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Elizabeth M. Caucutt, Nezih Guner, Christopher Rauh

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Incarceration, Unemployment, and the Racial Marriage Divide

Elizabeth M. Caucutt, Nezih Guner, Christopher Rauh*

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Abstract

The difference in marriage rates between black and white Americans is striking. Wilson (1987) suggests that a skewed sex ratio and higher rates of incarceration and unemployment are responsible for lower marriage rates among the black population. In this paper, we take a dynamic look at the Wilson Hypothesis. Incarceration rates and labor market prospects of black men make them riskier spouses than white men. We develop an equilibrium search model of marriage, divorce, and labor supply in which transitions between employment, unemployment, and prison differ by race, education, and gender. The model also allows for racial differences in how individuals value marriage and divorce. We estimate the model and investigate how much of the racial divide in marriage is due to the Wilson Hypothesis and how much is due to differences in preferences for marriage. We find that the Wilson Hypothesis accounts for more than three quarters of the model's racial-marriage gap. This suggests policies that improve employment opportunities and/or reduce incarceration for black men could shrink the racial-marriage gap.

JEL Classifications: J12, J,21, J64,

Key Words: Marriage, Race, Incarceration, Inequality, Unemployment.

* *Affiliations*: Elizabeth M. Caucutt: University of Western Ontario, ecaucutt@uwo.ca. Nezih Guner: Universitat Autonoma de Barcelona, ICREA, BSE, nezih.guner@cemfi.es. Christopher Rauh: University of Cambridge, cr542@cam.ac.uk. Guner acknowledges support from European Research Council (ERC) Grant 263600, the Spanish Ministry of Economy and Competitiveness (ECO2014-54401-P), and the Spanish Ministry of Economy and Competitiveness, through the Severo Ochoa Programme for Centres of Excellence in RD (CEX2019-000915-S). We thank our discussant at the CMSG at McGill University, Alejandro Badel, and seminar and workshop participants at the SAEe Girona, RES Meetings in Brighton, Barcelona GSE Summer Forum, EEA Meetings in Geneva, University of Barcelona, University of Cambridge, EUI, HCEO Workshop on Human Capital Formation, Family Economics at the University of Chicago, ECARES-ULB, Macroeconomics Across Time and Space Conference at Philadelphia Fed, University of Bonn, SED Edinburgh, NY Fed, VCU, McMaster, Insper, PUC Rio, McGill, Carlos III Madrid, NBER SI EFMM, and University of Laval.

1 Introduction

In 2018, 62% of white women between ages 25 and 54 were currently married, compared to only 32% of black women, a gap of 30 percentage points. The differences in household and family structure between the black and white population have been a concern for some time. Moynihan (1965) points to a link between family structure and social problems among the black population that is rooted in slavery and discrimination. Wilson (1987) suggests that black family formation is affected by the skewed sex ratio in the black population and by high rates of unemployment and incarceration amongst black men. This is referred to as *the Wilson Hypothesis* in the literature. Others, e.g. Murray (1984), suggest that the welfare state provides incentives for single motherhood. Today, the growing racial gap in marital status has led some researchers to question whether marriage is only for white people (Banks 2011).

Marital structure has implications for the living arrangements and well-being of children. In 2015, 54% of black children lived with a single mother, while the share of white children living with a single mother was 22%.[1] A growing body of literature suggests that the conditions under which children grow up matter for their well-being as adults. Carneiro and Heckman (2003) and Cunha, Heckman, Lochner and Masterov (2006), among others, find that differences between children appear at very early ages and that the family environment plays a significant role in generating these differences. Neal and Johnson (1996) and Carneiro, Heckman, and Masterov (2005a,b) show that pre-labor market conditions can account for most of the wage gap between black and white men.[2] Chetty et al (2018) document that black Americans have substantially lower upward mobility rates and higher rates of downward mobility than white Americans, leading to income disparities that persist across generations. There is also a large literature that points to the impact of family structure on children.[3] Gayle, Golan and Soytas (2018) find that differences in family structure between black and white parents play a key role in accounting for differences in children's outcomes.

Since the 1970s, two major developments have disproportionately affected black men. First, there has been a large withdrawal of major industries from the inner cities due to skill-biased technological change and globalization, leaving many low-skilled individuals jobless. Between 1980 and 2000, the U.S. lost 2 million manufacturing jobs and the decline has accelerated significantly since 2000 (Charles, Hurst and Schwartz 2018). These losses have been most pronounced for those with low levels of education. Batistich and Bond (2018) find that Japanese import competition in the 1970s and 1980s was associated with skill upgrading in manufacturing and generated a shift of employment from low-skilled black men to high-educated white men. As a consequence, in 2006, black men between ages 25 and 54

[1]The U.S. Census data on the Living Arrangements of Children, Tables CH2 and CH3. `https://www.census.gov/data/tables/time-series/demo/families/children.html`.

[2]For a quantitative analysis on the importance of initial conditions versus life-cycle shocks, see Keane and Wolpin (1997), Storesletten, Telmer and Yaron (2004), and Huggett, Ventura and Yaron (2011), and for the racial gap in particular, see Rauh and Valladares-Esteban (2018). The sources of racial-wage and employment gaps, such as discrimination, are not subjects of this study. See Hsieh, Hurst, Jones and Klenow (2019) for a quantitative analysis of the link between gender and race discrimination and US economic growth.

[3]See McLanahan and Sandefur (2009) and McLanahan, Tach, and Schneider (2013).

were less likely to be employed, 60% vs. 85%, and more likely to be unemployed, 7.3% vs. 3.6%, than their white counterparts.[4]

The second major development has been a drastic increase in incarceration. In a press conference in 1971, President Richard Nixon declared illegal drugs as public enemy number one. In 1982, President Ronald Reagan officially announced the War on Drugs leading to a substantial increase in anti-drug funding and incentives for police agencies to arrest drug offenders. The Sentencing Reform Act of 1984 as well as the Anti-Drug Abuse Act of 1986 included penalties such as mandatory minimum sentences for drug distribution. The federal criminal penalty for crack cocaine relative to cocaine was set to 100:1, which disproportionately affected poor, urban neighborhoods with predominately black populations.[5] In 1994 President Bill Clinton endorsed the "three strikes and you're out" principle, which led to multiple states adopting laws that sentenced offenders to life for their third offense (West, Sabol and Greenman 2010). State prisoners held for drug offenses in 2006 nearly matched the number of total state prisoners for any offense in 1980 (264,300 vs 304,759 (BJS 1981)).[6] In 2018, the incarceration rate of black men between ages 25 and 54 was five times as high as the incarceration rate for white men of the same age. Cumulative effects of incarceration on the lives of less-educated black men are very large. For black men born between 1965 and 1969, the cumulative risk of imprisonment by ages 30 to 34 was 20.5%, compared to only 2.9% for equivalent white men (Western 2006). For black men with less than high school education, the cumulative risk was close to 60%.[7]

Early empirical work investigating the Wilson Hypothesis, such as Lichter et al (1992) and Wood (1995), exploits variations across geographic locations in the availability of non-incarcerated employed men but fails to find significant effects that could explain the racial-marriage gap. In more recent work, Charles and Luoh (2010) and Liu (2021) follow a similar approach and find strong negative effects of incarceration rates of men on both the likelihood of women ever getting married and the education of their husbands.[8]

Any attempt to understand the racial-marriage gap faces two challenges: The first challenge is to disentangle whether it is driven by differences in preferences or circumstances. The second challenge is that marriage and divorce are dynamic decisions. As a result, the racial-marriage gap does not just reflect the lack of opportunities for black women to meet black men but also their decisions to start and end marriages. Given current incarceration policies and labor market prospects, black men are more likely to be and to become unem-

[4]Bayer and Charles (2018) study the recent trends in black-white earnings differentials. Fryer (2011) provides an overview of racial inequality in the U.S.

