college, and are much more likely to graduate themselves. The marriage market also contributes: Women’s chance of getting marriage offers at older ages has increased, enabling them to defer marriage. The labor market is the largest factor: Improvement in women’s *labor* market return to college in recent cohorts accounts for 50% of the increase in their graduation rate. But the labor market returns to college are still greater for men. Women go to college more because their *overall* return is greater, after factoring in marriage market returns and their greater utility from college attendance. We predict the recent large increases in women’s graduation rates will cause their children’s graduation rates to increase further. But growth in the aggregate graduation rate will slow substantially, due to significant increases in the share of Hispanics – a group with a low graduation rate – in recent birth cohorts.

Keywords: Returns to college, parental background, college graduation, education, gender wage gap, assortative mating, labor supply, marriage, fertility

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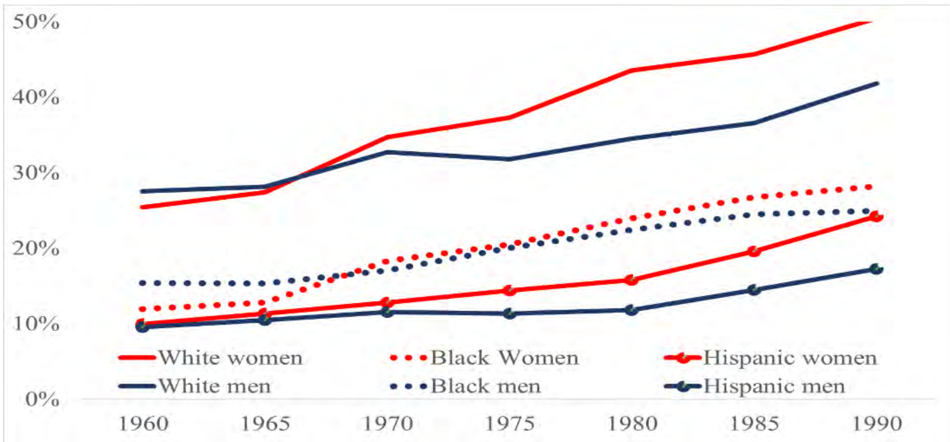
I. Introduction

College graduation rates in the US exhibit several key patterns that we seek to explain. Figure 1 plots college graduation rates of men and women using CPS data on 5-year birth cohorts from 1960 to 1990. In general, graduation rates have grown substantially. But they have grown much faster for women. In the 1960 birth cohort, women in all three ethnic groups graduated at rates very similar to men. But more recent cohorts of American women graduate from college at substantially higher rates than men, reversing a gender education gap in favor of men that existed for generations.[1] Differences across ethnic groups are also notable: Whites graduate at a much higher rate than Blacks, who in turn graduate at a higher rate than Hispanics. But, as a result of the general upward trend in the graduation rates across cohorts, the graduation rate for Blacks in the 1990 birth cohort is close to that for whites in the 1960 cohort.

Figure 1: The Growth in the Gender Education Gap



Note: We plot the college graduation rate for 5-year birth cohorts from 1960 to 90.

Several prior papers explored reasons for the rapid increase in educational attainment of women (relative to men). These include Becker, Hubbard and Murphy (2010a, b), Sanchez-Marcos (2008), Leukhina and Smaldone (2022) and Cervantes and Cooper (2023), who emphasize increasing labor market returns to education for women, Goldin, Katz and Kuziemko (2006) who emphasize contraception, delayed fertility and marriage, and changing work expectations of women, Ge and Yang (2013) who argue that higher divorce rates made college relatively more valuable for women, and Greenwood, Guner, Kocharkov and Santos (2016), who emphasize improvements in home production technology. In Eckstein, Keane and Lifschitz (2019) we argue that increasing returns to education in the marriage market and labor market, as well as family background were all important.

[1] In the '40 to '50 birth cohorts white men graduated college at an 8 percentage point higher rate than women. This gap closed suddenly in the '55 and '60 cohorts (who started college in about 1973 to 1978). Mechanically, this was driven by a substantial drop in college attendance of men, and a very slight increase for women.

Our innovation is to analyze the changes in education by cohort, gender and ethnicity shown in Figure 1 in a unified framework where education, marriage, fertility and labor supply are all endogenous. We formulate and estimate a model of individual and family decision making that succeeds in explaining the differences in college graduation rates by gender, and across ethnic groups and cohorts. Our model relies on 3 exogenous factors to explain education differences: Parental background (i.e., parent's education, marital status and immigration status), labor market constraints (wage offer functions and job offer functions) and marriage market constraints. We use the model to decompose differences in college graduation rates by gender/ethnicity/cohort into parts due to each of these 3 factors.[2] We impose discipline on the model by assuming common preferences across ethnic groups and cohorts. In our model education, labor supply, marriage and fertility are all endogenous, and we require the model to explain not only education but employment, marriage and fertility as well.

Parental background plays an important role in our model: It affects skill endowments at age 16, tastes for school, and tastes for marriage. This is consistent with a large literature in economics that emphasizes the important impact of family background on investments in both cognitive and non-cognitive skills of children – see, e.g., Cameron and Heckman (2001), Heckman and Masterov (2004), Cunha, Heckman, Lochner and Masterov (2006), Todd and Wolpin (2007), Cunha and Heckman (2008), Fiorini and Keane (2013), Attanasio et al (2022).

We model family background as consisting of three characteristics: mothers' education, parent's marital status and parent's immigration status. Parental education and immigration status play two key roles: They are correlated with "endowments'' of labor market skill at age 16 skill, and they shift tastes for education.[3] Similarly, parents' marital status is correlated with labor market skill, and it also shifts tastes for marriage. Our emphasis on mother's education as a driver of child skills is consistent with work by Sayer et al (2004), Guryan, Hurst and Kearney (2008), Kalil, Ryan and Corey (2012) and Potter and Roska (2013) showing college educated mothers spend more time in educational activities with children, and by Carneiro, Meghir and Parey (2013), who find causality from mother education to child skills.

[2] In Eckstein, Keane and Lifshitz (2019) we explored factors that drove changes in white men's and women's college attendance in earlier birth cohorts from 1935-75. During that period white women's college graduation rate increased from 6% to 36%. We find this enormous increase can be explained by three factors (one third each): (i) increasing returns to college in the marriage market for women, (ii) changes in the wage structure that favored women, and (iii) increasing mother's education, which increased daughters' tastes for college.

[3] Obviously other mechanisms may also be at work. Families with college educated mother's may invest more in daughters' human capital, and/or have higher aspirations for daughters. Having a college educated mother may raise a daughter's aspirations, or result in a daughter having better information about career opportunities after college. Our model captures these various mechanisms under the umbrella of increased taste for college.

Table 1 shows that differences in parental background across cohorts and ethnic groups are substantial, so they may be an important factor driving differences in education. The table shows the fraction of children whose mothers were college graduates is much greater for Whites than for Blacks or Hispanics, and it has increased substantially over time for all three groups. For example, for whites, it increased from 14% in the 1960 birth cohort to 38% in the 1990 cohort. Of special importance for Hispanics is that the percent with U.S. born parents increased substantially over cohorts – See Table 1, last column. This may have improved education prior to age 14, leading to better initial skill endowments. It may also imply changing tastes for education on the part of both parents and children.

Table 1: Mother's Education, Marital Status and Immigration Status by Cohort

	White		Black		Hispanic		
Cohort	% of CG+PC mothers	% of single mothers	% of CG+PC mothers	% of single mothers	% of CG+PC mothers	% of single mothers	% of US born mothers
1960	14.0%	6.4%	6.0%	37.0%	7.0%	12.7%	42.0%
1970	24.0%	11.8%	12.0%	48.9%	8.0%	18.6%	44.0%
1980	26.0%	18.7%	13.0%	61.5%	11.0%	25.9%	52.0%
1990	38.0%	26.6%	19.0%	67.6%	14.0%	31.1%	75.0%
2000	45.0%	21.7%	25.0%	69.8%	17.0%	33.2%	
2010	51.0%	21.9%	28.0%	74.5%	23.0%	40.0%	

Note: The table reports the % of college graduate mothers (two decades earlier at age 30), and the % of single mothers (two decades earlier at ages 23-30), both taken from CPS data. The % of US born Hispanics is taken from the American Community Survey.

The fraction of children born into single mother households also differs substantially across ethnic groups and cohorts. For whites, it increased from 6% in the 1960 cohort to 27% in the 1990 cohort. The rate for Hispanics is about 5 points higher. For Blacks the prevalence of single mother households is much higher: it increased from 37% in the 1960 cohort to 68% in the 1990 cohort. Table 2 shows that having a college graduate mother increases probability of college attendance while having a single mother reduces it, but the association is stronger for Whites and Hispanics than for Blacks.

Table 2: Association of College Graduation with Mother Education and Marital Status

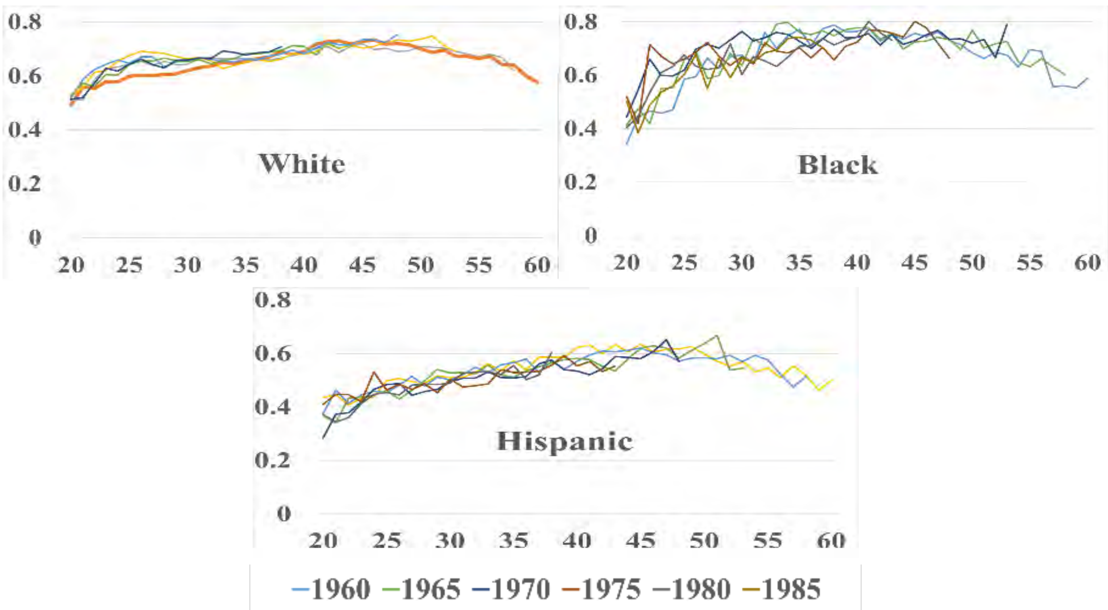
	White		Black		Hispanic	
	Men	Women	Men	Women	Men	Women
Single mom	-0.565***	-0.656***	-0.160	-0.366	-0.648**	-0.492*
	(0.17)	(0.16)	(0.26)	(0.22)	(0.24)	(0.23)
College mom	1.141***	0.922***	0.340	0.423*	0.925**	1.539***
	(0.18)	(0.19)	(0.25)	(0.20)	(0.30)	(0.32)

Note: NLSY97 data. Dependent variable: college graduation by age 30. We control for income in childhood, age of mother, year of birth, geographical variables.

Prior work modeling the impact of parental education on children's college attendance includes Cameron and Heckman (2001), Keane and Wolpin (2001), Abbott, Gallipoli, Meghir and Violante (2019) and Eckstein, Keane and Lifshitz (2019). These papers emphasize that parents' education matters for several reasons: 1) higher ability parents tend to have higher ability children (both via genetics and larger investments in child development), where ability includes both labor market skill and ability at school, 2) college education parents make larger transfers to finance college, and 3) better educated parents may influence children's taste for schooling, either directly, or via investments that enhance non-cognitive skills like self-discipline and persistence. These papers attempt to disentangle how these various factors contribute to the strong intergenerational persistence in education shown in Table 2.[4]

A potential explanation for the rapid increase in women's education is that women are investing more in human capital because they are forward-looking and expect to work more. But this is inconsistent with the data. Figure 2 shows employment rates of married women have been remarkably stable since the 1960 cohort. As we showed in EKL, Figure C1, employment of married women increased dramatically from the '25 to '60 birth cohorts, but then stabilized. So increased employment plays a key role in explaining growth in women's education prior to the '60 cohort, but not since. A key challenge is to explain substantial *increases* in women's education holding their employment *fixed*, using *fixed* preferences for leisure across cohorts.

Figure 2: Married Women's Employment over the Life-Cycle, by Birth Cohort



Note: CPS data on 5-year birth cohorts from 1960 to 1985.

[4] Gayle, Golan and Soytas (2022) study the impact of parents' marital status, operating through time and money investments in children, on child education outcomes. Their framework is very different from ours, as they model marriage market equilibrium, but education is not a choice – it is instead the result of a child production function.

Despite the fact that women's employment did not increase, we find evidence that their offer wage functions improved, both in terms of starting wages and returns to education and experience. This is an obvious potential factor increasing women's college attendance, as noted by Cervantes and Cooper (2023). But a key challenge for our model is to reconcile the higher wages and education of women with the stability in women's employment.

Finally, our work is also related to papers by Chiappori, Salanie and Weiss (2017), and Chiappori, Costa-Dias and Meghir (2018) that study how returns to education in the marriage market have increased for women over time. The former takes education as given, while latter consider a three-period model with education chosen first, followed by marriage, and then labor supply. The timing structure of these models does not allow them to assess how changes in marriage offer probabilities by age affects education choices, a factor that we find to be important (see below). Our work is more closely related to sequential choice models of education, marriage and labor supply in Ge (2011) and Keane and Wolpin (2010).

A brief summary of our results is as follows: Assuming preferences that are *common* across ethnic groups and *fixed* over cohorts, our model is successful in explain the differences in all endogenous variables (education, labor supply, marriage and fertility) by gender and ethnicity for cohorts from 1960-80 based on just three exogenous factors: family background, labor market and marriage market constraints. Our main result is that changes in parental background are a key factor driving the growing gender education gap: Women with college educated mothers get greater utility from college, and are much more likely to graduate.

The marriage market also contributes: Women's chance of getting marriage offers at older ages has improved, making it easier to defer marriage until after college. In contrast, we find that assortative mating did not increase much across the cohorts we study, so this is not an important factor driving the increase in women's college graduation rate.

The largest factor is the labor market: The improvement in women's' labor market return to college in recent cohorts accounts for 50% of the increase in their graduation rate.[5] Nevertheless, the labor market returns to college are still greater for men than women. The reason women go to college more than men is not that their labor market return is greater: It is that their *overall* rate of return is greater after factoring in marriage market returns and their greater utility from college attendance.

The *relative* impact of all three factors is similar across the three ethnic groups. But the absolute impacts are less for Blacks and especially for Hispanics. We estimate that labor market returns to education/experience have improved less for Hispanics than other groups.

[55] We treat wages as exogenous. Lee and Wolpin (2006) and Johnson and Keane (2013) model changes in the equilibrium wage structure over time that generating increases in women's wages.

Using our model to forecast behavior of future cohorts, we predict the graduation rate of white women has peaked with the ’90 to ’00 cohorts, and will plateau at about 53% going forward. The graduation rate of white men will (very) slowly catch up, causing the gender education gap between White men and women to narrow (very) gradually.

In contrast to Whites, we predict that the college graduation rates of Black and Hispanic women will continue to grow rapidly. We predict the college graduation rate of Black women will increase from 28% in the 1990 cohort to 34% in the 2010 cohort, roughly the rate of White women in the 1970 birth cohort. For Hispanic women we predict an increase from 23% to 30%. We predict gender education gaps will continue to grow within the Black and Hispanic groups.

We predict from the ‘90 to ‘10 cohorts college graduation rates will increase for all groups, from 7 pp for Hispanic women to 3 pp for Blacks men. But the aggregate graduation rate will increase very little, due to the increasing share of Hispanics in recent birth cohorts.

Our model implies that education gaps between Whites and both Blacks and Hispanics will remain substantial unless offer wage functions converge. We can use our model to quantify the impact of providing Blacks and Hispanics with tuition subsidies to attend college. We find that very substantial subsidies would be required to equalize educational opportunity between ethnic groups. We also quantify how subsidies impact the next generation, given that mother’s education affects the skills and tastes for school of their children.

The outline of the paper is as follows: In Section II we present and overview of our approach and discuss the literature. Section III presents our model. Section IV describes solution, estimate and model fit. We show how the model provides an excellent fit to CPS data from the ’60, ’70 and ’80 birth cohorts. We also show how, in an out-of-sample validation, our model provides a good fit to behavior of the 1990 cohort. Section V discusses the parameter estimates. Section VI presents our decompositions of education differences across groups into parts due to the various exogenous factors. Section VII presents our forecasts of future education levels. Section VIII presents education subsidy experiments aimed at equalizing opportunity across groups, and Section IX concludes.

II. Overview of our Approach

We develop and estimate a structural life-cycle model of education, marriage, fertility and labor supply decisions of men and women that succeeds in capturing all the key patterns in Figure 1, as well as fitting a broad range of other demographic and labor market outcomes. We fit the model to the behavior of the 1960-1980 birth cohorts. We then use the model to decompose the sources of the changes in educational attainment across cohorts, broken down by gender and race/ethnicity.

Our model builds on Eckstein, Keane and Lifshitz (2019), henceforth EKL, who present a life-cycle model of education, labor supply, marriage and fertility decisions. Their model was based on the separate life-cycle models for men and women in Keane and Wolpin (1997, 2010). EKL's innovation was to *jointly* model life-cycle behavior of men and women in a unified framework that accounts for marriage/divorce. In the married state couples make labor supply decisions jointly, while in the single state agents make decisions as individuals. All agents in the model retain their individual identity (and utility functions) through marriage and seek to maximize own lifetime utility. The EKL model provides an excellent fit to education, labor supply, wages, marriage and fertility decisions for five cohorts of Whites in the US.

Here we extend the EKL model to account for behavior of Blacks and Hispanics in the four cohorts born from 1960-90. This would be a trivial exercise if it were simply a matter of fitting the same model to Blacks and Hispanics. However, as we have discussed, the behavior of the 1960-80 cohorts differs tremendously between Whites, Blacks and Hispanics, particularly with regard to education. Our challenge is to find a *parsimonious* generalization of the EKL model that can explain these substantial behavioral differences, including both differences *across* ethnic groups as well as changes in behavior of each group *over time*.

A key aspect of the EKL model is that it imposes that preferences are invariant across birth cohorts. Thus, all changes in behavior over time are attributed to changes in the environment that the cohorts faced.[6] Here we show – rather remarkably – that we can also explain differences in behavior across Whites, Blacks and Hispanics using preferences that are not only cohort invariant but also common across the three groups.

The only parameters we allow to differ by ethnic group are wage offer functions, job offer probabilities, marriage offer distributions and the health process. Importantly, these parameters can only vary across groups in a rather restricted way, as the model must generate simulated wages, employment rates and marriage rates (by education) that are consistent with observables. For example, in the data we see that Hispanic men have very low rates of college attendance. The model <u>cannot</u> automatically explain this simply by assuming they have low returns to education, as that explanation is only tenable if it is consistent with the patterns of wages by education level actually observed in the wage data.

We extend EKL in three other important ways: First, we let the distribution of labor market skill endowments depend not only on parents' education but also on their marital status. This accommodates in a simple way the possibility that investments in child development may

[6] Where "environment'' means differences in (i) offer wages, (ii) parental background, (iii) the distribution of potential marriage partners, and (iv) contraception technology. Here, factor (iv) is similar for all three cohorts.

be greater in couples than in single parent families.

Second, we introduce inter-generational persistence in tastes for marriage by letting taste for marriage depend on parents' marital status. Marriage rates differ substantially across Whites, Blacks and Hispanics, which in turn generates differences in both skill endowments and tastes for marriage among their children. This is important for our model to explain the persistent behavioral differences across the three groups.

Third, we include welfare participation as an additional choice. We model welfare as an AFDC/TANF type system that provides benefits to single mothers only, and where participation generates "welfare stigma" as in Moffitt (1984). The welfare reform of 1996 made welfare receipt more difficult by imposing work requirements and time limits on recipients. We model the reform as introducing a 5-year time limit on benefit receipt. And we model work requirements parsimoniously as increasing the fixed cost of welfare participation.[7]

The impact of welfare programs on behavior depends on both skill endowments and marriage market opportunities. As these differ across Whites, Blacks and Hispanics, the impact of welfare on the behavior of the three race/ethnic groups differs in important ways as well.[8]

III. A Life-Cycle Model of Education, Labor Supply, Marriage/Divorce and Fertility

Agents enter the model at age 17 as single individuals in school. Both men and women make annual private decisions about school continuation and work. In addition, women make annual decisions about fertility, and single mothers decide whether to participate in a welfare program (if eligible). We assume only single people can attend school.[9] Retirement is enforced at age T=65, at which point agents receive a terminal value function. The men and women in the model also interact in a marriage market, so they can choose to form (and later dissolve) couples. Once a couple is formed, decisions about labor supply and fertility are made jointly.

To make marriage decisions, individuals compare the values of the married and single states. We first describe the problem of single individuals, followed by the problem of married couples. We are then in a position to explain how we model the marriage market.

III.A. The Decisions of Single Households

First we describe the optimization problems of single (i.e., unmarried) women and men. Let t denote the annual time period, and let $j = f, m$ denote gender.

[7] In related work, Blundell, Costas Dias, Meghir and Shaw (2016) model how welfare reform in the UK affected education choices of women, and their subsequent labor supply, but they do not model marriage and fertility choices (which are treated as exogenous processes). Low, Meghir, Pistaferri and Voena (2018) model effects of the 1996 US welfare reform on labor supply in a model with endogenous marriage, but they do not model effects on education or fertility.

[8] In EKL (2019) we found that welfare was not important for explaining the behavior of white cohorts over time.

[9] School attendance by married people is rare. We rule out school attendance after age 30 for the same reason.

III.A.1. Decisions while in School

All people start out in school at age 16, at education level "HSD" which stands for less than a high school degree. The first decision period is age 17, at which point they decide whether to continue in school (s_t = 1) or enter the labor market. Once a person has left school he/she cannot return. We do not allow agents to work or marry while in school, and we do not allow women to have children while in school. Education evolves as follows: Two years of school are required to become a high school graduate (HSG). For 1 to 3 additional years of school the person is at some college (SC) level, while 4 more years is needed to become a college graduate (CG). Any additional years lead to the PC level.

In equation (1), we specify that students receive ϑ_{jt} for j=m,f as a current payoff to school attendance. Later, we assume that workers' current payoff is a function of consumption and leisure (C_t, L_t). The asymmetry in how we treat students vs. workers is motivated by the fact that we cannot measure "leisure" time for students in a way comparable to that for workers,[10] as well as a desire to avoid modelling how consumption is financed by students.[11] Hence, consistent with prior work like Keane and Wolpin (1997), we simply define a "utility while in school" variable, given by:

$$(1) \qquad \vartheta_{jt} = \vartheta_{0j} + TC \cdot I(E_t > HSG) + \vartheta_{1j} I(PE > HSG) + \vartheta_{2j}\mu_j^W \quad \text{for } j=m,f$$

Here ϑ_{jt} is a function of a tuition cost TC for post-high school education,[12] the parents' education, denoted by PE, and the unobserved skill endowment at age 16, denoted by μ_j^W.

In (1), we specify that having a college educated mother shifts tastes for school. This is captured by the parameter ϑ_{1j} that multiplies the indicator $I(PE > HSG)$. Parental education may affect tastes for school directly, or it may affect ability at school, and hence the effort required for success. The important role of parental background in developing non-cognitive skills that increase school performance and the chances of college graduation is in line with findings of Heckman, Stixrud and Urzua (2006).

More educated parents also make larger financial transfers to support students in school – see Keane and Wolpin (2001) and Abbott et al (2019). And the sociology literature suggests that more educated parents are more involved with children's schooling and impart higher educational expectations – see, Coleman (1988), Lareau (2003), Davis-Kean (2005). Bear in mind that these factors are also subsumed in ϑ_{1j}, which we call a "taste shift" for simplicity.

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[10] While we can see hours of market work, we cannot measure hours spent on school work.

[11] Consumption while in school may be financed by a combination of parental transfers, financial aid, part-time work, etc. (see Keane and Wolpin (2001). It is beyond the scope of our paper to model all these possibilities.

[12] Note that ϑ_{ft} captures utility of school net of costs. Without data on costs these can't be identified separately.

The skill endowment μ_j^W that enters (1) is identical to the labor market skill endowment that enters the offer wage function that we describe below in Section III.C equations (23)-(24). The skill endowment comes in discrete types (low/medium/high) and the probability a person is each type will depend on parents' education and marital status. We emphasize that the skill endowment includes not just the initial genetic endowment but also all parental investments in children up through age 16. We hypothesize that more educated parents and dual parent households will invest more in children, and that this is an important reason, beyond genetics, that parents' education and marital status affect the age 16 skill endowment.

Another notable aspect of (1) is we let the intercept differ by gender. This is consistent with large literatures in both economics and sociology arguing that girls like school better than boys, or find school less difficult, or do better in school because they have more self-control. See for example, Becker, Hubbard and Murphy (2010a, b), Autor et al (2016), Heckman and Masterov (2004), Jacob (2002) and Voyer and Voyer (2014). Interestingly, Becker et al (2010a, b) argue that women find school less difficult than men, which causes them to have a higher elasticity of supply to college. Hence, they respond more than men to a given increase in the return to college. They propose this as a reason for the increase in the gender education gap.

III.A.2. Decisions that lead to Exit from School (Work, Marriage, Pregnancy)

In our model, a decision to work, get married, or (for women) to become pregnant all require exit from school. Workers are endowed with a unit of time, split between market work (h), and leisure (l), so $h_t^j + l_t^j = 1$. They may choose to work full-time, part-time, or not at all, $h_t^j \in \{1, 0.5, 0\}$, corresponding to leisure levels of $l_t^j \in \{0, 0.5, 1\}$.[13] Single men and women receive marriage offers probabilistically, and make decisions about marriage $M_t \in \{0,1\}$. In addition, women (single and married) make a decision about pregnancy, $p_t \in \{0,1\}$, and single women with children may decide to participate in a welfare program, $g_t \in \{0,1\}$.

III.A.3. Income and Consumption of Singles

The gross income of a single man is simply $GY_t^m = w_t^m h_t^m$, where w_t^m denotes his annual wage rate. The gross income of a single woman is:

$$(2) \quad GY_t^f = w_t^f h_t^f + CS_t \cdot a_t \cdot I[N_t > 0] + wb\left(N_t, w_t^f h_t^f, G_t\right) \cdot g_t$$

Here N_t is the number of children the women has, and a_t is an indicator that a single woman with children receives child support, *CS*. This occurs with probability $P(a_t = 1)$, which is a free parameter that we estimate.[14] We let $CS_t = \exp\,(\varepsilon_t^a)$ where $\varepsilon_t^a \sim N(\mu_a\,, \sigma_\varepsilon^a)$.

[13] We assume that full-time and part-time work correspond to 2000 and 1000 annual hours, respectively.

[14] The child support parameters are identified by the fraction of unemployed single mothers who go on welfare.

The term $wb(N_t, w_t^j h_t^j, G_t)$ denotes the level of welfare benefits to which a single mother with N_t children and income $w_t^f h_t^f$ is eligible. The state variable G_t is number of years the woman has received benefits in the post-1996 period and prior to age *t*.

The $wb_t(\cdot)$ function is designed to capture the array of social benefits targeted at single mothers in the US. These include AFDC/TANF benefits, public housing, childcare subsidies, etc. Rather than model the rules of these programs in detail, we treat $wb_t(\cdot)$ as an exogenous stochastic process that we fit from data prior to estimation, using the simple function form:

$$(3) \qquad wb_t(N_t, w_t^f h_t^f, G_t) = \begin{cases} \beta_{0t} + \beta_{1t} N_t + \beta_{2t} w_t^f h_t^f & if \quad G_t < 5 \\ 0 & if \quad G_t > 5 \end{cases}$$

Importantly, the benefit rule $wb_t(\cdot)$ provides a natural exclusion restriction. It affects behavior of single women *directly* through the budget constraint, but it only affects behavior of married women, and all men, *indirectly* through the marriage market and household bargaining.

The net income of a single person is given by:

$$(3) \qquad Y_t^j = GY_t^j - \tau_t^S(w_t^j h_t^j, N_t) \quad j = f, m$$

where $\tau_t^S(w_t^j h_t^j, N_t)$ is the time *t* tax function for single individuals calculated using the tax rules described in the Appendix B. Thus, the budget constraint for a single person is simply:

$$(4) \qquad C_t^j = (1 - \kappa(N_t)) Y_t^j$$

where $\kappa(N_t)$ is the cost of children which we specify as a fraction of income.[15] Note that both single men and women may have children ($N_t > 0$). These may be children from a previous marriage or, in the case of single women, children born outside of marriage.

III.A.4. Utility of a Single Person

The per-period utility function of a single female is given by:

$$(5) \qquad U_t^f(\Omega_{ft}) = \left(\frac{1}{\alpha}(C_t)^\alpha + L_j(l_t) - \Psi g_t + \pi_t p_t + A_f^s Q(l_t, 0, Y_t, N_t)\right)(1 - s_t) + \vartheta_{ft} s_t$$

Note that if she is in school ($s_t = 1$) she gets the utility from attending school ϑ_{ft}, while if she is out of school her utility depends on consumption, leisure, welfare participation and children via the term $\frac{1}{\alpha}(C_t)^\alpha + L_j(l_t) - \Psi g_t + A_f^s Q(\cdot)$. We now explain these terms in more detail:

The first term in (5) is a CRRA in consumption with curvature parameter α.

[15] The equivalence scale implies that $\kappa(N) = 0.194, 0.293, 0.367$ and 0.423 if $N = 1, 2, 3$ or 4, respectively.

The second term in (5), $L_j(l_t)$, captures the value of leisure and home production. The third term Ψ is a disutility of welfare participation. The fourth term captures the utility (or disutility) from a pregnancy ($p_t = 1$), and the fifth term captures utility from the quality and quantity of children. We now discuss the 2nd through 5th terms in more detail:

III.A.4.1. *Tastes for Leisure and Value of Home Production*

We write the utility from leisure $L_j(l_t)$ as:

(6a) $$L_{jt}(l_t^j) = \frac{\beta_{jt}}{\gamma}(l_t^j)^\gamma + \xi_{jt} l_t^j \qquad \gamma < 1, \alpha < 1$$

The parameter β_{jt}, which must be positive, shifts tastes for leisure. We allow β_{jt} to depend on education and on health status. For women it also depends on pregnancy p_t, as in:

(6b) $$\beta_{mt} = \beta_{0m} + \tau_{1m} E_t \qquad \text{and} \qquad \beta_{ft} = \beta_{0f} + \tau_{1f} E_t + \tau_{2j} p_t$$

The second term in (6) captures stochastic variation in the marginal utility of leisure. This is denoted by $\xi_{jt} l_t^j$ where ξ_{jt} is a random variable. We assume shocks to tastes for leisure (i.e., home time) follow a stationary AR(1) process, as in:

(7) $$\ln(\xi_{jt}) = \tau_{0j} + \tau_{1j} \ln(\xi_{j,t-1}) + \tau_{2j} p_{t-1} + \varepsilon_{jt}^l \qquad where \qquad \varepsilon_{jt}^l \sim iidN(0, \sigma_\varepsilon^l)$$

where $0 < \tau_{1j} < 1$. Importantly, the arrival of a new child at time t (i.e., $p_{t-1} = 1$) shifts tastes for home time (τ_{2j}). We expect that, particularly for women, the marginal utility of home time will jump up when a newborn arrives (i.e., $\tau_{2f} > 0$), capturing an increase in time required for home production and the desire to spend time with the child. Afterward, provided no new children arrive, tastes for home time gradually revert to normal, as $\tau_{1f} < 1$. This lets us generate the decline in women's employment after childbirth, as well as their subsequent gradual return to the labor force.[16] The stochastic terms ε_{jt}^l generate heterogeneity in these response patterns.

III.A.4.2. *Disutility of Welfare Participation*

The parameter Ψ in (5) is a disutility of welfare participation. It may capture social "stigma," as well as time and effort costs arising from the various work/training/search and reporting requirements imposed on welfare participants. The welfare reform of 1996 can be thought of as making these requirements more stringent, so we let Ψ increase after 1996.

III.A.4.3. *Utility from Pregnancy*

The utility from pregnancy π_t is given by:

(8) $$\pi_t = \pi_0 + \pi_1(1 - M_t) + \pi_2 H_{ft} + \pi_3 N_t + \pi_4 p_{t-1} + \varepsilon_t^p$$

where $\varepsilon_t^p \sim iidN(0, \sigma_\varepsilon^p)$. Here π_t is a function of marital status, where M_t is a 1/0 indicator for

[16] The intercepts β_{0j} in (6) and τ_{0j} in (7) are not separately identified, so we set $\beta_{0j} = 0$ for $j=m,f$.

marriage, the woman's health, the number of already present children and lagged pregnancy. The presence of health H_{ft} helps generate that fertility declines with age.

III.A.4.3. ***Utility from Quantity and Quality of Children***

Finally, consider the function $Q(\cdot)$ that determines the utility a couple receives from children. This depends on the quantity of children, and also on inputs that increase child quality: the home time (leisure) of both parents and the income of the parents – see Becker and Lewis (1973). We assume $Q(\cdot)$ is a CES function of the inputs, as follows:

$$(9)\quad Q\left(l_t^f, l_t^m, Y_t^M, N_t\right) = \left(a_f\left(l_t^f\right)^\rho + a_m(l_t^m)^\rho + \left(1 - a_f - a_m\right)(\kappa(N_t)Y_t^M/N_t)^\rho)\right)^{1/\rho} \cdot N_t^{\rho 0}$$

Here $\kappa(N_t)Y_t^M/N_t$ is spending *per child*, which is not a choice but rather determined by a square root equivalence scale. The parameter A_j^S in the utility function (4a) is a scale parameter that multiplies $Q(\cdot)$. This parameter is allowed to differ in the married state (see below). For single women with children we have $Q(l_t, 0, Y_t, N_t)$, so the male time input is set to zero.

III.A.4. Choice Specific Value Function for Single Men and Women

We can now write the choice-specific value function for single females. We let Ω_{ft} denote her current state. We assume for now the women chooses to stay single, and conditional on staying single she chooses school, labor supply, pregnancy and welfare participation:

$$(10)\quad V_t^f\left(s_t, l_t, p_t, g_t | \Omega_{ft}\right) = \left(\frac{1}{\alpha}(C_t)^\alpha + L_f(l_t) - \Psi g_t + \pi_t p_t + A_f^s Q(l_t, 0, Y_t, N_t)\right)(1 - s_t) + \vartheta_{ft} s_t + \delta E_{MAX} V(\Omega_{f,t+1})$$

Here δ is the discount factor and $E_{MAX}V(\Omega_{f,t+1})$ is the expected maximum of the t+1 value function, given the next period state $\Omega_{f,t+1}$ that is determined by the current state Ω_{ft} and the current choice $\{l_t, p_t, s_t, g_t\}$, as well as random factors.

One of these random factors is whether the woman receives a marriage offer at t+1, and whether that offer is good enough for her to decide to get married. The Emax function takes into account that the person may get married at t+1. It takes the form:

$$(11)\quad E_{MAX}V\left(\Omega_{f,t+1}\right) = E_{MAX}\left(M_{t+1}V_{t+1}^{fM}\left(\Omega_{m,t+1}, \Omega_{f,t+1}\right) + (1 - M_{t+1})V_t^f\left(\Omega_{f,t+1}\right)\right)$$

Notice that if $M_{t+1} = 0$ the future value function is simply $V_t^f\left(\Omega_{f,t+1}\right)$. But if $M_{t+1} = 1$ then the future value function is V_{t+1}^{fM} where the superscript *fM* denotes the value function of a married women. We will define the value functions for married men and women below.

The choice-specific value functions $V_t^m(l_t, s_t | \Omega_{mt})$ for single men are analogous, except they do not have the welfare participation (g_t) and pregnancy (p_t) options, so the $-\Psi g_t + \pi_t p_t$ term drops out. And utility from children is $Q(0, l_t, Y_t, N_t)$.

III.A.5. The Maximized Value Functions for Single Men and Women

Now we consider the optimization problem of singles. In Section III.E we discuss the marriage market, but we must first consider decision making *conditional* on being single – i.e., the state where no marriage offer is available or where it has already been declined.

Let $V_t^m(\Omega_{mt})$ and $V_t^f(\Omega_{ft})$ denote the maximized value functions of single males and females in period *t*. Let $\mathcal{S}_t^m$ and $\mathcal{S}_t^f$ denote the feasible set of choice options for a single male and female in period *t*, respectively. As we will see in Section III.C, workers receive job offers probabilistically, so $\mathcal{S}_t^m$ and $\mathcal{S}_t^f$ may not include all possible levels of work hours and leisure. To proceed, for women and men we have, respectively:

$$V_t^f(\Omega_{ft}) = \max_{\{l_t, p_t, s_t, g_t\} \in \mathcal{S}_t^f} V_t^f(l_t, p_t, s_t, g_t | \Omega_{ft}) \tag{12}$$

$$V_t^m(\Omega_{mt}) = \max_{\{l_t, s_t\} \in \mathcal{S}_t^m} V_t^f(l_t, s_t | \Omega_{mt}) \tag{13}$$

These value functions appear below in equations (21) and (29) that govern divorce and marriage decisions, respectively.

III.B. The Decisions of a Married Couple

In our model, utility functions exist at the *individual* level, and are not fundamentally altered by marriage. Consistent with this, we specify the utility functions of married agents to be as similar as possible to those of single agents. We assume a collective model of household decision making, as in Mazzocco (2007), Chiappori (1992), Apps and Rees (1988). Thus, within marriage, collective household decisions are made by constrained maximization of a weighted average of the individual partners' utility functions.

Conditional on marriage, couples have three choice variables: Leisure of the husband and wife, $\{l_t^m, l_t^f\}$, and pregnancy, $p_t \in \{0, 1\}$. Pregnancy leads deterministically to arrival of a child at *t*+1. Couples also make annual decisions about divorce/marriage continuation. We ignore this for now and focus on the joint decisions of couples' *conditional* on marriage.