[5]The Fair Sentencing Act of 2010 reduced the disparity to 18:1.

[6]The majority of prisoners, 86%, are held in state rather than federal correctional facilities.

[7]Western (2006) and Lofstrom and Raphael (2016) document the effects of the prison boom of recent decades on the economic prospects of the black community.

[8]O'Keefe (2020) studies increased sentencing severity in North Carolina finding that it reduced marriages for white women. Autor, Dorn and Hanson (2019) show that local trade (China) shocks that reduce economic conditions mainly for men reduce marriage and fertility. Other papers study how the sex ratio, the number of men for each woman, affects marriage outcomes, e.g. Angrist (2002) and Chiappori, Fortin and Lacroix (2002). The basic idea is that a high (low) sex ratio improves marriage prospects for women (men) as well as their bargaining power within marriages.

ployed or incarcerated than their white counterparts.[9] Marriage can be a risky investment for women (Oppenheimer 1988). These challenges call for a structural approach.

In this paper, we develop an equilibrium model of marriage, divorce and labor supply that takes into account transitions between employment, unemployment and prison. We consider the impact currently unemployed and incarcerated men have on marriage rates, as well as the role played by the possibility of becoming unemployed or incarcerated in the future. In each model period, single men and women, who differ by productivity are matched in a marriage market segmented by race. We abstract from inter-racial marriages for computational convenience and because occurrences are rarely observed in the data. In 2006 only 0.3% of white husbands had black wives and 9.6% of black husbands had white wives.[10] They decide whether to marry while taking into account what their next best option is. Husbands and wives also decide whether to stay married and whether the wife works in the labor market. There is a government that taxes and provides welfare benefits to poorer households. As in Burdett, Lagos and Wright (2003), men in our model move exogenously among three labor market states (employment, non-employment and prison).[11]

Our modeling strategy is built upon recent structural/quantitative models of household formation.[12] Despite a growing empirical literature and public interest, there have been few attempts to account for differences in marriage rates between the black and white population within an equilibrium model of the marriage market. Keane and Wolpin (2010) estimate that black women have a higher utility cost of getting married than white women and posit that this difference might reflect the pool of available men. Their analysis is silent on why black women might have a higher utility cost of getting married. Using a dynamic search model, Seitz (2009) finds that differences in the sex ratio by race can account for about one-fifth of the racial-marriage gap. Her analysis, however, abstracts from unemployment and incarceration risk. The black-white marriage gap is also related to the widening marriage and divorce gap by education. During recent decades the decline in marriage and rise in divorce in the US has been much sharper for those with less education (Lundberg and Pollak 2014, Greenwood et al 2016, and Bertrand et al 2020).

In our model, black and white individuals differ along five dimensions: First, there are more black women than black men leading to a skewed sex ratio for the black population. Second, white men and women tend to have higher levels of education. Third, black men

[9]For men that are neither employed nor incarcerated, we use unemployment and non-employment interchangeably throughout the paper.

[10]Chiappori, Oreffice and Quintana-Domeque (2016) provide an empirical analysis of black-white marriage and study the interaction of race with physical and socioeconomic characteristics. Wong (2003) estimates a structural model of inter-racial marriages, and identifies factors behind the shockingly low level of black-white marriages in the US.

[11]While in our model incarceration is not the consequence of a choice to engage in criminal activity, our paper is also related to the large literature, going back to Becker (1968), on the economics of crime. See, among others, Imrohoroglu, Merlo and Rupert (2000) and Lochner (2004). Guler and Michaud (2018) study persistence of criminal behavior within a dynamic general equilibrium model with overlapping generations.

[12]See Regalia and Ríos-Rull (2001), Caucutt, Guner and Knowles (2002), Voena (2015), Fernandez and Wong (2014), Greenwood, Guner, Kocharkov, and Santos (2016), Goussé, Jacquemet and Robin (2017), Chiappori, Costa Diaz and Meghir (2017), and Low, Meghir, Pistaferri and Voena (2018) for examples. Doepke and Tertilt (2016) and Greenwood, Guner and Vandenbrouke (2017) review this literature.

are more likely to go to prison than white men. Fourth, black men are also more likely to lose their jobs and less likely to find a job when not employed. Because there are more black women than black men and a large number of black men are in prison, single-black women may not meet anyone in the marriage market. Furthermore, because black men are more likely to go to prison or lose their jobs, meetings, even when they take place, are less likely to be converted into marriages, and existing marriages are more likely to end in divorce. Finally, the model allows black and white individuals to value marriage and divorce differently.

We estimate the model parameters to be consistent with key marriage and labor market statistics by gender, race and educational attainment for the US economy in 2006.[13] We then use our model to understand how much of the racial marriage gap is due to differences by race in: i) preferences for marriage, ii) the sex ratio, iii) the job loss and job finding probabilities for men; and iv) the probability of going to prison for men. We build a sequence of counterfactual economies where we eliminate these differences. When equalizing racial differences in preferences for marriage, the simulated racial-marriage gap shrinks by just 3%. We then investigate how much of the racial divide in marriage in the model is due to differences in the sex ratio and the riskiness of potential spouses. Equalizing the number of black women and men reduces the black-white marriage gap by almost one fifth. Differences in employment and incarceration rates account for half of the marriage gap. Putting together all three pieces of the Wilson Hypothesis closes more than three quarters of the racial-marriage gap. We also study the impact of more generous welfare payments to single women on the racial-marriage gap and find that the effects are small. The conclusion that the majority of the racial-marriage gap is due to circumstance rather than preference highlights the role policy might play in its reduction. Our results also call into question the effectiveness of limiting welfare support if the aim is to increase marriage rates.

2 Economic Environment

We study a stationary economy populated by a continuum of men and a continuum of women. Let $g \in \{f, m\}$ denote gender. Individuals also differ by race, black and white, indicated by $r \in \{b, w\}$. Whenever there is no confusion we drop indices for g and r. Individuals live forever, but face a constant probability of survival each period, denoted by ρ. Those who die are replaced by a measure $(1-\rho)$ of newborns. Agents discount the future at rate $\widetilde{\beta}$, so $\beta = \rho\widetilde{\beta}$ is the effective discount factor. Among individuals who enter the model economy each period, the sex ratio (the number of men per woman) is one for white men and women, while it is less than one and denoted by κ_0 for black men and women. Individuals are born with a given education level, h.

Men and women participate in labor and marriage markets. At any point in time, men are in one of three labor market states: employed (e), non-employed (u) or prison (p). Women are employed (e) or non-employed (u), they do not go to prison.[14] For those who work, wages differ by gender, race and education and are denoted by $\omega_g^{r,h}$. Each period, individuals also

[13]We focus on 2006 in order to exclude labor-market issues during the Great Recession.

[14]According to the Bureau of Justice Statistics, only about 7.5% of the prison population were women in 2018 (Carson 2020).

receive a persistent wage shock denoted by $\varepsilon \in \mathcal{E} \equiv \{\varepsilon_1, \varepsilon_2, ..., \varepsilon_{N_\varepsilon}\}$. Single women and single men meet each other in a marriage market and decide whether to get married. Because some single men are in prison, the sex ratio in the marriage market, denoted by κ^r, is less than 1. As a result, some single women do not meet anyone in the marriage market. The imbalance is potentially larger for black men and women, because the sex ratio is less than one for the black population born into the model economy, and, as it will become clear below, black men are more likely to be in prison. We denote marital status by $v \in \{S, M\}$.

A woman, married or single, has children according to an exogenous stochastic process. A woman is in one of three different fertility states: without children, with children, or empty nest (children have left her house), denoted by $K \in \{0, 1, 2\}$, respectively. All women start their lives with $K = 0$ and each period face a probability, which depends on their education, race and marital status, $\pi_K^{r,h,v}$, of having a child and moving to $K = 1$. Each period, children become adults with probability ρ_K^r, and their mothers move to the empty-nest absorbing state, $K = 2$. Children are costly. They consume part of the family's resources, and if $K = 1$ and a mother works, the household must pay childcare expenses.

Finally, a government taxes households according to a progressive tax schedule and provides transfers. Due to underlying heterogeneity and individual decisions, some households in the model are married couples with or without children, while others are made up of a single man or a single woman with or without children. In some married households both the husband and the wife work, while in others one or both members are non-employed, yet in others the husband is in prison. Similarly, some single women work, while others do not, and some single men might be in prison or non-employed. Among individuals who work some are lucky and enjoy a high ε, while others are unlucky and have a low ε.

2.1 Labor Markets and Prison Transitions for Men

There is an exogenous Markov process for men among the three labor market states, (e, u, p) and wage shocks (ε), which depends on their race, education, and whether they have ever been in prison. Let $P \in \{0, 1\}$ indicate whether a man has ever been in prison and $\Pi^{r,h,P}(\lambda', \varepsilon'|\lambda, \varepsilon)$ be the probability that a type-h man of race r with current labor market status $\lambda \in \{e, u, p\}$ and labor market shock ε moves to state (λ', ε') next period. Later, we refer to the matrix of probabilities that determine how men move between wage shocks by $\Upsilon_m^{r,h}(\varepsilon'|\varepsilon)$. For now, we embed this process within $\Pi^{r,h,P}$. Suppressing the race indicator r for ease of exposition, we have:

$$
\Pi^{h,P}(\lambda', \varepsilon'|\lambda, \varepsilon) = \begin{array}{c} \\ p \\ u \\ \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_N \end{array}
\begin{array}{c} \begin{array}{cccccc} p & u & \varepsilon_1 & \varepsilon_2 & ... & \varepsilon_{N_\varepsilon} \end{array} \\
\begin{pmatrix}
\pi_{pp}^{h,P} & \pi_{pu}^{h,P} & \pi_{pe}^{h,P}\widetilde{\Upsilon}_m^{h,P}(\varepsilon_1) & \pi_{pe}^{h,P}\widetilde{\Upsilon}_m^{h,P}(\varepsilon_2) & ... & \pi_{pe}^{h,P}\widetilde{\Upsilon}_m^{h,P}(\varepsilon_{N_\varepsilon}) \\
\pi_{up}^{h,P} & \pi_{uu}^{h,P} & \pi_{ue}^{h,P}\widetilde{\Upsilon}_m^{h}(\varepsilon_1) & \pi_{ue}^{h,P}\widetilde{\Upsilon}_m^{h}(\varepsilon_2) & ... & \pi_{ue}^{h,P}\widetilde{\Upsilon}_m^{h}(\varepsilon_{N_\varepsilon}) \\
\pi_{ep}^{h,P} & \pi_{eu}^{h,P} & \pi_{ee}^{h,P}\pi_{11}^{h} & \pi_{ee}^{h,P}\pi_{12}^{h} & ... & \pi_{ee}^{h,P}\pi_{1N_\varepsilon}^{h} \\
\pi_{ep}^{h,P} & \pi_{eu}^{h,P} & \pi_{ee}^{h,P}\pi_{21}^{h} & \pi_{ee}^{h,P}\pi_{22}^{h} & ... & \pi_{ee}^{h,P}\pi_{2N_\varepsilon}^{h} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\pi_{ep}^{h,P} & \pi_{eu}^{h,P} & \pi_{ee}^{h,P}\pi_{N_\varepsilon 1}^{h} & \pi_{ee}^{h,P}\pi_{N_\varepsilon 2}^{h} & ... & \pi_{ee}^{h,P}\pi_{N_\varepsilon N_\varepsilon}^{h}
\end{pmatrix} \end{array}.
$$

Each period a man stays in prison with probability $\pi_{pp}^{h,P}$. Upon getting out of prison, he moves to unemployment with probability $\pi_{pu}^{h,P}$ or gets a job with labor market shock ε_j with probability $\pi_{pe}^{h,P}\widetilde{\Upsilon}_m^{h,P}(\varepsilon_j)$, where $\widetilde{\Upsilon}_m^{h,P}(\varepsilon)$ is the distribution of wage shocks facing men who leave prison for employment. Similarly, an unemployed man goes to prison with probability $\pi_{up}^{h,P}$ or finds a job with labor market shock ε_j with probability $\pi_{ue}^{h,P}\widetilde{\Upsilon}_m^{h}(\varepsilon_j)$, where $\widetilde{\Upsilon}_m^{h}(\varepsilon)$ is the distribution of wage shocks facing men who move from unemployment to employment. Finally, an employed man with current productivity shock ε_i goes to prison with probability $\pi_{ep}^{h,P}$ or becomes unemployed with probability $\pi_{eu}^{h,P}$. Otherwise, he moves to another labor market shock ε_j next period with probability $\pi_{ee}^{h,P}\pi_{ij}^{h}$. Men do not make a labor supply decision, whenever they are employed they supply a fixed number of hours, $\overline{n}_m^{r,v}$, and earn $\omega_m^{r,h}\overline{n}_m^{r,v}\varepsilon$.