III.B.1. *Budget Constraint of a Married Couple*

Married couples have total gross income GY_t^M given by:

$$GY_t^M = (w_t^m h_t^m + w_t^f h_t^f) \tag{14}$$

Here w_t^j and h_t^j for *j* = *f*, *m* are annual full-time wage rates. We will use the *M* superscript throughout to indicate values for married individuals.[17] Net income is Y_t^M given by the equation:

[17] We could include an unemployment benefit (or value of home production) in (14) but it would not be separately identified from the value of leisure parameters β_{jt} in (6).

(15) $$Y_t^M = GY_t^M - \tau_t^M\big((w_t^m h_t^m + w_t^f h_t^f), N_t\big),$$

where $\tau_t^M(\cdot,\cdot)$ is the tax function for married couples based on the time t tax rules. We model the US federal tax system in detail, including deductions, exemptions, EITC, and the joint taxation of couples (see Appendix B). We assume perfect foresight regarding tax rules.

The household budget constraint takes the form:

(16) $$C_t^M = (1 - \kappa(N_t))Y_t^M$$

Here $\kappa(N_t)$ is the fraction of Y_t^M spent on children, based on a square root equivalence scale.[18] We assume a static budget constraint as it is computationally infeasible to add saving in addition to our other state variables. However, the terminal value function (at age 65) proxies for how labor supply affects Social Security and retirement assets, so these key aspects of savings do enter our model in a reduced form way.

III.B.2. *Utility Function of Married Individual*

The period utility of a married person of age t and gender j in state Ω_{jt} is given by:[19]

(17) $$U_t^{jM}(\Omega_{jt}) = \frac{1}{\alpha}(\psi C_t^M)^\alpha + L_{jt}(l_t^j) + \theta_t^M + \pi_t^M p_t + A_j^M Q(l_t^f, l_t^m, Y_t^M, N_t) \qquad j = m, f$$

We assume household consumption C_t^M is a "public" good. The full amount C_t^M enters the utility of both the husband and wife. The parameter $\psi \in (½, 1)$ captures household economies of scale in consumption. The square root equivalence scale gives $\psi = 1/\sqrt{2} = 0.707$, so a couple needs 41% more expenditure than a single person to obtain an equivalent consumption level.

Notice that most terms in (17) are also present in the utility functions for singles in (5). The exception is the third term (θ_t^M) that captures the utility from marriage itself. If a single woman is not in school ($s_t = 0$), her utility function is fundamentally identical to that of a married woman, as one can see by comparing (5) and (17). The only differences are that in (17) consumption is individual specific (i.e., $\psi = 1$), utility from marriage is (of course) dropped, utility from children is allowed to differ from the married state ($A_f^S \neq A_j^M$), the home-time of the husband is set to zero in the Q function, and welfare participation is an option.

Note that the utility from pregnancy, π_t^M, defined in (8), contains nothing individual specific. That is, it does not differ between the two partners in a couple. We assume pregnancy

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[18] For a household with two adults, the square root scale implies that $\kappa(N) = 1 - \sqrt{2/(2+N)}$.

[19] The state vector Ω_{jt} contains four variables that are relevant for $U_t^{jM}(\Omega_{jt})$. These are N_t and μ_{jt}, as well as parent's education and marital status, and health. The state vector Ω_{jt} contains several additional variables, whose role will only become clear after the full model is laid out. Thus, we defer giving the complete list of elements of Ω_{jt} until we finish expositing the full model and turn to discussing the DP problem solution (Section IV).

decisions are made jointly by the couple, and each party gets the same utility from the decision.[20] Next we describe utility from marriage in more detail:

III.B.2.1. *Match Quality and the Utility of Marriage*

The utility from marriage (θ_t^M) or match quality is given by:

$$\text{(18)} \quad \theta_{tj}^M = d_1 + d_2 \cdot I[E^m - E^f > 0] + d_3 \cdot I[E^f - E^m > 0] + d_4(H_t^m - H_t^f)^2 + \varepsilon_t^M$$

where $\varepsilon_t^M \sim iidN(0, \sigma_\varepsilon^M)$ and E^j denotes education, rank ordered as high school dropout (HSD), high school (HSG), some college (SC), college (CG) and post-college (PC), and $H_t^j \in \{1, 2\}$ denotes health (i.e., good or poor). The 2nd and 3rd terms capture assortative mating on education. $I[E^m - E^f > 0]$ indicates the man has greater education than the woman, and $I[E^f - E^m > 0]$ indicates the reverse. If $d_3 < 0$ people are averse to matches where the woman has more education. The 4th term captures assortative mating on health. If $d_4 < 0$ people prefer matches where partners have similar health. Finally, ε_t^M is a transitory shock to match quality.

III.B.3. Choice Specific Value Functions of Married Individuals

We are now able to write the choice-specific value functions for married *individuals*. These depend on both a person's own state and that of their partner:

$$\text{(19)} \quad V_t^{jM}(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}) = \frac{1}{\alpha}(\psi C_t^M)^\alpha + L(l_t^j) + \theta_t^M + \pi_t p_t + A_j^M Q(l_t^f, l_t^f, Y_t^M, N_t)$$
$$+\delta E_{MAX}\left(M_{t+1} V_{t+1}^{jM}(\Omega_{m,t+1}, \Omega_{f,t+1}) + (1 - M_{t+1}) V_t^j(\Omega_{j,t+1})\right) \qquad j = f, m$$

The current payoff simply reproduces (17). The future component in (19) consists of two parts, corresponding to whether the marriage continues at t+1 or not. The term $V_{t+1}^{jM}(\Omega_{m,t+1}, \Omega_{f,t+1})$ is the value of next period's state for partner j if the marriage continues. The term $V_t^j(\Omega_{jt+1})$ is the value of next period's state for partner j if he/she becomes single (i.e., a divorce occurs). These were defined in equations (12) and (13). We discuss the divorce decision below.

The t+1 state depends on the current state $\{\Omega_{mt}, \Omega_{ft}\}$ and current choices $\{l_t^m, l_t^f, p_t\}$ via the laws of motion of the state variables. δ is the discount rate and $E_{MAX}(\cdot)$ is the expectation taken over elements of the t+1 state that are unknown at t. These include M_{t+1}, $\{\varepsilon_{jt+1}^l\}$ for $j = m$, f, ε_{t+1}^M and ε_t^p, as well as realizations of wage shocks and job offers. We defer a detailed discussion of these until Section III.C which describes the labor market.

[20] Of course, one could imagine individuals in a couple getting different utilities from a pregnancy decision, but we cannot infer such differences from the data so we ignore them.

III.B.4. ***Household Decision Making for Married Couples***

In our collective model the household value function is given by:

(20) $V_t^M\left(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}\right) = \lambda V_t^{fM}\left(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}\right) + (1-\lambda) V_t^{mM}\left(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}\right)$

Here λ and (1-λ) are Pareto weights. We set $\lambda=0.5$ for simplicity.[21] The V_t^{jM} for *j=f, m* are the choice-specific value functions of the *individual* married partners. The Ω_{jt} for *j=f, m* are the state vectors of these individuals. Couples seek a choice vector $\{l_t^m, l_t^f, p_t\}$ to maximize (20), subject to the constraint that both parties prefer marriage over the outside option of divorce.[22]

Recall that $V_t^m(\Omega_{mt})$ and $V_t^f(\Omega_{ft})$ denote the maximized value functions of single males and females in period *t*, see equations (12)-(13). Utility is not transferable, so a divorce occurs if the value of the outside (single) option exceeds the value of marriage for *either* party. Let $\mathcal{F}$ denote the feasible set of choice options. A choice vector $\{l_t^m, l_t^f, p_t\} \in \mathcal{F}$ if:

(21) $$V_t^{jM}\left(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}\right) \geq V_t^j\left(\Omega_{jt}\right) - \Delta_{jt} \quad for \quad j = f, m$$

where Δ_{jt} is the cost of divorce. If no choice vector $\{l_t^m, l_t^f, p_t\}$ satisfies (11) then $\mathcal{F} = \emptyset$.

The cost of divorce depends on the number of children, $\Delta_{jt} = \alpha_4^j + \alpha_5^j \mathrm{N}_t$. This cost is fixed across cohorts. Many US States switched to unilateral divorce laws in the 1970s, which lowered divorce costs. Both Voena (2015) and Bronson (2015) find this had important impacts on behavior. But our oldest cohort (1960) entered the marriage market at the 1980s.

We can now formally define the solution to the maximization problem. Denote the vector of household choices that maximize equation (20) as $\{l_t^{m*}, l_t^{f*}, p_t^*\}$. That is,

$$\{l_t^{m*}, l_t^{f*}, p_t^*\} = \begin{cases} arg \max\limits_{\{l_t^m, l_t^f, p_t\} \in \mathcal{F}} V_t^M\left(l_t^m, l_t^f, p_t | \Omega_{mt}, \Omega_{ft}\right) & if \quad \mathcal{F} \neq \emptyset \\ \emptyset & if \quad \mathcal{F} = \emptyset \end{cases}$$

The form of (20) insures that $\{l_t^{m*}, l_t^{f*}, p_t^*\}$ is a Pareto efficient allocation. If one or more parties prefer to remain single for all possible $\{l_t^m, l_t^f, p_t\}$ then $\mathcal{F} = \emptyset$ and a divorce occurs.

The maximized value function of a married *individual* in state Ω_{jt} is given by:

(22) $$V_t^{jM}\left(\Omega_{mt}, \Omega_{ft}\right) \equiv \begin{cases} V_t^{jM}\left(l_t^{m*}, l_t^{f*}, p_t^* | \Omega_{mt}, \Omega_{ft}\right) & for \quad j = f, m \quad if \quad \mathcal{F} \neq \emptyset \\ -\infty & for \quad j = f, m \quad if \quad \mathcal{F} = \emptyset \end{cases}$$

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[21] This simple specification is similar to Voena (2015), who considers a household planning problem with a unilateral divorce regime. We discuss our decision to use this simple specification in EKL (2019) Section V.

[22] If we take the *unconstrained* maximum of (20), we might obtain a solution for $\{l_t^m, l_t^f, p_t\}$ where only one party prefers to stay married. In a transferable utility framework, a marriage may persist in such a case, using transfers between partners. We do not adopt this approach, as such transfers would be difficult to enforce.

The maximized value function depends on both the own state Ω_{jt} and that of the partner.[23]

We discuss the marriage market and decisions to get married in Section III.E. First, we need to describe the labor market and health transitions, so that we have defined all the state variables that are relevant when deciding on marriage offers.

III.C. The Labor Market – Wages Offers and Job Offers

The wage offer functions have a standard Ben-Porath (1967), Mincer (1974) form:

$$lnw_{Et}^{j} = \omega_{1E}^{j} + \omega_{2E}^{j}X_t - \omega_{3E}^{j}X_t^2 + \varepsilon_{jt}^{W} \qquad for \qquad j = f, m \tag{23}$$

where X_t is work experience (years) and $E \in \{HSD, HSG, SC, CG, PC\}$ is education level. We let the wage function parameters $\{\omega_{ke}^{j}\}_{k=1,3}$ vary freely by education, gender, race/ethnicity and cohort. Thus, at a given education level, both starting wages and returns to experience may differ between males and females and between race/ethnic groups, capturing two potential dimensions of discrimination.[24] Our specification allows returns to experience to differ by education, as recent studies (e.g., Imai and Keane, 2004, Blundell et al., 2016) find greater experience returns for more educated workers. We let parameters vary by cohort to allow for changes in the wage structure over time, particularly changes in returns to education/experience and relative wages between men and women and between race/ethnic groups.

The error term ε_{jt}^{W} in equation (23) has a permanent/transitory structure:

$$\varepsilon_{jt}^{W} = \mu_j^{W}(PE, PM) + \tilde{\varepsilon}_{jt}^{W} \qquad \text{where} \qquad \tilde{\varepsilon}_{jt}^{W} \sim iidN(0, \sigma_{\varepsilon}^{W}) \tag{24}$$

The time-invariant error component μ_j^{W} is the agent's skill "endowment" at age 16, as in Keane and Wolpin (1997). We allow for three initial skill levels (low, medium, high). The probability a person is each type depends on parents' education (*PE*) and marital status (*PM*). This accounts for intergeneration transition of ability, and different levels of investment in child development by parents of different education levels or marital status.

The probability a person is each of the three skill types is determined by a multinomial logit (MNL) with the latent indices:

$$\begin{aligned} \nu^{High} &= \eta_0^H + \eta_1^H \cdot PE + \eta_2^H \cdot PM + \epsilon^H \\ \nu^{Med} &= \eta_0^M + \eta_1^M \cdot PE + \eta_2^M \cdot PM + \epsilon^M \end{aligned} \tag{25}$$

where we normalize $\nu^{Low} = \epsilon^L$ for identification and where the ϵ vector is *iid* extreme value.

[23] Note that if $\mathcal{F} = \emptyset$ then no action exists such that person *j* can be married at time *t*, so a divorce occurs. Then $V_t^{jM} = -\infty$, so behavior is governed solely by the single value function $V_t^j(\Omega_{jt})$.

[24] Different intercepts or slopes between males and females may also capture that males and females of a given age and education are not perfect substitutes in production, causing rental rates on male/female labor to differ.

An important discipline we impose on the model is that, like preferences, we do not allow the distribution of latent ability *conditional* on parents' education and marital status to differ by race/ethnicity or cohort or gender. This allows us to identify how changes in parents' education across cohorts, and differences in parents' education across ethnic groups, lead to differences in the distribution of skill types across cohorts and ethnic groups. Similarly, it allows us to identify how changes in parents' marital status across cohorts, and differences in parents' marital status across ethnic groups, lead to differences in the distribution of skill types across cohorts and ethnic groups.

In contrast, given a single cohort and ethnic group we could only estimate how PE and PM are correlated with skill type, and we could not infer causality. But, given multiple cohorts and ethnic groups, and given the assumption that (25) is invariant to cohort, ethnic group and gender, we can identify how changes (differences) in PE and PM lead to changes (differences) in the distribution of skill types across cohorts and ethnic groups.

Now consider job offers: In each period, people who were unemployed at the start of the period ($h_{t-1} = 0$) may receive full- and/or part-time job offers probabilistically. Thus, their possible choice sets for hours are $D_t = \{0\}, \{0, 0.5\}, \{0,1\}$ or $\{0, 0.5, 1\}$. The probabilities of getting a full-time offer and a part-time offer are each determined by a logit model of the form:

(26) $$P_j(k \in D_t) = \frac{exp(\phi_{j0k}+\phi_{j1k}e_t^r+\phi_{j2k}X_t+\phi_{j3k}H_t)}{1+exp(\phi_{j0k}+\phi_{j1k}e_t^r+\phi_{j2k}X_t+\phi_{j3k}H_t)} \quad \text{for} \quad k=1, 2$$

where k=1,2 denote full- and part-time, respectively. Here $e_t^r = 1, \ldots, 5$ corresponds to the five education levels in ascending order, X_t is work experience and H_t is health.[25] An employed individual ($h_{t-1}>0$) has the option to keep his/her previous job, unless an exogenous separation occurs. The separation probability obeys a similar logit function that also depends on e_t^r, X_t and H_t.[26] We let the parameters of the logit models for job offers and separation probabilities differ freely by cohort and race/ethnicity (just like the wage function parameters).

III.D. Health Status

There are substantial disparities across race/ethnic groups in health and mortality in the US, so it is important for our model to account for these. We assume that health evolves over the life-cycle according to a two-state Markov chain, where $H_{jt} \in \{1,2\}$ indicate good and

[25] By introducing job offer probabilities that depend on work experience we can capture the idea that women who leave the labor force (perhaps after marriage or childbirth) may have a difficult time obtaining job offers later, as their work experience lags behind that of women who continue working. Hence, the impact of not working on experience (and wages) can accumulate over time.

[26] A person may be involuntary unemployed due to exogenous separation or due to drawing an empty choice set (i.e., $D = \{0\}$). A person may be voluntarily unemployed due to quitting their prior job or rejecting all offers.

fair/poor, respectively. The transition probabilities differ by age, cohort and race/ethnicity. We assume health is an *exogenous* process, so it can be estimated outside the model.

Health plays several important roles in our model. For example, we require people to retire by age 65, but declining health may induce them to retire earlier, as health affects both tastes for work (6) and job offer probabilities (26). Health is also a dimension on which people sort in the marriage market (18), and it shifts tastes for pregnancy (8). Furthermore, as we assume health is not affected by employment, marriage or fertility decisions, it generates exogenous variation in these decisions (*given* our model).

III.E. The Marriage Market

The final component of the model is the marriage market. Single people may receive marriage offers, and they choose to become married if they draw a good enough match. To make this decision, they must compare the value of remaining single to the value of entering the married state. This section describes how the matching process works.

III.E.1. *Marriage Offers*

At the start of a period a single individual may receive a marriage offer. Denote the probability of receiving an offer as $p_j^H(\Omega_{jt})$ for $j = f, m$. We assume the probability is given by a binomial logit model that depends on age and age-squared, whether a person is below 18, and whether a person is in school. The age effects differ by gender.

A marriage offer is characterized by a vector of attributes of a potential spouse, denoted by $\mathcal{M}_{jt}$. We assume marriage offers always come from a potential spouse of the same age (t). This is necessitated by technical issues that arise in solving the dynamic programming problem (see Appendix C1 for details). We do not think this assumption will have too great an effect on the results, because the large majority of married couples are in fact close in age.[27] It is convenient to describe the construction of marriage offers in three steps:

First, we draw the education of the potential spouse. We assume potential spouses have three possible education levels: high-school and below (HS, *ed = 0*), some college (SC, *ed = 1*) or college or above (C, *ed = 2*). The probability of receiving an offer from a potential spouse of the HS, SC or C type depends on a person's own education.[28]

Specifically, if the individual gets a marriage offer, we draw the potential partner's education using a multinomial logit (MNL) with the following latent indices:

[27] For the cohorts of 1960-1980, the age gap between partners is below 5 years for 79% of all couples. It is below 7 years for 88% of couples, and below 10 years for 94% of couples.

[28] To simplify the MNL we combine the HSD and HSG levels into "HS," and the CG and PC levels into "C." Then, if a person draws "HS" we assign education level HSD or HSG to the potential partner according to the actual fraction in the data (by cohort and age). We do the same to convert "C" draws to CG and PC offers.

$$
(27) \quad \begin{aligned} v_{jt}^{C} &= \eta_{0j}^{C} + \eta_{1j}^{C} \cdot I[ed^m - ed^f = 2] + \eta_{2j}^{C} \cdot I[ed^m - ed^f = 1] + \epsilon_{jt}^{C} \\ v_{jt}^{SC} &= \eta_{0j}^{SC} + \eta_{1j}^{SC} \cdot I[ed^m - ed^f = 1] + \epsilon_{jt}^{SC} \end{aligned} \qquad j=m,f
$$

High school is the base case with $v_{jt}^{HS} = 0$. The parameters η govern the probability that a person (of given education) receives offers from potential partners with different education levels. The η reflect both the supply of potential partners and tastes for partners of different types.[29]

Rather than solve explicitly for marriage market equilibrium, we estimate parameters η that, when combined with the rest of our model, generate (to a good approximation) the observed distribution of match outcomes between types of partners.[30] Our method of moments estimation algorithm ensures that the assortative mating patterns predicted by the model are very close to those observed in the data – see Section IV.