2.2 Labor Market and Fertility Transitions for Women

Because women do not go to prison, they are either employed (e) or non-employed (u). Unlike men, women make a labor-force participation decision. We assume that each period a non-employed woman receives an opportunity to work with probability $\theta^{r,h}$ and decides whether to accept it. Each period an employed woman faces a probability $\delta^{r,h}$ of losing her job. Employed women who keep their jobs also decide whether to continue working. Employed women work for $\overline{n}_f^{r,v}$ hours. Like men, each period women receive a productivity shock ε. If a woman decides to work, her earnings are given by $\omega_f^{r,h}\overline{n}_f^{r,v}\varepsilon$. As long as a woman is employed, her productivity shock ε follows a Markov process denoted by $\Upsilon_f^{r,h}(\varepsilon'|\varepsilon)$. When a non-employed woman becomes employed, she draws a new productivity shock from $\widetilde{\Upsilon}_f^{r,h}(\varepsilon)$.

Working is costly for a woman and her family. If a woman does not work, then she (if she is single) or both she and her husband (if she is married) enjoy a utility benefit q. We assume that q is permanent and distributed among women according to $q \sim Q^r(q)$. Women draw q at the start of their lives. This captures additional heterogeneity in the labor force participation decisions of women.[15] The labor supply decision of a woman depends on her education level, her marital and fertility status, her husband's characteristics if she is married, her current labor market shock, as well as her value of staying at home.

A woman without a child ($K = 0$) has a child next period with probability $\pi_K^{r,h,v}$ and moves to $K = 1$. Each period a child leaves the home with probability ρ_K^r, and the mother moves to the empty nest state, $K = 2$, which is absorbing. For $v \in \{S, M\}$, we represent these transitions with

$$\mathcal{F}^{r,h,v}(K'|K) = \begin{cases} 1 & \text{with probability} & \pi_K^{r,h,v} & \text{if} & K = 0 \\ 0 & \text{with probability} & 1-\pi_K^{r,h,v} & \text{if} & K = 0 \\ 1 & \text{with probability} & 1-\rho_K^r & \text{if} & K = 1 \\ 2 & \text{with probability} & \rho_K^r & \text{if} & K = 1 \\ 2 & \text{with probability} & 1 & \text{if} & K = 2. \end{cases}$$

If a woman has a child, $K = 1$, and she works, then her household pays childcare costs,

[15] Guner, Kaygusuz and Ventura (2012, 2020) and Greenwood et al. (2016) follow a similar strategy to model labor force participation of women.

denoted by $d^{r,h,v}$.

2.3 Marriage and Divorce

There is a marriage market where non-incarcerated single men and single women of each race meet other single women and non-incarcerated single men of the same race. For ease of exposition, in what follows we suppress the race indicator with the understanding that the process takes place in both marriage markets. Let $S_m^{h_m}$ and $S_f^{h_f}$ be the measure of type-h_m non-incarcerated single men and type-h_f single women, respectively, and define $S_m = \sum_{h_m} S_m^{h_m}$ and $S_f = \sum_{h_f} S_f^{h_f}$. These measures are endogenous and depend on the fraction of individuals who choose to marry or divorce, as well as the measure of single men who are in prison.

Because the initial sex ratio for the black population, κ_0, is less than one, and because some men of both races are in prison, not all single women meet a single man. Let p_m and p_f be the probabilities that a single man and a single woman meet a single person, respectively. These probabilities are given by

$$p_m = \frac{\min\{S_m, S_f\}}{S_m} = \frac{S_m}{S_m} = 1,$$

and

$$p_f = \frac{\min\{S_m, S_f\}}{S_f} = \frac{S_m}{S_f} = \kappa < 1,$$

where κ is the aggregate sex ratio in the marriage market.

Given κ, for any h, there are measure S_m^h and κS_f^h of single men and women, respectively, in the marriage market who meet others with probability one. Let $p_m^{h_m,h_f}$ be the conditional probability that a man of type-h_m meets a single woman of type-h_f, and define $p_f^{h_f,h_m}$ similarly. We represent these probabilities with

$$\{p_m^{h_m,h_f}, p_f^{h_f,h_m}\}_{h_m,h_f} = \mu(\{S_m^h\}_{h_m}, \{\kappa S_f^h\}_{h_f}),$$

where μ is a matching function that maps the measure of single individuals into matching probabilities.

We construct the matching function μ in two stages. In the first stage, a fraction φ_m^h of each type-h man meets a woman with the same education. The measure of single men and women who are matched with their own type in the first stage is given by $\min\{\varphi_m^h S_m^h, \kappa S_f^h\}$. As a result, $S_m^h - \min\{\varphi_m^h S_m^h, \kappa S_f^h\}$ men and $\kappa S_f^h - \min\{\varphi_m^h S_m^h, \kappa S_f^h\}$ women are left unmatched. In the second stage, single people who remain meet each other randomly.[16]

Once a single man meets a single woman of type-h_f, he takes a random draw with respect to her other characteristics, q, K, ε_f, and λ_f. Let $\psi_f^S(q, K, \varepsilon_f, \lambda_f|h_f)$ be the distribution of type-h_f single women over $(q, K, \varepsilon_f, \lambda_f)$. Similarly a single woman who meets a single man of type-h_m takes a random draw with respect to λ_m, ε_m, and P. Let $\psi_m^S(\lambda_m, \varepsilon_m, P|h_m)$ be

[16]Fernandez and Rogerson (2001) and Fernandez, Knowles and Guner (2005) follow a similar strategy to generate positive assortative mating.

the distribution of single men over (λ_m,ε_m, P). We define $p_m^{h_m,h_f}$ and $p_f^{h_f,h_m}$, describe the construction of ψ_f^S and ψ_m^S, and define a stationary equilibrium in Appendix B.

Upon a meeting, a couple draws a permanent match quality, γ, with $\gamma \sim \Gamma^r(\gamma)$. Each period, couples also observe a transitory match quality shock, ϕ, with $\phi \sim \Theta^r(\phi)$. Along with γ and ϕ, individuals see their partner's permanent education and home value characteristics, i.e. h_f, h_m, and q, their labor market status λ, labor market shocks ε, as well as the man's prison history, P, and woman's fertility status, K. They observe these at *the start of a period*, and decide whether to marry. Once marriage decisions are made, labor market status, earnings and fertility shocks for *the current period* are realized, and agents, married and single, make consumption and labor supply decisions. People decide whether to marry based on the expected value of being married conditional on the information they have at the start of a period. A marriage is feasible if and only if both parties agree. We assume that getting married involves a one-time fixed consumption cost denoted by $\varkappa^r$, which can be interpreted as the costs of a wedding and merging households. We also assume that having a husband in prison implies a utility cost to his spouse of ζ^r for every period he is there, which represents the potential stigma, emotional toll, and travel and legal costs.