Crucially, we let the η parameters differ by race/ethnicity and cohort. This captures different supplies of potential partners within each race/ethnic group and over time, as well as different and changing tastes for partners of different education levels.

Our approach allows us to side-step making explicit assumptions about intermarriage. We do this by searching for parameters η that enable us to match the frequencies with which both men and women in each race/ethnic group marry partners with each level of education, *irrespective* of the race/ethnic identify of the partners. For example, our estimation does not constrain the number of Hispanic women who marry college men to equal the number of married college-educated Hispanic men (or vice versa).[31]

Of course, substantial segregation of marriage markets along race/ethnic lines does exist, so we expect the η parameters to imply that black and Hispanic women have a much lower rate of receiving offers from college-educated men than white women (and to find similar differences for men). We find that such differences in marriage market prospects are important for explaining differences in behavior between race/ethnic groups.

Once the education is drawn, we calculate the potential work experience as the age of

[29] For example, suppose men have a strong preference for partners with similar education. Then a HSD woman may have little chance of receiving an offer form a college educated man, regardless of the supply of college educated men.

[30] Our estimated η are therefore reduced form parameters that implicitly combine (i) structural parameters of preferences for different types of partners with (ii) endogenously determined supplies of partners. This approach has two key advantages: (1) It greatly simplifies estimation of the model relative to a case where we solve explicitly for the marriage market equilibrium, and (2) it allows us to avoid making detailed assumptions about how the marriage market works. The downside of course, is that we must assume the η are invariant to any policy experiments we may choose to consider.

[31] The rate of college education among Hispanic men is very low, so if marriage markets were segmented by race/ethnicity we would expect Hispanic women to receive a low rate of offers form college men. But our estimated η parameters allow Hispanic women to receive offers from college-educated men at a higher rate – allowing implicitly for the possibility that they also receive offers from college educated white or black men.

the individual minus his years of schooling minus 6. Then, we draw the remaining elements of $\mathcal{M}_{jt}$. The five *observed* elements are drawn from the population distribution of all potential partners within a person's own age cell. These elements of $\mathcal{M}_{jt}$ are partner's health, number of children, PE, PM and lagged work. Their distributions are not conditional on un-observables, so we can obtain them from the raw data. We account for intermarriage by weighting the white, black, Hispanic matrixes according to the proportion of intermarriages in each group. However, inter-marriages are rare so the new matrixes are not very different from the unweighted.

Finally, the four *unobserved* elements of $\mathcal{M}_{jt}$ are drawn from their population distributions as specified in the model. These are the potential partner's tastes for leisure ξ_{jt}, labor market ability μ_j^W, transitory wage shock $\tilde{\varepsilon}_{jt}^W$, and the taste for marriage, ε_t^M. The stochastic terms ξ_{jt}, μ_j^W, $\tilde{\varepsilon}_{jt}^W$ and ε_t^M, are observed by both parties as part of the marriage offer. Both parties also understand which terms are permanent and which terms are only transitory.

Putting this all together, the marriage offer for a single female consists of the vector:

(28) $$\mathcal{M}_{ft} = (E^m, X^m, H^m, N^m, PE^m, PM^m, h_{t-1}^m, \xi_{mt}, \mu_m^W, \tilde{\varepsilon}_{mt}^W, \varepsilon_t^M)$$

Marriage offers for males ($\mathcal{M}_{mt}$) have an analogous form.

III.E.2. *Marriage Decisions*

Given a marriage offer $\mathcal{M}_{jt}$, a single person can construct the vector $(\Omega_{ft}, \Omega_{mt})$ that characterizes the state of the couple if they marry. That is, $(\Omega_{jt}, \mathcal{M}_{jt}) \rightarrow (\Omega_{ft}, \Omega_{mt})$ for j=f,m. The potential partner also knows $(\Omega_{ft}, \Omega_{mt})$. Both parties calculate the value of marriage, denoted by $V_t^{jM}(\Omega_{mt}, \Omega_{ft})$ for $j = f, m$ in equation (22). A marriage is formed if and only if:

(29) $$V_t^{fM}(\Omega_{mt}, \Omega_{ft}) - \Delta(\text{PM}_f) > V_t^f(\Omega_{ft}) \text{ and } V_t^{mM}(\Omega_{mt}, \Omega_{ft}) - \Delta(\text{PM}_m) > V_t^m(\Omega_{mt})$$

Here $\Delta(\text{PM}_j)$ is a fixed cost of marriage that we allow to depend on the marital status of the parents of each partner, as in:

(30) $$\Delta(\text{PM}_j) = \alpha_{m0}^j + \alpha_{m1}^j \text{PM}_j \quad for \quad j = f, m$$

This allows for the possibility that there is intergenerational transmission in tastes for marriage.

If the pair decides to marry they proceed to make collective decisions about work and fertility as described in Section III.B. If the pair decides to remain single they individually make decisions about work, school and (for women) fertility as described in Section III.A.

III.F. Terminal Period and Retirement

The terminal period in the model is fixed at age 65, at which point everyone must retire. Of course, people can choose to stop working earlier if desired. By setting the terminal period at 65 we avoid the complications of modelling Social Security and the accumulation of retirement savings.[32] To reduce computational burden, we assume the terminal value function $V^j_{T+1}(\Omega_{jT})$ at *T*=65 is a simple function of state variables – see Appendix E. Thus, the terminal value function accounts for retirement savings in a reduced form way.

III. G. Summary

This completes the exposition of the model. Note that the choice set of a married couple is $\{l^m_t, l^f_t, p_t\}$, as well as whether to stay married. The choice set of both single men and women includes work hours, school attendance, and whether to marry. Single women also make choices about pregnancy and, if eligible, welfare participation.

Finally, it is useful to discuss the mechanisms that drive marriage in the model. First, there is the public good nature of couples' consumption. Each partner consumes 71% of total household consumption. Thus, marriage may increase consumption of both parties. However, if a person has much higher earning capacity than their potential spouse, his/her consumption may fall with marriage. Thus, a person with higher earning capacity will tend to have a higher reservation earning capacity for their spouse (*ceteris paribus*). This occurs for two reasons: (i) the higher a person's income, the higher the income of his/her spouse must be to prevent consumption from falling after marriage, and (ii) a person with higher earning capacity will have a higher probability that his/her offers are accepted, enabling them to be more selective. These mechanisms help to generate assortative mating in the model.

Second, people get utility from marriage itself – see (18). But the magnitude of this utility differs across potential spouses. This gives the individual an incentive to search over marriage offers (i.e., an option value for waiting). In (18) we specified that people prefer spouses with similar education. This helps to generate assortative mating on education. Interestingly, there is a trade-off between θ^M_t and w^j_t (as noted earlier). This means a person is willing to accept a larger education difference if it is compensated by a higher wage.

---

[32] For our four cohorts, the "normal" age for claiming Social Security (SS) benefits was gradually increased from 65 to 67. But workers can also opt to receive "early" SS benefits at age 62, subject to a penalty in the form of a reduced benefit level. To avoid having to model this decision, we chose to fit our model only to data up through age 61. By setting the terminal value function at age 65, we implicitly assume away the early SS option.

IV. Solution, Estimation and Model Fit

We back-solve the model from age 65 to 17, assuming a terminal value function at age 65. We stress that we solve the dynamic programming (DP) problems of *individual* males and females. An individual solves his/her problem knowing the probabilities of marriage and divorce, and how decisions are made by couples. The state space Ω_{jt} of our DP problem is discrete. The state variables are marital status, number of children, taste for leisure (which is shifted by arrival of children), education, experience, age, the lagged choice, latent skill type and parental background. The state of a married person also includes the state variables of the spouse, and the stochastically evolving match quality, which determines utility from marriage.

Starting at age 17, a single person makes choices taking into account how these affect his/her marriage market opportunities. This requires predicting the distribution of potential spouse *conditional* on own age/education in *future* periods. We assume people have perfect foresight about these distributions. This is imposed implicitly in estimation by: (i) using the same offer distribution that we fit within the estimation as the distribution that people use to forecast offers, and (ii) requiring that the model based on this assumed distribution provide a good fit to realized assortative mating patterns. This circumvents the need to solve for the spouse offer distribution as an endogenous object that emerges from the marriage market equilibrium, which would be infeasible in a dynamic model with many state variables.

We estimate our model using annual repeated cross-section data from the March CPS from 1962 to 2021. We divide the sample into three separate ethnic groups: Whites, Blacks and Hispanics, and into three cohorts born within two years of 1960, 1970 and 1980. We consider only civilian non-institutionalized adults aged 17-65. For out-of-sample validation and forecasting we also use data for cohorts born within two years of 1990, 2000 and 2010.

We estimate the model using the method of simulated moments (MSM), proposed by McFadden (1989) and Pakes and Pollard (1989). As we explain in Appendix D, we use simulated life-cycle histories from the model (5000 men and women for each cohort) to generate statistics that we match to the data. Statistics we attempt to match include completed schooling, employment rates, annual wages, marriage rates, welfare participation, assortative mating and fertility, for men and women of each ethnic group in the 1960, 70 and 80 cohorts. There are a total of 2844 moments that we list in detail in Appendix F. This includes 396 moments for each of the three ethnic groups in the 1960 cohort, 316 moments for each group in the 1970 cohort, and 236 moments for each group in the 1980 cohort. The identification of the model is discussed in detail in EKL. The main difference here is that changing welfare rules over time provide an additional source of exogenous variation. And Section III.C above provides additional discussion of how we identify effects of parental background.

We estimate the model jointly for all the three cohorts and three ethnic groups, as we assume 87 model parameters are common across cohorts/groups. These common parameters are 47 preference parameters, 24 terminal value function parameters, 8 shock variances, 6 parameters for how ability depends on parent background, and 2 parameters for the distribution of alimony. The 47 preference parameters include tastes for leisure (12), school (7), kids (8), pregnancy (5), marriage (8), welfare (2), divorce (4) and the CRRA in consumption.

We observe cohorts for different age ranges; the last observation is age 61 for the 1960, 51 for the 1970 cohort and 41 for the 1980 cohort. In simulating the model, we use the actual rates of mother's college graduates that were born in the US and single mothers for each cohort and ethnic group as indicated by Table 1. It should be noted that we assume that mothers of whites and blacks are born in the US and that Hispanic mothers that were not born in the US are equivalent to mothers without college degree. We use these to derive the labor market skill endowments and taste for college as explained above.

We allow wage offer functions, job offer functions and marriage offer functions to differ by ethnic group, cohort and gender, which generates a large number of parameters. For each cohort/ethnic group/gender (3*3*2) group we have 15 parameters for wage offers and 12 parameters for job offers, giving a total of 27 labor market parameters per group (giving 486 labor market parameters in total over all 18 groups). For each cohort/ethnic group we have 15 parameters for the marriage market (giving 135 in total for all 9 groups). So, the model has 708 parameters in total for the 18 cohort/ethnic/gender groups. This is an average of about 39 1/3 parameters per group. Thus, the total number of parameters is not very large considering the large number of statistics being fit (for each of 18 different cohort/ethnic/gender groups).

Our assumption that preferences parameters are common across all cohorts and ethnic groups is an important discipline imposed on the model. An important result is that we can achieve a very good fit to a large range of behaviours and outcomes (education, labor supply, wages, marriage, fertility, welfare participation, assortative mating) for all cohorts and ethnic groups assuming common preferences. We now discuss the model fit in more detail:

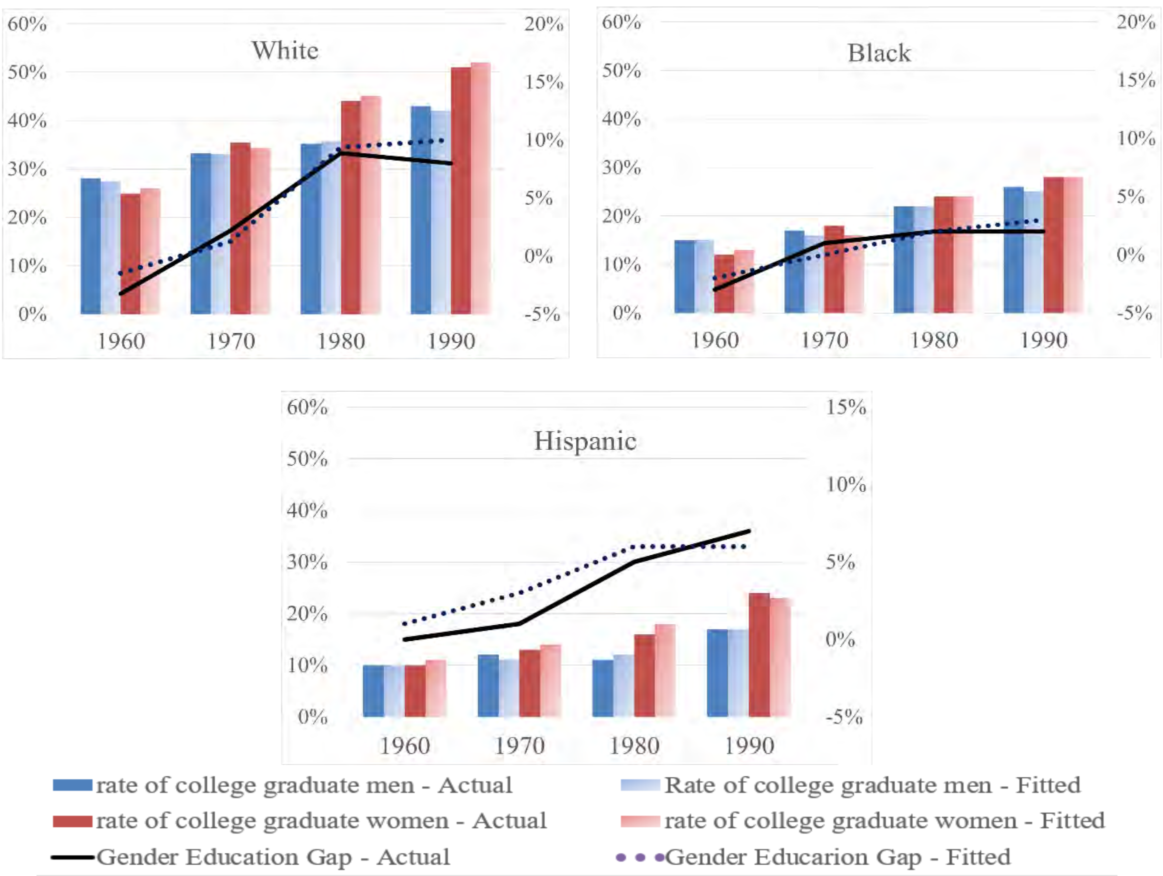
Tables 3 displays the fit to completed education levels by cohort, for Whites, Blacks and Hispanics. The fit is remarkably good. For example, for white women the fraction for whom college is the highest level completed is 20%, 26% and 30% in the 1960, '70 and '80 cohorts, while the model predicts 21%, 25% and 32%, respectively. The fraction of women who get post-graduate education increases even more quickly. It is 5%, 9% and 14% in the 1960, '70 and '80 cohorts, while the model predicts 5%, 9% and 13%, respectively.

Table 3: Model Fit to Education by Cohort for Whites, Blacks and Hispanics

	1960 White		1970 White		1980 White		1960 Black		1970 Black		1980 Black		1960 Hispanic		1970 Hispanic		1980 Hispanic	
	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted
Men education distribution at 30																		
HSD	0.10	0.11	0.07	0.07	0.06	0.03	0.16	0.22	0.10	0.14	0.1	0.07	0.41	0.44	0.39	0.4	0.35	0.32
HSG	0.38	0.35	0.31	0.33	0.30	0.35	0.44	0.42	0.43	0.40	0.39	0.41	0.31	0.25	0.29	0.27	0.34	0.39
SC	0.24	0.27	0.29	0.27	0.29	0.27	0.25	0.21	0.30	0.30	0.28	0.3	0.18	0.21	0.21	0.22	0.2	0.17
CG	0.20	0.21	0.25	0.24	0.25	0.25	0.13	0.12	0.13	0.14	0.16	0.17	0.08	0.10	0.09	0.09	0.09	0.10
PC	0.08	0.06	0.08	0.09	0.10	0.10	0.02	0.03	0.04	0.02	0.06	0.05	0.03	0.00	0.03	0.02	0.02	0.02
Women education distribution at 30																		
HSD	0.09	0.08	0.06	0.05	0.04	0.04	0.18	0.20	0.12	0.13	0.09	0.10	0.36	0.32	0.34	0.36	0.31	0.30
HSG	0.38	0.40	0.29	0.29	0.22	0.23	0.42	0.38	0.36	0.40	0.32	0.34	0.35	0.37	0.3	0.28	0.28	0.33
SC	0.28	0.26	0.31	0.32	0.30	0.28	0.28	0.29	0.34	0.31	0.35	0.32	0.19	0.20	0.23	0.22	0.24	0.19
CG	0.20	0.21	0.26	0.25	0.30	0.32	0.11	0.12	0.13	0.13	0.17	0.16	0.08	0.10	0.10	0.12	0.12	0.14
PC	0.05	0.05	0.09	0.09	0.14	0.13	0.02	0.01	0.04	0.03	0.07	0.08	0.02	0.01	0.03	0.02	0.04	0.04

As the main focus of the paper is on college graduation, we display the fit to college graduation rates in Figure 3. Our model provides an excellent fit to the graduation rates for each gender/ethnic group/cohort. It succeeds in predicting the college graduation rate gaps between groups, the growing graduation rates across cohorts, and the substantial increase in college attendance of women relative to men in 1970 and 1980 cohorts.

Figure 3: Fit to College Graduation Rate by Gender and Cohort and Ethnic Group



As we are able to fit the education differences across gender/ethnic/cohort groups almost exactly using fixed preferences, our model decomposes these differences completely into parts due to each of the exogenous factors in the model (i.e., differences in parental background, labor market constraints, marriage market constraints, etc.).

Our model also gives an excellent fit to many other statistics (employment rates, assortative mating, fertility and wages). Figure 4 highlights one particularly important statistic, the employment rate of women at ages 32-36. As we noted in the introduction, employment rates of women in this age range grew rapidly from the ’25 to ’60 birth cohorts, and this was a key reason for their increase in education. But employment rates then stabilized. A particular challenge for our model is to explain why education of women continued to grow rapidly, even after employment rates stopped growing. As we see in Figure 4, employment rates of white women with at least some college education were very stable from the ’60 to ’80 cohorts, while those of women with high school of less education actually fell. The model captures these patterns well, even with fixed preferences across cohorts.

Figure 4: Fit to Employment Rates conditional on Education, Women, Age 32-36

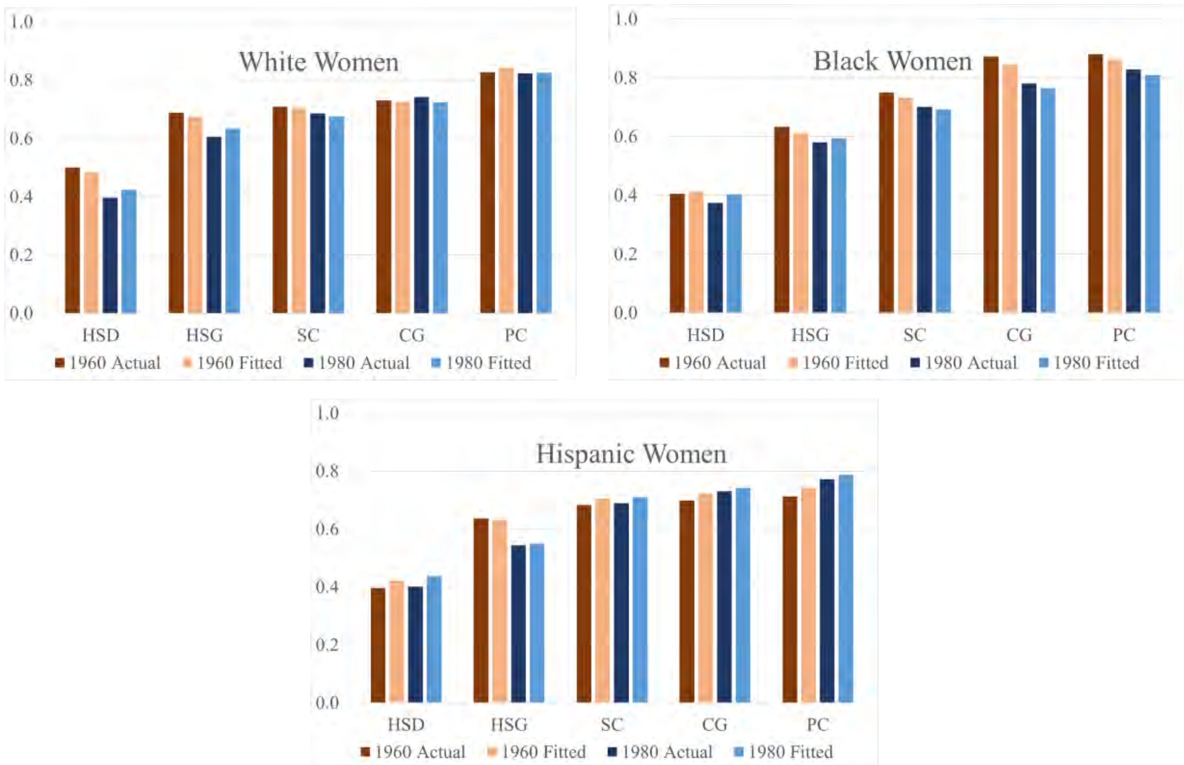


Figure 4 shows the patterns are different for Black and Hispanics, and our model captures these differences. For Black women employment fell slightly in all education groups. For Hispanic women, it increased among the college educated, and dropped for high school graduates. It is rather remarkable how well the model fits all these patterns assuming common preferences across ethnic groups, using only the three exogenous factors (parental background, marriage market, labor market). This gives us some confidence in using the model to provide explanations for the key patterns in college graduation rates that we set out in the introduction.

Table 4 shows the model fit to wages, employment and welfare participation. The fit is very good on all three dimensions. For example, the fraction of single mothers who receive welfare benefits declined dramatically across the three cohorts, and our model captures this well. For Whites in the 1960, ’70 and ‘80 cohorts, the fraction of unemployed single mothers aged 27-31 who participated in welfare fell from 60% to 33% to 13%, and our model predicts a decline from 56% to 35% to 10%. For Blacks and Hispanics welfare participation rates are higher but also fell substantially. For instance, for Blacks in the 1960 cohort, 71% of unemployed single mothers aged 27-31 participated in welfare, but in the 1980 cohort this dropped to only 24%. Our model predicts a decline from 75% to 20%.

Table 4: Model Fit to Wages, Employment and Welfare

	1960 White		1970 White		1980 White		1960 Black		1970 Black		1980 Black		1960 Hispanic		1970 Hispanic		1980 Hispanic	
	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted	Actual	Fitted
Gross Annual Wages (Thousands of $) by age**																		
Married Women - 27-31	31.1	30.6	37.1	37.5	41.8	40.5	26.4	27.3	30.5	31.2	36.6	36.7	25.3	23.1	28.6	28.0	31.9	31.4
Married Women - 32-36	36.2	35.5	45.4	45.9	50.1	51.3	30.3	30.8	37.1	38.3	40.9	43.3	27.5	25.9	33.2	32.8	36.3	35.1
Married Women - 37-41	41.3	41.6	50.4	50.8	55.5	55.0	35.9	34.5	43.6	42.0	47.6	50.6	32.5	32.6	36.6	35.6	38.8	37.7
Unmarried Women-27-31	32.2	32.7	36.2	36.0	39.4	40.5	25.5	27.6	29.7	30.4	33.0	33.8	27.1	26.5	29.6	30.9	30.9	30.9
Unmarried Women-32-36	36.2	36.6	41.8	41.6	43.9	43.9	28.6	30.7	35.2	34.2	36.5	34.2	28.0	28.3	32.6	34.0	34.5	35.1
Unmarried Women-37-41	41.7	42.3	46.2	46.4	47.8	50.5	33.3	33.2	37.0	37.4	39.5	41.7	29.1	30.7	32.9	34.8	35.4	35.8
Married Men - 27-31	43.2	43.1	47.7	47.2	52.8	53.3	33.2	33.7	38.4	37.7	42.7	41.8	31.6	30.5	33.2	33.3	35.3	36.1
Married Men - 32-36	53.0	53.8	65.4	64.7	68.1	69.1	39.0	40.2	47.7	48.9	49.6	50.1	36.6	36.6	40.2	40.9	43.4	45.4
Married Men - 37-41	67.3	67.3	77.1	77.0	77.3	78.0	48.7	49.5	52.0	52.5	56.8	54.4	42.5	41.8	45.2	47.2	47.3	47.0
Unmarried Men - 27-31	37.8	40.6	42.3	42.6	44.8	42.9	29.6	30.8	33.4	34.4	36.5	36.1	29.5	30.0	30.4	30.8	32.5	32.4
Unmarried Men - 32-36	42.7	41.6	50.6	50.9	52.2	49.4	33.4	35.4	40.2	42.7	40.9	40.2	31.2	33.6	35.0	36.0	37.5	37.8
Unmarried Men - 37-41	50.1	47.3	55.8	56.0	57.6	57.7	36.8	36.4	41.3	43.4	41.5	42.7	36.8	38.4	40.4	42.4	42.0	43.0
Employment rate by age group****																		
Married Women - 27-31	0.59	0.62	0.66	0.68	0.64	0.63	0.63	0.66	0.66	0.69	0.61	0.64	0.47	0.51	0.48	0.50	0.46	0.46
Married Women - 32-36	0.63	0.66	0.64	0.65	0.65	0.63	0.73	0.72	0.71	0.68	0.66	0.69	0.53	0.55	0.50	0.50	0.49	0.49
Married Women - 37-41	0.68	0.68	0.66	0.64	0.68	0.67	0.74	0.75	0.74	0.72	0.73	0.75	0.57	0.57	0.54	0.52	0.51	0.51
Unmarried Women-27-31	0.75	0.75	0.77	0.78	0.74	0.73	0.52	0.56	0.64	0.63	0.63	0.62	0.55	0.52	0.62	0.59	0.63	0.61
Unmarried Women-32-36	0.76	0.76	0.76	0.76	0.71	0.69	0.61	0.61	0.68	0.68	0.65	0.68	0.58	0.56	0.64	0.67	0.64	0.67
Unmarried Women-37-41	0.78	0.80	0.72	0.72	0.71	0.74	0.69	0.74	0.68	0.70	0.68	0.69	0.64	0.63	0.67	0.70	0.66	0.67
Married Men - 27-31	0.90	0.88	0.91	0.90	0.87	0.85	0.84	0.85	0.85	0.88	0.79	0.77	0.85	0.84	0.86	0.84	0.86	0.85
Married Men - 32-36	0.91	0.89	0.91	0.92	0.89	0.87	0.85	0.85	0.84	0.85	0.79	0.79	0.86	0.87	0.88	0.87	0.86	0.85
Married Men - 37-41	0.91	0.89	0.89	0.91	0.89	0.89	0.83	0.84	0.82	0.83	0.82	0.79	0.86	0.87	0.86	0.87	0.89	0.87
Unmarried Men - 27-31	0.80	0.80	0.83	0.79	0.76	0.75	0.66	0.67	0.69	0.69	0.63	0.66	0.75	0.74	0.78	0.75	0.78	0.78
Unmarried Men - 32-36	0.80	0.78	0.81	0.81	0.76	0.79	0.65	0.67	0.71	0.70	0.63	0.67	0.74	0.74	0.79	0.78	0.77	0.79
Unmarried Men - 37-41	0.79	0.80	0.75	0.79	0.74	0.77	0.66	0.66	0.66	0.68	0.65	0.66	0.74	0.72	0.76	0.75	0.79	0.78
Welfare Share of Single mothers by employment status																		
Unemployed - 27-31	0.60	0.56	0.33	0.35	0.13	0.10	0.71	0.75	0.46	0.42	0.24	0.20	0.77	0.69	0.45	0.42	0.16	0.13
Unemployed - 32-36	0.50	0.48	0.15	0.20	0.11	0.10	0.67	0.62	0.24	0.22	0.17	0.14	0.63	0.63	0.30	0.32	0.20	0.16
Unemployed - 37-41	0.21	0.10	0.08	0.10	0.09	0.08	0.37	0.26	0.16	0.10	0.09	0.03	0.40	0.29	0.18	0.09	0.09	0.04
Employed - 27-31	0.12	0.20	0.11	0.09	0.05	0.05	0.17	0.13	0.15	0.17	0.06	0.04	0.13	0.14	0.13	0.14	0.05	0.04
Employed - 32-36	0.07	0.10	0.03	0.03	0.02	0.03	0.13	0.11	0.06	0.04	0.04	0.00	0.10	0.10	0.06	0.02	0.03	0.02
Employed - 37-41	0.05	0.02	0.02	0.02	0.01	0.00	0.05	0.00	0.03	0.00	0.01	0.00	0.07	0.01	0.02	0.02	0.03	0.01

Finally, Table 5 shows the fit to marriage and divorce rates, total fertility at age 35, and educational assortative mating. Marriage rates fall across cohorts for all three ethnic groups, especially at young ages (27-31). The model captures this pattern well. Total fertility at age 35 is fairly stable for all groups, and the model also captures this. The rate of HSG women matching with HSG men falls, while rates of CG women matching with CG men, and PC women matching with PC men, increase across cohorts, for all groups, and the model captures this well.

Table 5: Model Fit to Family Moments and Educational Assortative Mating

	1960 White		**1970 White**		**1980 White**		**1960 Black**		**1970 Black**		**1980 Black**		**1960 Hispanic**		**1970 Hispanic**		**1980 Hispanic**	
	Actual	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**	**Actual**	**Fitted**
Family moments by age group																		
Marriage Rate - 27-31	0.68	0.67	0.63	0.62	0.58	0.57	0.37	0.39	0.32	0.30	0.28	0.26	0.65	0.65	0.62	0.64	0.57	0.59
Marriage Rate - 32-36	0.73	0.71	0.70	0.73	0.67	0.70	0.40	0.42	0.39	0.39	0.34	0.32	0.65	0.66	0.67	0.69	0.61	0.62
Marriage Rate - 37-41	0.73	0.73	0.71	0.73	0.69	0.70	0.41	0.43	0.40	0.38	0.38	0.36	0.66	0.66	0.65	0.67	0.63	0.63
Divorce Rate - 27-31	0.10	0.12	0.08	0.10	0.07	0.10	0.08	0.08	0.07	0.09	0.05	0.03	0.08	0.09	0.05	0.07	0.05	0.08
Divorce Rate - 32-36	0.11	0.12	0.11	0.11	0.10	0.09	0.14	0.12	0.11	0.09	0.09	0.10	0.10	0.09	0.08	0.10	0.08	0.08
Divorce Rate - 37-41	0.14	0.11	0.14	0.13	0.13	0.10	0.17	0.14	0.15	0.12	0.13	0.13	0.13	0.11	0.11	0.10	0.10	0.07
Married Women - kids distribution at age 35																		
no children	0.15	0.12	0.16	0.15	0.17	0.17	0.14	0.13	0.17	0.18	0.20	0.18	0.12	0.09	0.11	0.10	0.12	0.14
1 child	0.20	0.24	0.21	0.24	0.21	0.20	0.21	0.20	0.19	0.19	0.19	0.23	0.17	0.19	0.16	0.13	0.15	0.12
2 children	0.41	0.44	0.39	0.40	0.37	0.40	0.34	0.41	0.32	0.36	0.29	0.33	0.31	0.38	0.33	0.40	0.35	0.31
3+ children	0.25	0.20	0.24	0.21	0.26	0.23	0.32	0.26	0.32	0.27	0.32	0.26	0.41	0.34	0.40	0.37	0.38	0.43
Un-Married Women - kids distribution at age 35																		
no children	0.52	0.46	0.53	0.57	0.52	0.52	0.25	0.33	0.32	0.31	0.35	0.31	0.32	0.36	0.32	0.29	0.32	0.36
1 child	0.20	0.30	0.20	0.19	0.19	0.21	0.24	0.26	0.21	0.28	0.21	0.26	0.20	0.20	0.19	0.22	0.17	0.18
2 children	0.18	0.12	0.17	0.23	0.18	0.20	0.26	0.21	0.23	0.21	0.21	0.26	0.23	0.25	0.22	0.18	0.26	0.30
3+ children	0.10	0.12	0.10	0.01	0.11	0.07	0.25	0.20	0.24	0.20	0.24	0.17	0.25	0.19	0.27	0.31	0.25	0.16
Assortative Mating																		
HSD with HSD	0.36	0.35	0.27	0.25	0.31	0.32	0.38	0.40	0.32	0.35	0.33	0.31	0.74	0.70	0.73	0.69	0.69	0.69
HSG with HSG	0.60	0.58	0.49	0.44	0.40	0.39	0.53	0.52	0.49	0.46	0.43	0.41	0.53	0.56	0.52	0.51	0.51	0.56
SC with SC	0.46	0.43	0.48	0.52	0.46	0.46	0.53	0.47	0.52	0.52	0.49	0.50	0.45	0.47	0.46	0.48	0.48	0.48
CG with CG	0.46	0.50	0.51	0.53	0.51	0.50	0.40	0.42	0.44	0.46	0.42	0.45	0.40	0.44	0.43	0.46	0.43	0.44
PC with PC	0.31	0.34	0.41	0.45	0.49	0.44	0.38	0.35	0.40	0.43	0.47	0.49	0.25	0.29	0.34	0.34	0.48	0.47

V. Parameter Estimates

Recall that we constrain preferences parameters to be common across cohorts and ethnic groups. They are only allowed to differ by gender. Then we seek to explain differences in behavior across cohorts and groups using three exogenous factors: (i) parental background, (ii) wages and job offer functions and (iii) marriage offer probabilities. We now explain parameter estimates related to these factors in turn.

V.A. Parental Background

Parental background affects the labor market skill endowment, tastes for school and tastes for marriage. The mapping from parental background to the low/medium/high ability types is invariant across cohort, gender and ethnicity. The estimated mapping implies, not surprisingly, that a person whose mother is a college graduate is more likely to be the high skill type. A person from a two-parent household is also more likely to be the high skill type, although this effect is not as strong as the effect of mother's education.

The mapping from mother's education to tastes for school is invariant to cohort and ethnicity, but importantly it differs by gender. Recall that we have:

$$(1) \qquad \vartheta_{jt} = \vartheta_{0j} + TC \cdot I(E_t > HSG) + \vartheta_{1j} I(PE > HSG) + \vartheta_{2j}\mu_j^W \quad \text{for } j{=}m{,}f$$

We estimate the parameters ϑ_{1m} and ϑ_{1f} to be 257 and 402, respectively. Given our estimated CRRA utility function, this translates into a consumption equivalent of roughly \$9,126 per year of school for men, and \$20,786 for women. Thus, we find that having a college educated mother substantially increases tastes for college, especially for daughters.

This could be interpreted as meaning people – especially women – whose mothers were college graduates enjoy school more, or get more utility from school because they are better at it (it is less work), or they simply value education more highly, or they get more help to pay tuition, or some combination of all four (our model cannot distinguish these stories). These factors create important intergenerational links in college attendance.

Our estimates of parameter ϑ_{2j} imply that higher (labor market) ability types like school better, and this effect is stronger for men. In fact, our estimates imply that low and even medium ability men have a strong dislike for school. In contrast, medium ability women whose mothers did (did not) graduate have a modest positive (negative) taste for school.

We also find that both men and women whose parents were married get more utility from marriage. As a result, both men and women whose parents were married are more likely to decide to marry as well. This creates important intergenerational links in marriage.

V.B Wage and Job Offer Functions

Our model also allows wage offer functions and job offer functions to differ by ethnic group, gender and cohort. Cohorts face different offer wage functions at a point in time because skills and training differ in important ways by cohort. For example, members of the 1980 birth cohort tend to have better computer skills (and better computers and machines at work) than members of the 1960 birth cohort, due to improvements in the technological environment over time. Returns to college will differ by cohort at a point in time because the set of skills taught in college differs by cohort, and skill-biased technical change will affect different cohorts differently because cohorts have different training. This differs from the usual treatment of technical change, which views it as shifting returns to college for all cohorts in a similar way at a point in time. We find important differences in the wage structure across cohorts. These differences in wage offer functions and job offer functions are important in explaining differences in education across ethnic, gender and cohort groups.

Our estimates uncover several interesting differences in wage offer functions by gender, ethnicity and cohort. Table 6 presents selected offer wage function estimates for Whites. As we see, starting wages of college graduate white women and men both improved substantially from the 1960 to 1980 birth cohort. But women still lag behind men by .12 log points. Experience returns of white women in the 1960 birth cohort were smaller than those for white men, but by the 1980 cohort they have almost caught up.

Appendix G2 shows starting wages of Black and Hispanic women almost caught up to White women, but experience returns did not. Differences in starting wages between White, Black and Hispanics men are modest, but differences in experience returns are substantial. Those of Hispanic men improved modestly but those of Black men stagnated. Thus, experience returns of Whites (both men and women) are well above those of Blacks and Hispanics.

Table 6: Selected Offer Wage Function Estimates, Whites

		Intercept			**Experience Coefficient**		
		1960	1980	**Δ 60-80**	1960	1980	**Δ 60-80**
Men	High School	10.00	10.05	**+.05**	.058	.074	**+.016**
	College	10.42	10.60	**+.18**	.076	.087	**+.011**
	Δ HS-College	**+0.42**	**+0.55**		**+.018**	**+.13**	
Women	High School	9.76	9.81	**+.05**	.041	.065	**+.024**
	College	10.30	10.48	**+.18**	.053	.08	**+.027**
	Δ HS-College	**+.54**	**+.67**		**+.012**	**+.015**	

Table 7 reports selected job offer rates. Job offer probabilities of white women were well below those of white men in the 1960 cohort. Since then, rates for women improved while those of men are almost unchanged, so by the 1980 cohort offer rates for white women are almost as high as those for white men. Job offer probabilities of Black men and women improved slightly but remain inferior to those of whites. Interestingly, job offer probabilities of Hispanic men now look similar to those of white men, but those of Hispanic women are in between those of Black and White women.