Similarly, each period, currently married couples decide whether to divorce. This decision is also made based on all available information at the start of the period. Divorce is unilateral, and if a couple decides to divorce, each party suffers a one-time utility cost, η^r. Note that given this information structure, a wife whose husband is incarcerated in a period can opt for divorce only at the start of the next period.

To sum up, there are several potential factors that can account for the racial-marriage gap in the model: First, black and white individuals differ in how they value marriage and divorce. Second, fewer black men are born into the model than black women, while the sex ratio of white men to white women is one. Third, black and white men and women have different distributions over educational attainment. Finally, transitions between wages when employed, between employment and unemployment for women, and between employment, unemployment and prison for men differ by race.

2.4 Welfare System and Taxes

There is a government that taxes households and runs transfer programs. Tax collection less transfers is treated as government expenditure. Income taxes are progressive. The government runs two transfer programs. First, each eligible household receives the Earned Income Tax Credit (EITC). The EITC, a fully-refundable tax credit, works as a wage subsidy for households who fall below a certain income level. Second, the government runs a transfer program, where each household below an income threshold receives a transfer from the government. Along with income, both taxes and transfers depend on marital status of a household and whether the household has children at home. For single men, single women, and married couples with income level Y and $K \in \{0, 1, 2\}$, total earned income credits and transfers are represented by $TR_m^S(Y)$, $TR_f^S(Y, K)$ and $TR^M(Y, K)$, respectively. Similarly, taxes are represented by $T_m^S(Y)$, $T_f^S(Y, K)$ and $T^M(Y, K)$.

3 Household Problems

We begin by developing the decision problems after all uncertainty in a period is realized and households are making their labor supply decisions. These value functions depend on current utility and the value of starting next period either single or married before the marriage market takes place and any uncertainty is realized. We define the start-of-the-period value functions in the next section. The within period (after the marriage choice and all uncertainty is realized) value functions are denoted as V, while the start of period (before the marriage market and any uncertainty is realized) value functions are denoted as $\widetilde{V}$. Because marriage markets are segmented by race, we do not indicate explicitly the race of an individual with the understanding that preferences; meeting probabilities; wage levels and transitions; hours worked; exogenous labor market and prison transitions for men; and arrival of employment opportunities, job destruction probabilities, and fertility shocks for women differ by race.

3.1 Single Women

Consider the problem of a single woman whose state is given by $\mathcal{S}_f^S = (h, q, K, \varepsilon)$ and employment status λ. If $\lambda = e$, she can choose to work $\overline{n}_f^S$. If $\lambda = u$, she is non-employed and does not have any labor income. A single woman's pre-tax labor income is given by $Y_f^S = \omega_f^h \overline{n}_f^S \varepsilon$, if she works and by $Y_f^S = 0$, if she does not. Given government transfers, her after tax-and-transfer income is $Y_f^S - T_f^S(Y_f^S, K) + TR_f^S(Y_f^S, K)$. If she works and $K = 1$, she must pay the childcare cost $d^{h,S}$. Finally, if she does not work, she enjoys the utility of staying home, q.

At the start of the next period, she enters the marriage market. The value of being in the marriage market at the start of the next period depends on her state, $\mathcal{S}_f^S$, and her updated employment status, λ'. This is denoted by the value function $\widetilde{V}_f^S(\mathcal{S}_f^S, \lambda')$. As it will become clear below, $\tilde{V}_f^S$ depends on the measure and distribution of single men and women that take part in the marriage market next period. Given $\widetilde{V}_f^S(\mathcal{S}_f^S, \lambda')$, the value of being a single woman in the current period is given by:

$$V_f^S(\mathcal{S}_f^S, \lambda) = \max_{n_f^S} \{ \frac{c^{1-\sigma}}{1-\sigma} + \chi_{(n_f^S=0)} q + \beta \widetilde{V}_f^S(\mathcal{S}_f^S, \lambda') \}, \tag{1}$$

subject to

$$c = \frac{1}{1 + \xi_2 \chi_{(K=1)}} \left[Y_f^S - T_f^S(Y_f^S, K) + TR_f^S(Y_f^S, K) - \chi_{(n_f^S \neq 0, K=1)} d^{h,S} \right] ,$$

and

$$n_f^S = \begin{cases} \in \{0, \overline{n}_f^S\} \text{ if } \lambda = e \\ 0 \text{ if } \lambda = u \end{cases} , \ \lambda' = \begin{cases} e \text{ if } n_f^S \neq 0 \\ u, \text{ otherwise} \end{cases} ,$$

where $0 \leq \xi_2 < 1$ captures economies of scale in households with children, χ_x is an indicator function, and Y_f^S is defined as above. A woman's labor market status at the start of next period, λ', is determined by her current labor market status, λ, and her labor supply decision this period. If $\lambda = u$, then $\lambda' = u$ as well. If $\lambda = e$ and she decides to work, then $\lambda' = e$, otherwise, $\lambda' = u$.

3.2 Single Men

A single man's state is given by $\mathcal{S}_m^S = (h, \lambda, \varepsilon)$ and his prison history indicator, P. A single man makes no decisions. If $\lambda = e$, he works $\overline{n}_m^S$ and earns pre-tax income $Y_m^S = \omega_m^h \overline{n}_m^S \varepsilon$. His consumption is then, $c = Y_m^S - T_m^S(Y_m^S) + TR_m^S(Y_m^S)$. If a man is unemployed, he does not work, $Y_m^S = 0$, and his only income comes from government transfers. Finally, when a man is in prison we assume that he consumes an exogenously given level of consumption c_p.[17] The value of being a single man in the current period, once uncertainty is realized, is given by

$$V_m^S(\mathcal{S}_m^S, P) = \frac{c^{1-\sigma}}{1-\sigma} + \beta \widetilde{V}_m^S(\mathcal{S}_m^S, P'), \tag{2}$$

subject to

$$c = \begin{cases} Y_m^S - T_m^S(Y_m^S) + TR_m^S(Y_m^S) \text{ if } \lambda \neq p \\ c_p \text{ if } \lambda = p \end{cases} \quad \text{and } P' = \begin{cases} 1 \text{ if } \lambda = p \\ P \text{ otherwise} \end{cases},$$

where Y_m^S is defined as above, and $\widetilde{V}_m^S(\mathcal{S}_m^S, P')$ is the value of starting next period as a single man, which will depend on the distribution of single women and men next period. If a man is in prison this period, $\lambda = p$, then next period P' is 1 (regardless of his prison history). Otherwise, $P' = P$ and his prison record is not updated.

3.3 Married Couples

The problem for a married couple, when all uncertainty is resolved, depends on their current state $\mathcal{S}^M = (h_f, q, K, \varepsilon_f; h_m, \lambda_m, \varepsilon_m; \gamma, \phi)$, which combines the characteristics of the wife, $(h_f, q, K, \varepsilon_f)$, those of the husband, $(h_m, \lambda_m, \varepsilon_m)$, and their match qualities γ and ϕ. It also depends on the wife's employment status, λ_f, and the husband's prison history indicator, P. We assume that a married household maximizes the weighted sum of their utilities, with exogenous weight on the woman given by ς.