Table 7: Job offer rate by race and cohort, by experience and education

	Women 1960		Men 1960		women 1980		Men 1980	
	HSG	CG	HSG	CG	HSG	CG	HSG	CG
White								
EXP. = 3	0.42	0.46	0.52	0.59	0.48	0.56	0.51	0.60
EXP. = 5	0.44	0.49	0.56	0.63	0.51	0.59	0.55	0.64
EXP. = 10	0.51	0.56	0.66	0.71	0.57	0.65	0.65	0.73
Black								
EXP. = 3	0.30	0.31	0.34	0.36	0.34	0.37	0.39	0.41
EXP. = 5	0.31	0.32	0.35	0.37	0.36	0.38	0.41	0.43
EXP. = 10	0.33	0.35	0.38	0.40	0.39	0.42	0.46	0.48
EXP. = 15	0.36	0.37	0.41	0.43	0.43	0.45	0.51	0.54
Hispanics								
EXP. = 3	0.36	0.41	0.48	0.53	0.39	0.46	0.51	0.58
EXP. = 5	0.38	0.43	0.51	0.57	0.42	0.49	0.55	0.62
EXP. = 10	0.44	0.49	0.60	0.65	0.49	0.57	0.66	0.72

Table 8 reports selected job destruction rates. In the 1960 cohort job destruction rates of White women were higher than those of White men, but in the 1980 cohort they are almost identical (mostly because those of men got slightly worse). Job destruction rates for Blacks are well above those for Whites, and they have improved only slightly across cohorts. In contrast to Whites, the destruction rates of Blacks women are slightly better than those of Black men. The job destruction rates of Hispanics are slightly higher than those of Whites. Those of Hispanic men were unchanged, while those of Hispanic women improved slightly.

Table 8: Job destruction rate by race and cohort, by experience and education

	Women 1960		Men 1960		women 1960		Men 1960	
	HSG	CG	HSG	CG	HSG	CG	HSG	CG
White								
EXP. = 3	0.15	0.12	0.12	0.10	0.14	0.11	0.14	0.12
EXP. = 5	0.11	0.09	0.08	0.06	0.10	0.08	0.09	0.08
EXP. = 10	0.04	0.04	0.02	0.02	0.04	0.03	0.03	0.03
Black								
EXP. = 3	0.25	0.23	0.27	0.25	0.24	0.22	0.25	0.23
EXP. = 5	0.22	0.21	0.25	0.23	0.21	0.19	0.22	0.20
EXP. = 10	0.16	0.15	0.19	0.18	0.16	0.14	0.15	0.14
Hispanic								
EXP. = 3	0.17	0.15	0.15	0.13	0.17	0.13	0.15	0.13
EXP. = 5	0.13	0.12	0.11	0.09	0.13	0.10	0.11	0.09
EXP. = 10	0.07	0.06	0.05	0.04	0.06	0.05	0.04	0.04

V.C. Marriage Market Parameters

The third important exogenous factor in our model is the marriage market. We allow marriage offer functions to vary in two key ways by cohorts and ethnic groups: First, we allow the probability of getting offers from potential spouses of different education levels to vary. But we find that this actually changed very little across cohorts, and differences across ethnic groups were stable. Thus, there was little change in the degree of assortative mating.

Second, we consider how the probability of getting marriage offers differs by age. As we see in Table 9, the probability a women can get marriage offers at older ages (especially 35 and 40) increased dramatically from the '60 to '80 cohort, and this was true for all ethnic groups. As we will see, this increased the incentive for women to graduate from college, as it became easier to delay marriage and fertility.

Table 9: Marriage Offer Probabilities by Age, Cohort and Race

	White		Black		Hispanic	
Age	1960	1980	1960	1980	1960	1980
25	0.24	0.27	0.16	0.19	0.22	0.25
30	0.12	0.19	0.10	0.13	0.13	0.16
35	0.05	0.11	0.05	0.07	0.06	0.09
40	0.01	0.05	0.02	0.03	0.02	0.04

Finally, our estimates imply the fixed utility cost of marriage is 748 greater for people from single parent households, which translates into a consumption equivalent of roughly \$65,753. It is worth noting that fixed costs of marriage are typically very large in models where agents search for spouses, as marital formation is not a common event. Thus, a large "love" shock is needed to overcome the large fixed cost and induce people to marry.

V.D. The Option Value of College

The impact of skill endowments and parental background on the value of college are illustrated in Table 10. The table reports the value of college for different types of agent in our model, focussing on Whites. We construct this value by running a counterfactual where we shut down the option to attend college. We then calculate the amount of initial assets (at age 16) that each type of agent must be given to compensate for the loss of the college option. This is the ex ante expected value of the college option at age 16. Giving agents this amount equalizes their expected present value of lifetime utility under the baseline vs. the counterfactual.

The figures in Table 10 reflect all aspects of the value of college: labor market returns, marriage market returns and utility from college attendance. We report values of college broken down by cohort, gender and type. The low skill endowment types in the model almost never go to college, so their option values are close to zero. Thus, we exclude them from the table.

In the 1960 birth cohort, values of college were very similar for men and women. For instance, consider a high-skill agent whose mother graduated from college and who came from a two-parent household: the value of college was \$660k for men and \$645k for women. The values are similar for other types as well (i.e., high and medium ability, mother did or did not graduate from college, dual or single parent household). The similarity of college values (for all types) explains why men and women graduated at similar rates in the 1960 cohort.

Table 10: Value of College by Type, for Whites (PV in thousands \$)

			1960					1980				
Skill endowment	Mother 's education	Mother's marital status	type proportion (%)	PV women (1000 \$)	CG rate (%)	PV men (1000 \$)	CG rate (%)	type proportion (%)	PV women (1000 \$)	CG rate (%)	PV men (1000 \$)	CG rate (%)
High	HS	Married	23.8	600	77.8	570	83.3	17.8	885	98.4	700	97.6
High	COL	Married	6.4	645	98.7	660	99.7	10.4	930	97.7	755	98.4
High	HS	Single	1.0	560	74.3	540	73.5	2.5	835	98.6	635	99.1
High	COL	Single	0.3	615	99.6	630	97.4	1.9	890	99.2	710	98.7
Medium	HS	Married	36.8	95	0.0	97	0.0	27.5	140	0.5	105	0.0
Medium	COL	Married	5.6	110	0.0	100	0.0	9.0	620	95.6	220	26.3
Medium	HS	Single	1.9	11	0.0	5	0.0	4.9	75	0.0	15	0.0
Medium	COL	Single	0.4	75	0.0	60	0.0	2.0	580	96.2	200	19.7

Table 10 also shows graduation rates for each type. Amongst high skill types whose mothers were college graduates, almost 100% graduated from college. If the mother did not graduate from college, the value of college falls by \$90k for men and \$45k for women.[33] In this group, about three-quarters of women and 80% of men graduate from college.[34] And, if the person was from a single parent household, the value of college drops by about \$30k for both men and women, and graduation rates drop about 10% for men and 4% for women.

Values of college for medium skill types are much smaller (\$110k or less). A key point is that almost no medium ability men or women graduated from college in the 1960 cohort.

In the 1980 birth cohort, values of college are much higher, particularly for women. Consider again a high-skill agent whose mother graduated from college and who came from a two-parent household: the value of college was \$755k for men and \$930k for women. Compared to 1960, that is a \$95k increase for men but a \$285k increase for women. Approximately three-quarters of high skill women whose mothers did not graduate from college graduated from college in the 1960 cohort, but in the 1980 cohort it is close to 100%, reflecting that their value of college increased from \$600k to \$885k.

[33] It is surprising the drop is greater for men, as mother's college has a bigger impact on daughter's utility from school. But the labor market returns to college are greater for men. So an increase in the utility "cost" of college that reduces the rate of college attendance causes a bigger drop in present value of lifetime earnings of men.
[34] The ex ante (at age 16) option value of college for women of this type was \$600k in the 1960 cohort. But about 25% of these type agents do not attend college due to adverse draws of the stochastic terms in the model.

The biggest change in the 1980 cohort is among medium skill women whose mothers graduated from college (5.9% of population in 1960, and 11% in 1980). Their value of college increased by roughly $500k from 1960 to 1980. This caused their college graduation rate to increase from near zero to above 95%. For medium skill men whose mothers graduated from college, the graduation rate in the 1980 cohort was only 20 to 25%. The much higher graduation rate for women vs. men in this medium skill group is an important factor driving the higher graduation rate of women overall. As we saw earlier, our estimates imply that medium skill women get much more utility from school than men.

College graduate mothers are more likely to have high skill children, and effect that is common for boys and girls. In Table 11 we show how the labor market skill endowment type proportions vary by mother's college and across cohorts. We include model forecasts for future cohorts, a point we return to in Section VII. Notice how, as mothers become more educated, the proportion of agents who are high skill increases. The higher fraction of single parent households is a factor working in the opposite direction. On net, the fraction of agents who are high skill increased only very slightly from the 1960 to 1980 cohorts according to our model.

Table 11: Skill Type Proportions by Cohort, Whites

	Mother no college			Mother college			ALL		
	low	medium	high	low	medium	high	low	medium	high
1960	22.5	38.7	24.8	1.3	5.9	6.8	23.8	44.6	31.6
1970	20.8	33.8	21.5	2.4	10.1	11.5	23.1	43.9	33.0
1980	21.3	32.4	20.3	2.8	11.0	12.3	24.0	43.4	32.6
1990	18.9	26.6	16.5	4.4	16.0	17.6	23.3	42.6	34.1
2000	16.2	23.9	14.9	4.9	19.0	21.1	21.1	42.9	36.0
2010	14.4	21.3	13.3	5.6	21.5	23.9	20.0	42.8	37.2

The college graduation rate of women increased from 25.9% in the 1960 cohort to 44.9% in the 1980 cohort. But as we see, the fraction who are high skill only increased from 31.6% to 32.6%. Thus, the impact of mother's education on child skill was not the major factor driving increased college graduation. Rather, in the 1980 cohort a substantial number of medium skill women began to graduate from college.[35] This was driven by three factors: The impact of mother's education on tastes for school, improved labor market opportunities, and changes in marriage market opportunities. We now turn to the labor and marriage markets.

[35] Two cautions are in order in interpreting this result: First, we cannot infer that women who graduated from college in the 1980 cohort were on average less skilled than those in the 1960 cohort, as absolute skill levels of medium and high skill types may have changed over time. Second, we cannot infer that women graduates on average are less skilled than male graduates, as skill types are defined *within* genders. Furthermore, labor market skill is only one dimension of skill, and women's greater utility from college may reflect that they are more skilled at studying and learning college material.

VI. Explaining Gender, Cohort and Ethnic Gaps in College Attainment

In the following Sections we use the model to address the following three questions: (A) Why do recent cohorts of women get more education than men?, (B) Why has the college graduation rate increased across cohorts? And why has it increased more for women?, (C) What explains gaps in college education between Whites, Blacks and Hispanics?

VI.A. Why are Recent Cohorts of Women getting more Education than Men?

First, we ask why women in the 1980 cohort graduated from college at a much higher rate than men – e.g., a gap of 44.9% vs. 35.9% for Whites. We address this question via counterfactual experiments where we equalize, in turn, the labor market opportunities and preferences for school of women and men. These results are reported in Table 12.

A striking result on Table 12 is that the *labor market* returns to college are actually greater for men than for women. If we give white women in the 1980 cohort the same wage offer function as men, their college graduation rate increases substantially from 44.9% to 51.1%.[36] Thus, if women had the same labor market opportunities as men, their college graduation rate would increase even further, and the gender education gap would widen dramatically! The gender gap in college graduation does not arise because women have a higher labor market return to college than men.

Table 12: Explaining Gender Differences in College Graduation

	White	Black	Hispanic
Women's College Rate – 1980 cohort	44.9	24.5	17.9
Men's Labor Market Parameters	51.7	28.5	19.7
Men's Utility from School	34.4	21.6	17.4
Both	41.6	26.4	19.4
Men's College Rate – 1980 cohort	35.9	22.6	12.2

It is interesting to examine our offer wage function estimates in light of this result. According to our estimates (see Table 6), having a college degree vs. a high school degree increases the log wage function intercept for white women in the 1980 cohort from 9.810 to 10.476. This 0.666 log point difference implies the starting wage for college women is exp(.666)-1 = 95% higher than that for high school women. In contrast, for white men in the 1980 cohort we have instead a 10.595 - 10.051 = 0.544 log point gap, which means the starting wage for college men is exp(.544)-1 = 72% higher than for high school men.

Thus, the so-called "college premium" for women is about 23% higher than for men. This 23% gap might be taken to indicate that the labor market return to college is greater for

[36] If we also give women the same job offer probabilities as men, it increases their graduation rate only slightly more, to 51.7%. This is because job offer rates for white men and women were similar in the 1980 cohort.

women than for men. Just looking at the starting wage ignores differences in wage growth, but factoring in wage growth with experience doesn't change the calculation in any important way. Our estimates imply college educated men and women enjoy faster wage growth with experience than the high school educated, but the gap is similar for men and women, so the 23% gap is quite stable at all levels of experience. This may appear to contradict the finding from our counterfactual that the labor market return to college is greater for men. But the apparent contradiction only arises because economists have often tended to conflate the "college wage premium" with the actual labor market return to college education.

The reason the labor market return to college is greater for men is that, while women get a larger *percentage* gain in wages than men, men get a larger *absolute* gain in wages. This occurs for two reasons: First, high school men have higher earnings than high school women. On top of that, the men have higher employment rates than women, which also causes their *absolute* increase in earnings to be greater. Of course, economic agents care about the absolute gains in earnings that result from college when calculating the return to college – they do not care about percentage gains in wages (except as far as these influence earnings).

So why do women go to college more than men? If we give white women the men's tastes for college their college graduation rate drops by 10.5 percentage points, from 44.9% to 34.4%. This is because our estimates imply that women get substantially more utility from school than men. Thus, it is not a higher return to college, but rather a greater taste for college attendance that causes white women in the 1980 cohort to graduate from college at a much higher rate than men. Given the structure of our model, this may subsume a number of factors: For example, woman may be better at studying (or like it more), so they get less disutility from putting in effort at college. Or they may place greater value on learning for its own sake. Or they may simply get more utility from social activities at college.

The bottom row of Table 12 reports a counterfactual where we give white women <u>both</u> the labor market constraints and tastes for school of white men. Their college graduation rate then drops from 44.9% to 41.6%. Thus, the drop due to tastes outweighs the increase due to better wage offers.[37] Nevertheless, this 41.6% graduation rate is still 5.7 points higher than the 35.9% rate of men. The 5.7 percentage point gap that remains reflects other factors that create different incentives for men vs. women to attend college, even after we equalize tastes and

[37] We also performed the reverse experiment where we give men the labor market constraints and tastes for school of women. As expected, giving men the wage and job offers of women reduces their college graduation rate (from 35.9% to 31.1%), and giving them women's tastes for school raises their college graduation rate (to 41.7%). Interesting, doing <u>both</u> increases their graduation rate further to 43.6%. This illustrates an interesting interaction effect: When taste for school is very strong, reducing labor market opportunities increases college attendance, as agents often choose to go to school (rather than stay at home) when they get poor wage offers (or no offers).

labor market opportunities. The gap reflects the fact that marriage market returns to college are greater for women than for men. In particular, as women are likely to have children and spend time out of the labor force, their gain from finding a college educated (high income) husband exceeds a male's gain from finding a college educated wife.

VI.A.1. Does the Explanation of the Gender Gap differ by Ethnic Group?

Consider next the results for Blacks. According to our estimates, college leads to larger wages gains for Black men than Black women. And job offer probabilities are slightly better for Black men. Thus, when we give Black women the wage offers and job offers of men their college graduation rate increases from 24.5% to 28.5%. Again, the labor market returns to college are greater for men than women. If we give Black women the same tastes for school as men their college graduation rate drops to 21.6%. So again, Black women derive more utility from school attendance than Black men.

If we give Black women *both* the labor market opportunities and tastes for school of Black men, their college graduation rate *increases* from 24.5% to 26.4%. This contrasts to White women, whose college graduation rate dropped in this experiment. The difference arises because Black women's taste for school is not as strong as White women's. Recall that tastes for school depend on mother's education. Black women's taste for school is less strong than White women's (on average) because their mothers are less educated.

When we give Black women *both* the labor market opportunities and tastes for school of Black men, their college graduation rate of 26.4% exceeds the 22.6% rate of Black men. But in contrast to whites, the marriage market does not provide a strong incentive for Black women to attend college, because their marriage probability after college is very low (So going to college does not do much to raise the chance of an offer from a college man). Instead, it is children that make the difference: Black women have an incentive to get more education than Black men so they can afford to raise children as singles.

Hispanics graduate from college at much lower rates than Blacks. In the 1980 cohort, graduation rates for Hispanic women and men were only 17.9% and 12.2%. In percentage terms the gender gap between Hispanic women and men, 47%, is the largest of any group. As we see in Table 12, giving Hispanic women the labor market opportunities of men increases their graduation rate to 19.7%. So again, greater labor market returns do not explain their higher rate of college graduation. Giving Hispanic women the tastes for school of men only causes their graduation rate to drop slightly, to 17.4%. Thus, a higher return to college in the marriage market is a key reason Hispanic women get more college education than men. This is similar to what we saw when comparing White women and men.

VI.B. Why has the College Graduation Rate Increased? Especially for Women?

In the 1960 cohort, men and women graduated from college at roughly the same rate, and this was true for Whites, Blacks and Hispanics. But in the 1980 cohort, graduates rates were higher in general, and women graduated from college at a much higher rate than men. This was true for all groups. In this section we ask the questions: "Why has the college graduation rate increased?," and "Why has the gender gap in college graduation *increased* over time?" An important point of our paper is that the latter question is very different from the question we posed in the previous section, which was: "Why is the college graduation rate of women *currently* higher than that of men?" And as we'll see, the answers are very different.

In the 1960 cohort the college graduation rates of White women and men were 26% and 27%, respectively. But in the 1980 cohort these rates increased to 45% and 36%. Thus, the college graduation rate of men increased by a substantial 9 percentage points, but the rate for women increased by a staggering 19 percentage points, opening up a 9 point gender gap. The patterns are similar for Blacks and Hispanics (see Figure 1).[38] Here we ask what exogenous factors drove this huge increase in college graduation, and the opening of the gender gap.

We address these questions by analysing the marginal contributions of the three main exogenous processes (family background, labor market and marriage market) to changes in college graduation rates. Table 13 reports the marginal contribution of each factor to the change in the college graduation rate from the 1960 birth cohort to the 1980 birth cohort. Recall that we assume preferences are fixed across cohorts and ethnic groups – i.e., we only allow preferences to differ between men and women. Also note that mother's marital status affects both ability and taste for marriage. In Table 13 we decided to allocate the first effect to the parental background category, and the second to the marriage market category.

Parental background: Consider first the results for Whites. Our results imply changes in parental background, which affects the labor market skill endowment and taste for school, caused the college graduation rate of White women to increase by 5 percentage points between the 1960 and 1980 cohorts. Changes in parental background also caused the college graduation rate of White men to increase, but by a much smaller 1.4 percentage points.

Why is the effect of parental background so much greater for women? As we discussed in Section V, having a college educated mother increases tastes for school, and this effect is much stronger for daughters. Between the 1960 and 1980 birth cohorts, the college graduation rate of mothers increased from 14% to 24% (see Table 1), and this increased tastes for

[38] For Blacks the increases for men and women were 8% and 13%, while for Hispanics they were 2% and 8%.

schooling, especially for daughters. Having a college graduate mother also increases the probability a person is the high skill type, but it does so equally for men and women, so this skill channel cannot explain why women's graduation increased much more than men's.