The only decision a married couple makes is whether the wife works, and this is relevant only when she has the opportunity, $\lambda_f = e$. This decision, along with the husband's employment/prison status determines household pre-tax income, Y^M. If the wife works, she contributes, $\omega_f^{h_f} \overline{n}_f^M \varepsilon_f$. If the husband works, he contributes, $\omega_m^{h_m} \overline{n}_m^M \varepsilon_m$. Consumption for each household member is then given by

$$c_f = \frac{1}{1 + \xi_1 + \xi_2 \chi_{(K=1)}} (Y^M - T^M(Y^M, K) + TR^M(Y^M, K) - \chi_{new} \varkappa - \chi_{(n_f^M \neq 0, K=1)} d^{h_f, M}). \tag{3}$$

[17] Because we do not conduct any normative analysis and also do not finance c_p from taxes, its level does not matter for the quantitative analysis.

where both $\xi_1,\ \xi_2 \in [0,1)$ capture economies of scale in household consumption, and χ_{new} is an indicator function for a new marriage. If the husband is in prison then $\xi_1 = 0$, and the husband consumes c_p. Households suffer a utility cost ζ if the husband is in prison. Whenever the wife does not work, both wife and husband enjoy q, and if she does work and they have children, the household pays childcare costs $d^{h_f,M}$.

At the start of each period, a married couple decides whether to get divorced. Recall that couples make their marriage/divorce decisions after they observe the new value of the match quality, ϕ, but before their labor market and fertility statuses update. Let $\widetilde{V}_g^M(\mathcal{S}^M, \lambda'_f, P')$ for $g \in \{f, m\}$ be the value of being married at the start of the next period, with an option to divorce.

The problem of a married couple is

$$\max_{n_f^M}[\varsigma \frac{c_f^{1-\sigma}}{1-\sigma} + (1-\varsigma)\frac{c_m^{1-\sigma}}{1-\sigma} + \chi_{(n_f^M=0)}q - \chi_{(\lambda_m=p)}\zeta + \gamma + \phi \tag{4}$$
$$+\varsigma\beta E_{\phi'}\widetilde{V}_f^M(\mathcal{S}^M, \lambda'_f, P') + (1-\varsigma)\beta E_{\phi'}\widetilde{V}_m^M(\mathcal{S}^M, \lambda'_f, P')],$$

subject to Equation (3) and

$$c_m = \begin{cases} c_p, \text{ if } \lambda_m = p \\ c_f, \text{ otherwise} \end{cases}, n_f^M = \begin{cases} \in \{0, \overline{n}_f^M\} \text{ if } \lambda_f = e \\ 0 \text{ if } \lambda_f = u \end{cases},$$

$$P' = \begin{cases} 1 \text{ if } \lambda = p \\ P \text{ otherwise} \end{cases}, \text{ and } \lambda'_f = \begin{cases} e \text{ if } n_f^M \neq 0 \\ u, \text{ otherwise} \end{cases}.$$

As with single women, the labor market status of the wife at the start of next period is determined by her employment status and labor supply choice in the current period. The prison history indicator for the husband at the start of next period is updated if he has no prison history, but is currently in prison. Let the value functions for wives and husbands associated with the optimal solution to this problem be given by $V_f^{M,o}(\mathcal{S}^M, \lambda_f, P)$ and $V_m^{M,o}(\mathcal{S}^M, \lambda_f, P)$, for existing (old) marriages and by $V_f^{M,n}(\mathcal{S}^M, \lambda_f, P)$ and $V_m^{M,n}(\mathcal{S}^M, \lambda_f, P)$ for newly-formed marriages.

3.4 Start-of-the-Period Values

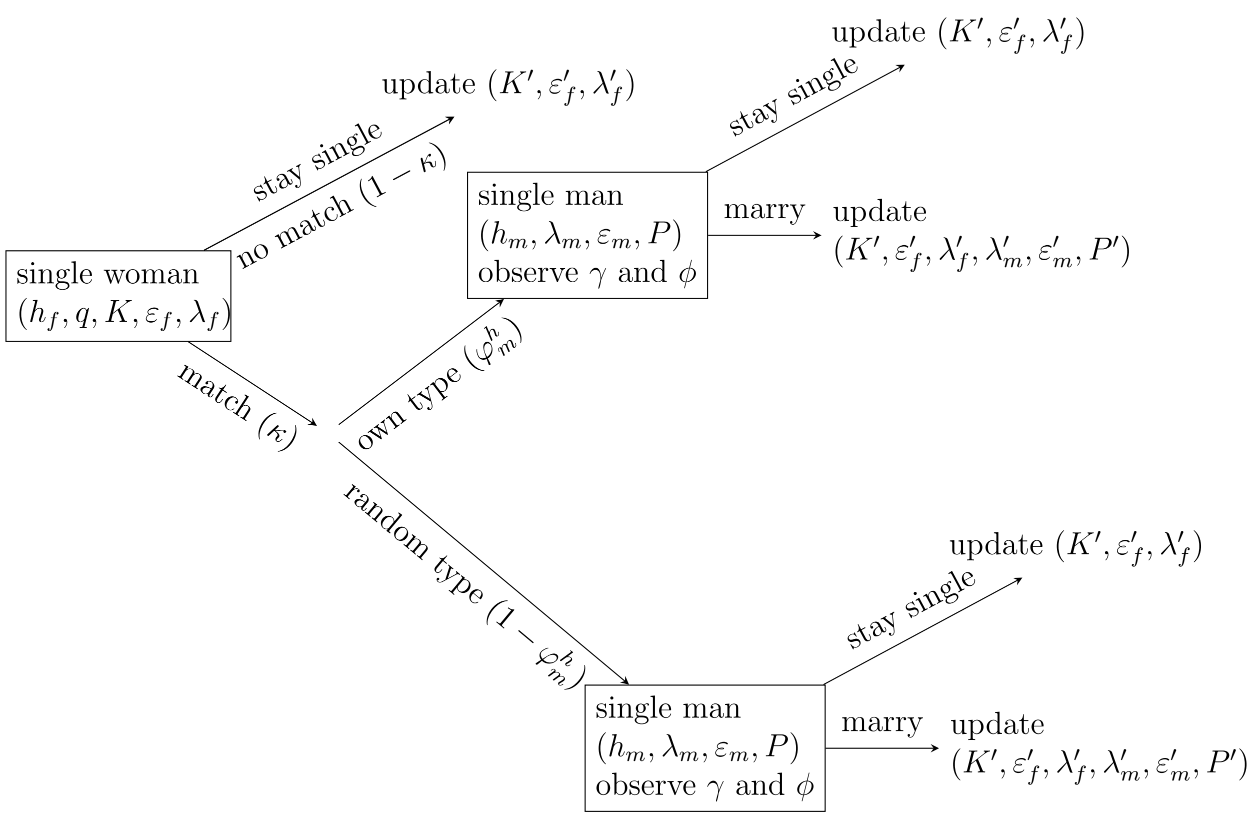
Consider now the value of being a single woman of type-h_f at the start of a period. This single woman meets no one with probability, $1-\kappa$, and meets a single man of type-h_m with probability $\kappa p_f^{h_f,h_m}$. If she meets a type-h_m man, she takes a draw from $\psi_m^S(\lambda_m, \varepsilon_m, P|h_m)$ and observes her match's start-of-the-period state, i.e. $\lambda_m \in \{e, u, p\}$, ε_m, and P. The pair draws γ (the permanent match quality) and ϕ (the transitory match quality). They then decide whether to marry. A marriage is only feasible if both parties agree.

Let $EV_f^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$ be the expected value of entering into this new marriage for a single woman *before* the fertility and labor market shocks (including prison status for men) are updated, and let the function $I_m(.)$ indicate whether this marriage is acceptable for the man. Her start-of-the-period value function is then given by:

$$\begin{aligned}
\widetilde{V}_f^S(h_f, q, K, \varepsilon_f, \lambda_f) \quad = \quad & (1-\kappa) EV_f^S(h_f, q, K, \varepsilon_f, \lambda_f) + \\
& \kappa \sum_{h_m} p_f^{h_f, h_m} \sum_{\lambda_m, \varepsilon_m, P, \gamma, \phi} \max\{EV_f^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \\
& I_m(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi), \\
& EV_f^S(h_f, q, K, \varepsilon_f, \lambda_f)\}\Gamma(\gamma)\Theta(\phi)\psi_m^S(\lambda_m, \varepsilon_m, P|h_m)\}. \qquad (5)
\end{aligned}$$

Figure 1 illustrates the decision tree behind the value function in Equation (5). The expected value of being single, $EV_f^S(h_f, q, K, \varepsilon_f, \lambda_f)$, depends on how her fertility, K, wage shocks, ε_f, and labor market status, λ_f, evolve. Similarly, the expected value of a new marriage to a type-$(h_m, \lambda_m, \varepsilon_m, P)$ man with match qualities γ and ϕ, $EV_f^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$, depends on how fertility, labor market status, prison history, and wage shocks for both parties evolve within the period. We detail these functions as well as the remaining start of period value functions, $\widetilde{V}_m^S, \widetilde{V}_f^M$, and $\widetilde{V}_m^M$ in Appendix A.

Figure 1: Decision tree for single women



4 Quantitative Analysis

In this section, we describe how we construct model inputs: distribution of population (by race, gender, education), wage levels and transitions (by race, gender, education), hours worked (by race, gender, marital status), fertility transitions (by race, mother's education, marital status), childcare costs (by race, mother's education, marital status), job loss and offer probabilities for women (by race, education), and transitions between employment, non-employment and prison for men (by race, education, prison history). We also present tax and transfer functions. Then, we discuss our estimation strategy. We leave the details to Appendix C. Appendix G provides further information on the data sets used in the analysis.

The quantitative analysis focuses on black and white non-Hispanics and non-immigrants between ages 25 and 54. We fit our model economy to US data around 2006. We assume that the model period is one year. There are four education levels: less than high school (<HS), high school (HS), some college (SC), and college and above (C).

Population, Wages and Hours

We use the 2006 US American Community Survey (ACS), downloaded from the Integrated Public Use Microdata Series (King 2010), to calculate the distribution of population across gender and education within each race. The ACS is also used to calculate wages ($\omega_g^{r,h}$) and hours worked ($\overline{n}_g^{r,v}$). In the benchmark economy, 88% of the population is white and 12% is black. Because men make up 46.5% of the black population, we assume that when individuals are born into the model economy, there are $\kappa_0 = 0.87 = 46.5/53.5$ black men for each black woman. There are roughly equal amounts of white men to white women.

White individuals are more educated than black individuals, and for both races, women are more educated than men. The college-education gap between black women and men is particularly striking. Of black women, 10.3% have a college degree, while only 6.5% of black men do. For men and women of all education levels, those who are white have higher average hourly wages than those who are black. Averaging across all individuals of each race, wages of black workers are 16% lower than those of white workers. While men on average earn more than women, the gender-wage gap is smaller among black men and women than it is among white men and women, 16% vs. 25%, respectively.Finally, white men tend to work more than black men, irrespective of marital status. On the other hand, while white single women work more than black single women, white married women work fewer hours than black married women.

Fertility and Children

Children are born exogenously in the model, but their arrival rates, denoted by $\pi_K^{r,h,v}$, depend on their mother's race, education and marital status. To discipline these probabilities, we use the ACS 2006 to find the fraction of women between ages 20-40 who have their first births in the past year by race, marital status and education. Averaging across all women, a single woman has a 6.6% chance of having a newborn, while the probability is 15% for those who are married. For both white and black women, these probabilities decline sharply with education, and single black women of all education levels have higher fertility rates than single white women.

In order to compute childcare costs, $d^{r,h,v}$, which in our model depend on mother's race, education and marital status, we use 2001, 2004, and 2008 waves of the Survey of Income and Program Participation (SIPP). We compute total annual expenditures for care provided for children aged 0-15 paid to childcare/daycare centers, relatives, and non-relatives. Additionally, for children aged 0-5 we include expenditures on preschool and head start, and for children aged 5-15 expenditures on clubs, lessons, after school care, and sports. The numbers reflect effective expenditure and capture differences in prices, quality, and access to informal care. On average, households spend 1.9% of mean household income on childcare, about $1,400. Expenditures tend to be increasing in education and are higher for married than single mothers. Conditional on education and marital status, white and black mothers spend very similar amounts.

4.1 Labor Market, Prison, and Wage Transitions

We construct the transition matrix between employment shocks, unemployment, and prison for men, $\Pi^{r,h,P}(\lambda', \varepsilon' | \lambda, \varepsilon)$, in three steps. First, let $\Lambda^{r,h,P}(\lambda' | \lambda)$ be the race, education and prison history dependent transition matrix, which determines how men move between employment, non-employment, and prison. Next, define a race and education dependent transition matrix for idiosyncratic productivity shocks ε, given by $\Upsilon_m^{r,h}(\varepsilon' | \varepsilon)$. Finally, we determine the race and education dependent wage distributions for men who move from non-employment into employment, $\widetilde{\Upsilon}_m^{r,h}(\cdot)$, and the race, education and prison history dependent wage distributions for men who move from prison to employment, $\widetilde{\Upsilon}_m^{r,h,P}(\cdot)$. Because women make a labor force participation decision and do not go to prison, we construct $\Upsilon_f^{r,h}(\varepsilon' | \varepsilon)$ and $\widetilde{\Upsilon}_f^{r,h}(\cdot)$.