Table 13: Factors Driving Increasing Education Across Cohorts

	White		Black		Hispanic	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
College Rate Fitted - 1960	**27.0%**	**25.9%**	**14.7%**	**11.6%**	**10.3%**	**11.0%**
1) Family Background - A- mother's education	0.019	0.047	0.020	0.039	0.010	0.025
1) Family Background - B - mother's marital status	-0.001	-0.001	-0.006	-0.002	-0.007	-0.004
1) Family Background - B1 - mother's marital status	-0.007	-0.004	-0.008	-0.004	-0.005	-0.003
1) Family Background - A+B1+C	**0.014**	**0.050**	**0.015**	**0.038**	**0.006**	**0.026**
2) Taxes (brackets, deductions, exemptions, no change	0.002	0.007	0.000	0.004	0.001	0.003
2) Welfare rules (AFDC, EITC, welfare reform 1996)	0.001	0.008	0.003	0.023	0.001	0.017
2) Job offer function - D	0.022	0.048	0.028	0.056	0.009	0.012
2) Wage offer function - E	0.050	0.077	0.040	0.059	0.014	0.031
2) Labor Market - D + E + Taxes and Welfare	**0.054**	**0.104**	**0.057**	**0.085**	**0.015**	**0.041**
3) Marriage Market - B2 - mother's marital status (only	0.001	0.007	0.000	0.008	-0.006	-0.002
3) Marriage Market - F – change in education	0.011	0.010	0.003	0.008	0.004	0.007
3) Marriage Market - G – change in offer by age	0.017	0.034	0.005	0.013	0.003	0.013
3) Marriage Market - F +G + B2 (marriage cost)	**0.021**	**0.044**	**0.010**	**0.029**	**0.004**	**0.021**
College Rate Fitted - 1980	**35.9%**	**44.9%**	**22.6%**	**24.5%**	**12.2%**	**17.9%**

The mother's marital status is a second dimension of parental background. It affects both the probability a person is high ability and the taste for marriage. But as we see in Table 13 these effects are very small compared to the effects of mother's education.[39]

The impacts of mother's education are similar for Blacks and Hispanics. For Blacks the fraction of college graduate mothers increased from 6% to 13%, and for Hispanics it increased from 7% to 11%, while for Hispanics the percentage of native born mothers increased from 42% to 52% (Recall that for Hispanics we assume that only having a native born college educated mother increases taste for school). Hence, changes in parental background caused the college graduation rate of Black women to increase by 3.8 pp, compared to 1.5 pp for Black men, while causing the college graduation rate of Hispanic women to increase by 2.6 pp, compared to 0.6 pp for Hispanic men.

Labor Market: Next we consider the impact of changes in the labor market (offer wages and job offer probabilities, as well as taxes and welfare rules). As we see in Table 13, our results imply that changes in labor market opportunities caused the college graduation rate of White women to increase by 10.4 percentage points between the 1960 and 1980 cohorts. Changes in labor market opportunities also caused the college graduation rate of White men to increase, but by a much smaller 5.4 percentage points.

[39] The rate of single parent households increased substantially between the 1960 and 1980 cohorts (from 6.4% to 11.8% for whites), and this had two opposite effects on college: It lowered ability, causing college to fall, but it also reduced tastes for marriage, which raised college education. When women know they are less likely to be married it creates an incentive to get more education.

Changes in taxes and welfare rules led to small increases in education for women, but negligible changes for men. For both men and women it is changes in the job offer probabilities and especially offer wages that are the main factors. So why did the labor market have a bigger effect on women?

As we saw in Section V, Table 6, both starting wages and experience returns for white male and female college graduates improved between the 1960 and 1980 birth cohorts. The college vs. high school wage premium for men increased from .42 to .54 log points, while for women it increased from .54 to .67, so for both men and women it increased by .13 log points. But the experience returns for college graduate women improved much more than for men (i.e., as we see in Table 6, for college women the experience coefficient increased by .027, compared to an increase of .011 for men). Experience returns of white college women in the 1960 birth cohort were much smaller than those for white college men, but by the 1980 cohort they have almost caught up. In addition, job offer probabilities of white women improved across the three cohorts, so by the 1980 cohort they are very similar to those for white men. These improvements in experience returns and job offer probabilities explain why changes in labor market opportunities led to large increases in education for women than for men.

If we look at Blacks the story is similar. Changes in labor market opportunities caused the college graduation rate of Black women to increase by 8.5 percentage points compared to 5.7 points for Black men. For Hispanics effects are smaller but still much larger for women: the figures are 4.1 pp for women and only 1.5 pp for men. The very low college graduation rate of Hispanic men, as well as its very slow growth from the 1960 to 1980 cohorts, is notable. According to our estimates, the college vs. high school wage premium for Hispanic men was only .46 log points in the 1980 cohort, and this is the lowest of any group. It compares to .54 log points for both black and white men, .67 for white women, and .55 for Hispanic women. Black women at .47 is the next smallest.

A key reason that college grew less for Black and Hispanic women than for White women is that experience returns for Black and Hispanic college women grew much less than for white women. The same was also true for Black and Hispanic men relative to white men.

Marriage Market: Finally we look at the contribution of the marriage market. As we see in Table 13, our results imply changes in marriage market opportunities caused the college graduation rate of White women to increase by 4.4 percentage points between the 1960 and 1980 cohorts, compared to a 2.1 pp increase for men. So all three factors (parental background, labor market, marriage market) caused the college graduation rate of White women to increase roughly twice as much as that of men.

Table 13 decomposes the marriage market effect into that due to changes in assortative mating vs. changes in the probability of marriage offers by age. We see that the increase in the probability of getting marriage offers at older ages is the larger factor. This alone causes the graduation rate of White women to increase by 3.4 pp. College became more attractive for women because college attendance does not crowd out opportunities for marriage (and fertility) to the extent that it did in the past. The results for Blacks and Hispanics are similar, except the effects are more modest than for whites.

One popular explanation for the increase in women's education is increased returns to college in the marriage market, due to an increase in assortative mating. So it is interesting to explore further why we find changes in assortative mating are <u>not</u> a very important factor:

Table 14 reports assortative mating patterns for the '60 to '80 birth cohorts for whites.[40] Clearly the fraction of couples where both spouses are college graduates increased substantially (from 18.9% to 35.0% of all marriages). But this 85% increase in the prevalence of college couples is roughly consistent with what we would expect given the increase in college education across cohorts (i.e., the fraction of college graduate women increased 73% from 26.3% to 45.5%). The degree of assortative mating did not change to any appreciable degree. In fact, the conditional probability of a college women matching with a college man fell very slightly from 69% to 68%.[41]

Table 14: Assortative Mating Patterns by Cohort, Whites only

1960		HUSBANDS		
		HSD + HSG	SC	CG + PC
	HSD +HSG	29.5%	9.3%	4.4%
WIVES	SC	9.5%	12.3%	7.7%
	CG + PC	3.3%	5.3%	18.9%

1970		HUSBANDS		
		HSD + HSG	SC	CG + PC
	HSD +HSG	19.3%	6.2%	2.9%
WIVES	SC	9.8%	13.0%	7.2%
	CG + PC	5.3%	8.1%	28.1%

1980		HUSBANDS		
		HSD + HSG	SC	CG + PC
	HSD +HSG	13.3%	4.7%	2.2%
WIVES	SC	9.0%	12.8%	6.4%
	CG + PC	6.0%	10.6%	35.0%

Finally, it is notable that if we sum the three marginal effects of parental background, labor market and marriage market, we get roughly the total increase in education, For example, for white women we have 26.0 + 5.0 + 10.4 + 4.4 = 46.2 compared to 45.0. This suggests that interaction effects among the three factors are modest.

[40] Appendix H shows patterns for Blacks and Hispanics.

[41] One can also see in Table 14 that the probability a woman marries a man with less education than her increased substantially, from 18.1% in the 1960 cohort to 25.6% in the 1980 cohort, while the probability a man marries a women with less education than him fell from 21.4% to 13.3%. Gihleb and Lifshitz (2022) show that women who "marry down" tend to supply more labor than women who "marry up," so these changes tend to increase married women's labor supply. They find this is important in cohorts earlier than those we study.

VI.C. Explaining gaps in College Graduation between Whites, Blacks and Hispanics

Here we focus on the 1980 cohort and assess what factors account for different college graduation rates across ethnic groups. The differences are substantial: the college graduation rates of White men and women were 35.9% and 44.9%. In contrast, as we see in Table 15, the rates for Black men and women were 22.6% and 24.5%, and those for Hispanics were 12.2% and 17.9%. We now examine the impact on college graduation rates of Blacks and Hispanics if we give them the same exogenous factors facing whites (parental background, labor market, marriage market). If all three are equated then college graduation rates are equalized, as these are the only ways the groups differ in our model. We assume all three ethnic groups have identical preferences, and of course they all face the same tax and welfare rules.

Table 15: Explaining College Gaps between Whites, Blacks and Hispanics, 1980 Cohort

	Black		Hispanic	
Fitted 1980 college rate	22.6%	24.5%	12.2%	17.9%
	Men	**Women**	**Men**	**Women**
1) Family Background - A- mother's education	0.033	0.055	0.027	0.051
1) Family Background - B - mother's marital status	0.017	-0.018	0.003	0.006
1) Family Background - B1 - mother's marital status (only ability)	0.014	0.018	0.002	0.004
1) Family Background - C - mother's immigration status			0.024	0.019
1) Family Background - A+B1+C	**0.042**	**0.074**	**0.047**	**0.069**
2) Job offer function - D	0.038	0.051	0.023	0.033
2) Wage offer function - E	0.029	0.038	0.111	0.103
2) Labor Market - D + E	**0.074**	**0.092**	**0.132**	**0.137**
3) Marriage Market - B2 - mother's marital status (only marriage cost)	-0.002	-0.021	0.003	0.008
3) Marriage Market - F – change in education distribution	0.003	0.007	0.009	0.009
3) Marriage Market - G – change in offer by age	0.002	0.009	0.012	0.013
3) Marriage Market - F +G + B2 (marriage cost)	**0.013**	**0.030**	**0.025**	**0.033**
White Fitted - 1980 college rate	35.9%	44.9%	35.9%	44.9%

In Table 15 we have split the impact of mothers' marital status into two components: its impact on skill endowments and its impact on fixed costs of marriage. We include the former under family background (section 1), and the latter under marriage market changes (section 3). Thus, our decomposition has three main parts: (i) the effect of family background on skill endowments and tastes for school, (ii) effects of labor market opportunities (wage and job offers), and (iii) the effect of the changes in marriage offer functions, plus the effect of parents' marital status on fixed costs of marriage.

Parental Background: If we give Black women the same mother's education as Whites (i.e., we increase the mother's college graduation rate from 13% to 26%) we predict their college graduation rate would increase by 5.5 percentage points. The rate of single parent households was 61% for Blacks in the 1980 birth cohort, compared to only 18.7% for whites. This leads to lower ability and lower tastes for marriage. If we eliminate only the negative effect on ability, we predict the college graduation rate of Black women would increase by 1.8 points. The combined impact of equalizing mother's education and the rate of single parent households (ability effect only) raises Black women's college graduation rate by 7.4 points, eliminating 35% of the gap with Whites. If we look at Black men, we get an increase of 4.2 points, eliminating 32% of the gap with whites.

For Hispanics, the effect of equalizing mother's education is similar to Blacks. For Hispanics it is important to remember that we only count a mother as college educated if she was born in the US.[42] If we equalize mother's education, and assume all parents were born in the US, then the college graduation rate of Hispanic men and women increases by 2.7 and 5.1 points. If we also equalize the rate of single parent status (reducing it from 25.9% to 18.7%), the college graduation rate of Hispanic men and women increases by 4.7 and 6.9 points.

Labor Market: Next, we consider the impact of labor market opportunities, both the wage offer function and the job offer function. According to our estimates, Whites, Blacks and Hispanics in the 1980 cohort have fairly similar starting wages conditional on schooling, but the Whites have much higher returns to experience. This is true for both men and women. Black men have inferior job offer functions to White and Hispanic men, both in terms of the offer probability for men with zero experience and the rate at which offer probabilities increase with experience. Black women also have inferior offer functions to White women in terms of both the offer probability for women with zero experience and the rate at which offer probabilities increase with experience. The Hispanic women are similar to the Blacks in terms of initial offer probabilities, but similar to Whites in how the probabilities increase with experience.

If we give Blacks the same labor market constraints as Whites it increases their rates of college graduation by 7.4 and 9.2 percentage points for men and women. This closes the college gap with whites by about 55% for men and 45% for women. Thus labor market opportunities explain roughly half the college gap between Blacks and Whites.

If we give Blacks the same offer wage functions as Whites we get increases of 3 and 3.8 percentage points, while if we give then the same job offer rates we get increases of 3.8 and 5.1 percentage points. So the difference in offer rates is actually more important. The overall results for Hispanics are similar, but for them the wage offer function matters much more than the job offer functions (as their baseline job offer functions are more similar to whites).

[42] In 1980, 52% of Hispanic mothers were born in US, and their college rate is 11%, so we set the rate of college mothers to (.52)(.11) = 5.5%. In counterfactual A, we increase the mother's college rate from 5.5% to 26%, the rate for whites. In counterfactual C, where we assume all mothers are born in the US, we increased mothers college rate from 5.5% to 11%.

Marriage Market: Finally, we consider equalizing marriage market opportunities. Our estimates of the marriage offer functions imply that the probabilities of receiving offers from spouses of different types conditional on ones' own education do not differ very much across Whites, Blacks and Hispanics. [Assortative mating patterns do not differ much across these groups, conditional on marriage]. As a result, giving Blacks and Hispanics the offer functions of whites only modestly increase their education. We tend to see larger impacts when we equalize how offer probabilities vary with age. Whites are more likely to get marriage offers at older ages than Blacks or Hispanics, as we saw in Table 9. This facilitates college completion. So, when we apply the Whites' offer probabilities to Blacks and Hispanics they tend to stay in school longer, increasing college graduation rates modestly.

In our model, parents' marital status effects both the skill endowment and the fixed cost of marriage. Conceptually, we argue that equalizing marriage market opportunities implies also equalizing the fixed cost of marriage across ethnic groups. Consider replacing the rate of single mothers for Blacks (61.5%) with the rate for whites (18.7%). This experiment reduces the fixed cost of marriage for blacks substantially, causing their marriage rate at age 32-36 to increase from 26% to 53%.

As we see in the bottom panel of Table 15, when we give Blacks the same marriage market opportunities as Whites, the college graduation rates of Black men and women increase by 1.4 and 3 percentage points, respectively. Interestingly, for women, the effect of reducing the fixed cost of marriage by itself is negative (minus 1.8 points). With marriage more likely, black women foresee that they will work less, which reduces the return to college. However, if a higher chance of marriage is combined with a higher chance of getting offers at older ages, the women are able to complete college and marry later. The later effect dominates, giving an overall positive effect.

For Hispanics equalizing marriage market constraints with whites increases college graduation rates by 2.6 and 3.3 percentage points for men and women, respectively. Overall, we find that equalizing marriage market constraints closes 10% and 15% of the college gap for black men and women, and 11% and 12% of the gap for Hispanic men and women.

Summary: The sum of the three exogenous factors (parental background, labor market, marriage market) closes 85% to 95% of the college graduation gap between Whites, Blacks and Hispanics, for both men and women. In our model, because we assume common preferences for all three ethnic groups, equalizing the three exogenous factors equalizes college graduation rates across the groups by construction. Thus, the model implies a very small complementarity when the three factors are changed simultaneously.

VII. Will Graduation rates Continue to Increase? Will the Gender gap continue to grow?

In this section we use our model to address three questions about future trends in college graduation rates: Will graduation rates continue to increase? Will the gender gap continue to grow? Will Blacks and Hispanics catch up to Whites?

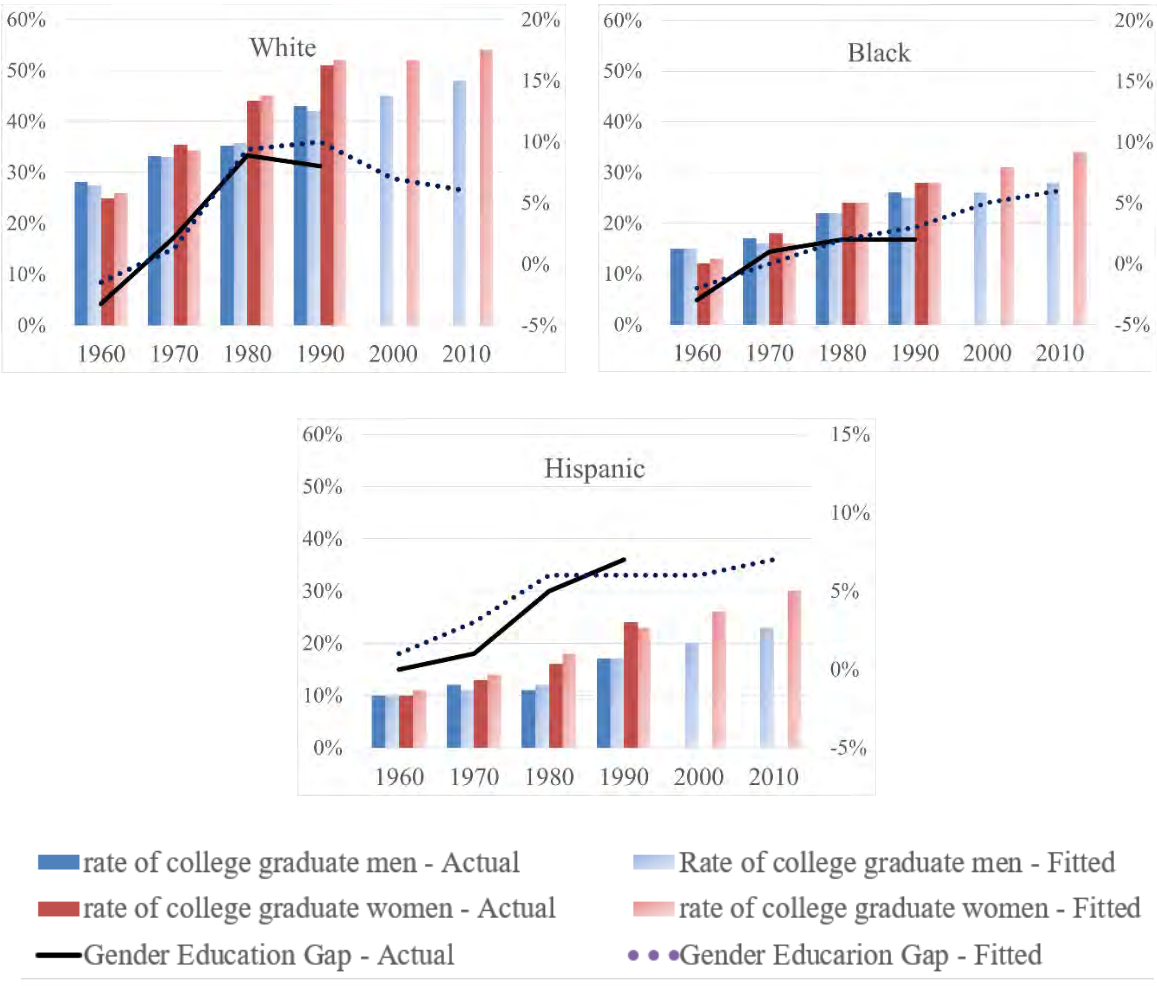
We use the family background (i.e., mothers' education, parents' marital status and immigration status) of the 1990, 2000 and 2010 cohorts (see Table 1), to predict their college graduation rates. In this exercise, we assume labor market and marriage market opportunities of these cohorts are the same as the 1980 cohort. Enough time has passed that we can see the collge graduation rates of the 1990 cohort (at age 30). Surprisingly, our predicted graduation rates for the 1990 cohort are very close to what we observe in the data, with a deviation of at most one percentage point (see Figure 5). The main reason this prediction is so accurate is that wage paths for the 1990 cohort do not appear to be much different from the 1980 cohort (at least at the young ages where we can observe data). Therefore, it seems reasonable to also predict the collge graduation rates of the 2000 and 2010 cohorts based on the same assumptions as for the 1990 cohort – i.e., using only information on their family background.

Consider first the results for Whites. The college graduation rate of White mother's increased from 38% in the 1990 cohort to 51% in the 2010 cohort. As we see in Figure 5, our model predicts the growth in the college graduation rate of White women will slow down and stabilize at about 53% to 54% in the 2000 and 2010 cohorts.

The reason we predict the graduation rate of White women will stabilize is that, by the 2000 cohort, a very high share of medium skill women with college graduate mothers are themselves graduating from college. The marginal group consists largely of medium skill women whose mothers did <u>not</u> graduate. It is difficult to induce these women to graduate from college, because they get disutility from school (see Section V). We also predict the college graduation rate of White men will grow slighly faster than for White women. As a result, the gender gap will narrow slightly, from 9% in the 1980 cohort to 6% for the 2010 cohort.

The story is rather different for Blacks and Hispanics. For Black women the college graduation rate of mother's increased from 13% in the 1980 cohort to 19% in the 1990 cohort and 28% in 2010. As a result, we predict the college graduation rate of Black women will increase from 24% in the 1980 cohort to 28% in the 1990 cohort and 34% in 2010. This brings the college graduation rate of Black women to roughly the rate of White women in the 1970 cohort. These substantial increases arise because the marginal Black women was still high skill in these cohorts, making it easier to induce them into attending college.

Figure 5: Actual and Predicted Graduation Rates, 1960 to 2010 cohorts

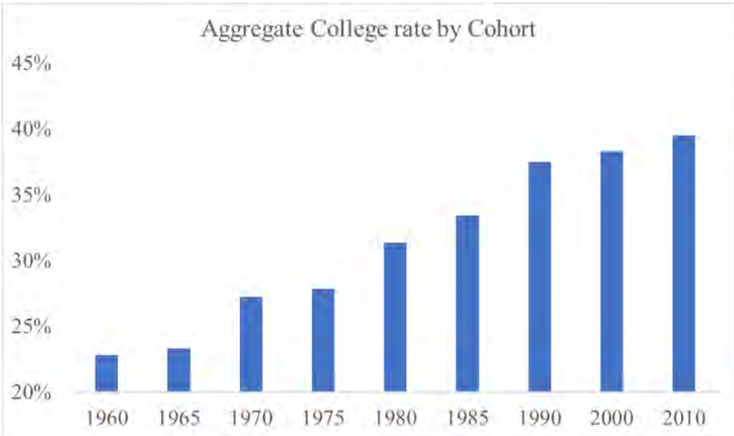


For Hispanic women the fraction of US born college graduate mothers increased from 5.7% in the 1980 cohort to 10.5% in the 1990 cohort to 17.3% in 2010. As a result, we predict the college graduation rate of Hispanic women will increase from 18% in the 1980 cohort, to 23% in 1990 and to 30% in 2010. Again, these large increases occur because the marginal Hispanic woman was high skill in this period.

For Black men, we predict the college graduation rate will increase modestly, from 22% in the 1980 cohort to 28% in the 2010 cohort. Hence the gender gap in the graduation rate for Blacks will widen from 2 pp in the 1980 cohort to 6 pp in the 2010 cohort. Interestingly, for Hispanic men, we predict the graduation rate will increase substantially, from 12% in the 1980 cohort to 23% in the 2010 cohort. This means the gender gap for Hispanics will increase only slightly, from 6 percentage points to 7 pp.

In summary, we predict increases in college graduation rates for all six gender and ethnic combinations. The largest increases from 1980 to 2010 are for White men (12pp) and Hispanic women (12pp), followed by Hispanic men (11pp), Black women (10pp), White women (9pp) and finally Black men (6pp). All the above predictions are based on changes in family background, where increases in collge graduation rates of mothers across cohorts is the key factor driving the predicted increases in education. But the increase in single parent families, which tends to reduce ability, also plays a role. From the 1980 to 2010 cohorts, the rate of single parent households for Whites only increases slightly, from 18.7% to 21.9% (3 pp). But for Blacks the increase is 61.5% to 74.5% (13 pp), and for Hispanics it is 25.9% to 40.0% (14.1 pp). These large increases in single parent rates for Blacks and Hispanics tends to dampen their increases in education.

Figure 6: Aggregate College Graduation Rate



Finally, in Figure 6 we aggregate across genders and ethnic groups to construct the overall college graduation rate by cohort. This is historical from the 1960 to 1990 cohorts, and predicted for the 2000 and 2010 cohorts (whose true rates will not be observed until roughly 2030 and 2040). Our model predicts that the aggregate college graduaiton rate will only increase by 2 percentage points from the 1990 to 2010 cohorts (a 1 pp increase for for each).

This result may seem surprising, as our model predicts larger increases than 2pp for each individual group: If we compare the 1990 and 2010 cohorts, the largest predicted increase is for Hispanic women (7pp), followed by White men (6pp), Hispanic men (6pp), Black women (6pp), White women (4pp) and finally Black men (3pp).

The reason for this contrast is the dramatic drop in the population share of Whites, from 63% in the 1990 birth cohort to only 52% in the 2010 birth cohort. This is mainly driven by an increase in the share of Hispanics, from 25% in the 1990 cohort to 35% in the 2010 cohort. As the Hispanics have the lowest college graduation rate of any group, the increase in their population share drives down the aggregate rate. This is despite the fact that we predict large increases in college graduation rates for Hispanics.

VIII. College Tuition Subsidy Experiments

In this section we use the model to assess the size of tuition subsidies that would be needed to negate the impact of parental background on college graduation. According to our estimates, the annual cost of college implied by parameter TC in equation (18) is \$58k per year. It is important to note that this is measured *relative* to high school, and that it includes tuition, room and board, travel costs, and the utility cost of college (i.e., the effort cost of studying). In addition to this, different types of agents get additional utility or disutility of school attendance (but we assume these differences are invariant across grade levels) – e.g., high ability women with college educated mothers get incremental utility from school at all levels.

As we saw in Table 15, our model implies that, in the 1980 birth cohort, differences in mother's college graduation accounted for 5.1 points of the college gap between Hispanic and White women. We predict that a tuition subsidy of \$12.9k per year would increase the college graduation rate of Hispanic women by 5.1 pp, eliminating this source of difference with White women. Assuming that their children are in the 2000 birth cohort (20 years later), and that the subsidy is eliminated, we can further predict that the increase in mother's education in the 1980 cohort would cause the graduation rate of their daughters in next generation (2000 cohort) to increase by 3.5 pp, and their sons by 2.1 pp. Thus, there is a large passthrough of the subsidy impact to the next generation.

Interestingly, the same size subsidy would only increase the college graduation rate of Black women by 2.3 pp. This is because, in the 1980 cohort, over 90% of high ability Black women were already graduating from college. In contrast, only about 60% of high ability Hispanic women were graduating – see Table 16 (Note: In the 1980 cohort the baseline attendance rate for Hispanic women was only 17.9%, compared to 24.5% for black women). Thus, it is more difficult to induce additional Black women to graduate using subsidies.

Table 16.A: Values of College for Blacks

			1960					1980				
Skill endowment	mother 's education	mother's marital status	type proportion (%)	PV women (1000 \$)	CG rate (%)	PV men (1000 \$)	CG rate (%)	type proportion (%)	PV women (1000 \$)	CG rate (%)	PV men (1000 \$)	CG rate (%)
High	HS	Married	27.0	200	47.4	260	52.2	15.3	680	89.6	620	82.3
High	COL	Married	1.6	600	99.2	640	97.3	2.1	790	97.5	710	97.6
High	HS	Single	12.4	180	36.3	250	46.5	19.0	670	96.4	550	81.2
High	COL	Single	0.9	590	98.4	620	98.5	3.3	775	98.3	640	97.8
Medium	HS	Married	14.7	10	0.0	15	0.0	8.3	70	0.0	25	0.0
Medium	COL	Married	0.3	60	0.0	45	0.0	0.4	90	0.0	80	0.0
Medium	HS	Single	16.0	0	0.0	0	0.0	24.7	0	0.0	10	0.0
Medium	COL	Single	0.4	0	0.0	0	0.0	1.6	20	0.0	20	0.0

Table 16. B: Values of College for Hispanics

			1960					1980				
Skill endowment	mother 's education	mother's marital status	type proportion (%)	PV women (1000 $)	CG rate (%)	PV men (1000 $)	CG rate (%)	type proportion (%)	PV women (1000 $)	CG rate (%)	PV men (1000 $)	CG rate (%)
High	HS	Married	24.0	190	32.4	240	32.1	19.5	510	57.3	360	37.3
High	COL	Married	3.0	570	98.4	600	98.3	4.0	760	95.9	700	97.4
High	HS	Single	2.2	180	27.8	230	27.6	4.2	490	53.2	340	33.9
High	COL	Single	0.3	540	99.2	585	99.3	1.1	740	98.2	620	98.2
Medium	HS	Married	37.1	0	0.0	0	0.0	30.1	35	0.0	15	0.0
Medium	COL	Married	2.6	70	0.0	60	0.0	3.5	85	0.0	70	0.0
Medium	HS	Single	4.2	0	0.0	0	0.0	8.2	0	0.0	0	0.0
Medium	COL	Single	0.4	0	0.0	0	0.0	1.2	15	0.0	20	0.0

Returning to Table 15, we see that differences in mother's college graduation accounted for 5.5 points of the college gap between Black and White women. We predict that a tuition subsidy of $26.3k per year would be required to increase the college graduation rate of Black women by this amount. We further predict that this would increase the graduation rate of their daughters in next generation (2000 cohort) by 2.6 pp (and their sons by 1.4 pp). Thus, there is again a large passthrough of subsidy impact to the next generation, although not as large as we saw for Hispanics.

IX. Conclusion

In this paper we have specified and estimated a model of individual and household decision making in which education, labor supply, marriage and fertility are all endogenous. We use the model to explain changes in college graduation rates in the 1960 through 1980 birth cohorts, by gender/ethnicity, based on three exogenous factors: family background, labor market opportunities and marriage market constraints. We discipline the model by requiring it to explain differences in all endogenous variables by gender, birth cohort (1960, 70, 80) and ethnicity (White, Black, Hispanic), using preferences that are fixed across cohorts and groups – differing only by gender. We use the model to assess the contribution of each exogenous factor to changes in graduation rates by cohort/gender/ethnic group. We also use the model to predict graduation rates in the 1990, 2000 and 2010 birth cohorts.

We use counterfactual experiments to address four important questions:

The first question is "Why do women *currently* graduate from college at a higher rate than men?" For example, in the 1980 cohort, White women graduated at a 45% rate compared to 36% for men, giving a 9 percentage point gender gap. For Hispanics the gap was 6 pp and for Blacks it was 2 pp. We find that labor market returns do not explain the gender gap: In fact, labor market returns to college are actually greater for men than women. However, the overall returns to college – factoring in labor market returns, marriage market returns and tastes for education – are greater for women than men. The main reason is that women simply get more utility from school than men. Given the structure of our model, this may subsume a number of factors: For example, woman may be better at studying (or like it more), so they get less disutility from putting in effort at college. Or they may place greater value on learning for its own sake. Or they may simply get more utility from social activities at college.

This result is consistent with a large literature in economics, sociology and psychology arguing that girls like school better than boys, or that they are find school less difficult than boys, or that they do better in school because they have more self-control. See for example, Becker, Hubbard and Murphy (2010a, b), Autor et al (2016), Heckman and Masterov (2004), Jacob (2002) and Voyer and Voyer (2014).

The second question is "Why has the college graduation rate increased in general across the three cohorts?" For instance, in the 1960 cohort the college graduation rates of White women and men were 26% and 27%, respectively. But in the 1980 cohort these rates had increased to 45% and 36%. According to our model, the largest factor was increasing labor market returns to education. Between the 1960 and 1980 birth cohorts, the college vs. high school offer wage premium for both men and women increased by .13 log points. This caused the college graduation rate of White women (men) to increase by 10.4 (5.4) percentage points, which accounts for more than half of the actual overall increase of 19 (9) points.

Increases in mother's education across cohorts also contributed importantly to increases in the graduation rate: We find mother's education increases the child's labor market skill endowment (at age 16) as well as tastes for (ability at) college. This is consistent with important work by Sayer et al (2004), Guryan, Hurst and Kearney (2008), Kalil, Ryan and Corey (2012) and Potter and Roska (2013), showing that college educated mothers spend much more time in educational activities with children. We find the taste (or ability at school) channel is much more important than the labor market skill channel.

The third question is: "Why did the gender gap in college graduation *increase* over time?" A key point of our paper is that this is very different from the first question: "Why is the college graduation rate of women *currently* higher than that of men?" We find there are three key reasons that the graduate rate of women grew faster than that of men:

1) The increasing share of mothers with a college degree caused the college graduation rate of White women to increase by 5 percentage points between the 1960 and 1980 cohorts. It also caused the college graduation rate of White men to increase, but by only 1.4 pp. This is

because the effect of mother's education on tastes for school is much stronger for daughters. (Having a college education mother also increases the labor market skill endowment, but this effect is similar for men and women). Similar patterns hold for Blacks and Hispanics.

2) Experience returns of White college women in the 1960 birth cohort were much smaller than those for White college men, but by the 1980 cohort they have almost caught up. In addition, job offer probabilities of White women improved across the three cohorts, so by the 1980 cohort they are very similar to those for white men. These improvements in experience returns and job offer probabilities explain why changes in labor market opportunities led to *larger* increases in education for women than for men. (Although, despite these improvements, women's *labor* market returns to college are still less than those of men.)

However, a key reason college grew less for Black and Hispanic women than for White women is that experience returns for Black and Hispanic college women grew much less than for White women. The same was also true for Black and Hispanic men relative to white men.

3) An increase in the probability of getting marriage offers at older ages made it easier for women to delay marriage and fertility while pursuing a college degree. This caused the college graduation rate of White women to increase by 3.4 percentage points from the 1960 to 1980 birth cohorts. The same was true for Black and Hispanic women, but to a lesser degree, as their chances of getting offers at older ages are still lower than for whites.

The fourth question is "Why do Blacks and Hispanics have much lower graduation rates than Whites?" Our model assumes common preferences across groups, so taste differences are not a factor. We find parental backgroundg explains roughly 1/3 of the college graduation rate gap between Blacks and Whites (for both men and women). Roughly ¾ of this parental background effect is due to the gap in mother's education, and ¼ is due to the impact of Black's high rate of single parent households. For Hispanics the role of parental background is a bit smaller, because the single parent rate for Hispanics is similar to whites.

Labor market opportunities are the largest factor: They account for roughly half the college gap between Blacks and Whites. The most important difference is that Blacks have worse returns to experience than Whites, and lower job offer probabilities (both initially and conditional on experience). Results for Hispanics are similar overall, but their wage offer functions are relatively worse than Blacks while their job offer functions are closer to Whites.

Finally, the marriage market plays a relatively small but still significant role. E.g., if Black and Hispanic women had the same marriage market opportunities as White women, it would close about 1/7 of the college graduation rate gap. The probability of getting offers declines more quickly with age for Black and Hispanic women than White women.

We also use the model to predict future trends in college graduation rates. These are intergenerationally linked, as mother's college affects children's tastes for college (especially for daughters), and children's ability. Thus, we can predict how increases in mother's college in one cohort (e.g., 1990) increase education in their children's cohort (e.g., 2010). In general, we predict the recent large increases in women's graduation rates will cause their children's graduation rates to increase further. But the results differ substantially by ethnic group:

For Whites, we predict that growth in women's college graduation rate will slow down considerably in the 2000 and 2010 cohorts. This is because the marginal woman is now a medium ability person whose mother did not attend college. Such women get disutility from school attendance, and their labor market returns to college are not as great as for high ability women. So it is difficult to induce them to attend college and graduate. Thus, we predict the college graduation rate of white women will plateau at about 54%. We predict that the rate of White men will slowly catch up, so gender gaps amongst Whites will slowly narrow.

The story is different for Blacks and Hispanics. We predict the college graduation rate of Black women will increase from 28% in the 1990 cohort to 34% in the 2010 cohort. This will bring the college graduation rate of Black women to roughly the rate of White women in the 1970 cohort. Similarly, for Hispanic women we predict the graduation rate will increase from 23% in the 1990 cohort to 30% in the 2010 cohort. These substantial increases arise because the marginal Black or Hispanic women is still a high ability type person in these cohorts, making it easier to induce them into attending college.

Thus, we predict the gender education gap will continue to grow for Blacks and Hispanics, although the growth for Blacks is greater. In general, if we compare the 1990 and 2010 cohorts, the largest predicted increase in the college graduation rate is for Hispanic women (7pp), followed by White men (6pp), Hispanic men (6pp), Black women (6pp), White women (4pp) and finally Black men (3pp). However, if we aggregate across gender/ethnic groups, we predict the aggregate college graduation rate will only increase by 2 pp from the 1990 to 2010 cohorts. This is because Hispanics, who have the lowest graduation rate of any group, make up large shares of the 2000 and 2010 birth cohorts.

Finally, we use our model to predict the impact of tuition subsidies on college attendance. In contrast to prior work, the intergenerational linkage through mother's education allows us to predict how subsidies would affect college attendance not only for the generation directly affected by the subsidy but also for the next generation (after the subsidy is eliminated).

We predict a tuition subsidy of $12.9k per year would increase the college graduation rate of Hispanic women in the 1980 birth cohort by 5.1 pp. Going forward, this would increase the college graduation rate of their daughters in the 2000 birth cohort (20 years later) by 3.5 pp, and their sons by 2.1 pp. Thus, there is a large passthrough of the subsidy impact to the next generation. This represents an important benefit of a tuition subsidy.

Interestingly, the same size subsidy would only increase the college graduation rate of Black women by 2.3 pp. This is because, in the 1980 cohort, over 90% of high ability Black women were already graduating from college. So it is hard to induce additional Black women to graduate. In contrast, only about 60% of high ability Hispanic women were graduating.

We predict that a much larger tuition subsidy of $26.3k per year would increase the college graduation rate of Black women by 5.5 pp. We further predict that this would increase the graduation rate of their daughters in next generation (2000 cohort) by 2.6 pp, and their sons by 1.4 pp. Thus, there is again a large passthrough of subsidy impact to the next generation, although not as large as we saw for Hispanics.

In future work, our model is well suited to study the impact of tax structure, especially joint vs. individual taxation, on a range of endogenous outcomes (i.e., labor supply, marriage, fertility and education choices), as in work by Eckstein, Keane and Lifshitz (2019) and Borella, De Nardi and Yang (2023). Such policies are likely to have different effects on Blacks vs. Whites/Hispanics, due to their lower marriage rates. Our model is also well suited to study the changes in fertility across cohorts, and to study the impact of welfare reform on labor supply, marriage and fertility of Whites, Blacks and Hispanics.

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