In order to build $\Lambda^{r,h,P}(\lambda' | \lambda)$, we start with transitions between e (employment) and u (non-employment) for non-incarcerated men. Non-employment comprises both unemployment and out of the labor force. We calculate these transitions for the civilian population from the Merged Outgoing Rotation Group (MORG) of the Current Population Survey (CPS). We use data for 2000-2006 and compute average year-on-year transitions for the same month for 25-54 years old non-Hispanic black and white men that were born in the US. The resulting transition matrices are shown in Table 1. Later we adapt these transitions to take into account prison history.

Black men, in particular, those with less education, are more likely to lose their jobs and less likely to find one relative to equally educated white men. For men with less than high school education, a black man has a 15% probability of moving from employment to non-employment. The same probability is 8.9% for a white man. Similarly, a black man with less than a high school degree has a 15.7% chance of moving from non-employment to employment, while the same probability is 19.5% for a white man. The racial differences in job finding probabilities persist for men with a college degree: it is 35.4% for black men and 47.8% for white men.

Despite the large prison population, data on prison stocks and flows is scarce. The most

Table 1: Yearly employment transitions of men, 2000-2006

Education		Black		White	
		e	u	e	u
Less than high school	e	.850	.150	.911	.089
	u	.157	.843	.195	.805
High school	e	.897	.103	.947	.053
	u	.244	.756	.309	.691
Some college	e	.918	.082	.954	.046
	u	.328	.672	.368	.632
College	e	.950	.050	.975	.025
	u	.354	.646	.478	.522

Notes: The rows indicate the state in t and the columns in $t+1$. Each row for each race sums to one, i.e. conditional transitions are presented. The states are employed (e) and non-employed (u). The data comes from the MORG CPS 2000-2006.

detailed survey is the 2004 Survey of Inmates in State and Federal Correctional Facilities (SISCF), which is an extensive and representative survey of inmates providing a snapshot of the composition of prisoners at one point in time.[18] We restrict our sample to imprisoned men aged 25 and 54 who entered a state or federal prison within the past year before being surveyed. The average prisoner in our sample is about 36 years old, which contrasts with the common belief that the prison population is young. Appendix Figure G.1 shows that the age distribution of inmates is surprisingly flat between ages 20 and 50. The average education of inmates is low. In state prisons, for example, almost 90% of inmates have at most a high school degree. The average sentence length of inmates in our sample is about 6 years for those in state prisons, where the majority (86%) of prisoners is held, and about 9 years for those in federal prisons. We present the distribution of sentence lengths in Appendix Figure G.3. It is clear that black and white men in state prison have a similar distribution of sentence lengths. In federal prison, the sentence lengths tend to be longer than in state prison, and longer for black men than for white men. Finally, as can be seen in Appendix Figure G.4, the most common charges, in particular against black men, are related to illegal drugs.

In order to approximate transitions to prison, we follow Pettit and Western (2004). First, using the 2004 SISCF, we compute the fraction of prisoners between ages 25 and 54 who were admitted within the last 12 months for each level of education and race. Second, we multiply these shares by the total number of admissions to state and federal prisons in 2004, which we obtain from the Bureau of Justice Statistics (BJS). This step assumes the SISCF is representative of total admissions in 2004. Third, using the CPS and the number of people

[18] The data covers state and federal prisons but not jails, which generally hold individuals with sentences of less than one year.

for each race and level of education from the second step, we compute the fraction of a given race and level of education who were admitted to prison in 2004. The results are reported in Table 2, under the $(e, u \to p)$ panel. Black men are about five times more likely to transition into prison within each education category.

Table 2: Yearly probability of going to prison, men 25-54

	$e, u \to p$		$p \to e$		$p \to u$	
Education	Black	White	Black	White	Black	White
Less than high school	.085	.015	.358	.541	.642	.459
High school	.030	.007	.492	.492	.508	.508
Some college	.010	.002	.532	.67	.468	.33
College	.005	.001	.706	.452	.294	.548

Notes: The columns $p \to e$ and $p \to u$ indicate the probability of transitioning into employment (e) or non-employment (u) when leaving prison (p). The data source for columns $e, u \to p$ is the SISCF 2004, while for the remaining columns the data source is the NLSY.

These transitions-to-prison calculations have two shortcomings: First, we are not able to differentiate between transitions to prison from employment and unemployment. Second, we are not able to condition the transitions on whether an individual has ever been incarcerated. Furthermore, transitions between employment and non-employment found in Table 1 are also independent of prison histories.

To address these issues, we turn to the National Longitudinal Survey of Youth 1979 (NLSY). The individuals in the NLSY panel are followed even if they enter prison. As a result, we can calculate from the NLSY how the likelihood of going to prison differs between the employed and the non-employed, and between those with and without prior incarcerations. We then use these likelihood ratios to adjust the transitions to prison computed from the SISCF in Table 2.[19] Similarly, we calculate how transitions between employment and non-employment differ by prison history, and adjust the transitions between employment and non-employment from the CPS in Table 1. We report these likelihood ratios in Appendix Table C.4. Individuals with a prison history are less likely to keep their jobs, i.e. they have lower π_{ee}, and face higher transitions to prison, π_{ep} and π_{up}. For instance, for a black man with less than high school education the probability of keeping his job is almost 20% lower after having been to prison.

Next, we use the mean sentence length from the SISCF to calculate the probability an incarcerated man remains in prison, π_{pp}. The mean sentence length of men between ages 25 and 54 who were admitted to state prison in 2004 is around 6 years for both black and white men.[20] However, most sentences are not fully completed. According to the National

[19]We do not rely solely on the NLSY to compute prison transitions, because the resulting prison population would be much smaller than the one observed in aggregate data. Our assumption is that while the NLSY might not capture the level of prison transitions, it reflects differences in transitions by education and prison history.

[20]Small sample sizes complicate computing sentence lengths by level of education within racial groups. We investigate the robustness of our results to sentence lengths that are decreasing by education in Appendix F.1 and find that the results remain very similar.

Corrections Reporting Program from the BJS, the average share of sentence in terms of time served was 49% for men in 2004, which suggests that the average time spent in prison is 3 years.[21] Given that a model period is one year, the average prison stay is three model periods. Therefore, for both white and black men we set $\frac{1}{1-\pi_{pp}} = 3$ or $\pi_{pp} = 0.667$.

Finally, we again use the NLSY to split the probability of getting out of prison, $1-\pi_{pp}$, between employment and non-employment. We first compute the probability of transitions into employment or non-employment conditional on exiting prison in the NLSY. These probabilities are presented in the transition from prison to employment and non-employment columns ($p \to e$ and $p \to u$) in Table 2. For black men, the probability of transiting into employment is increasing in education from 0.358 for those with less than high school education to 0.706 for those with a college degree. For white men, no clear pattern is detectable with probabilities roughly around one half. We then multiply these probabilities by the probability of transiting out of prison, $1 - \pi_{pp} = 0.333$.

Wage Shocks

To construct the wage transition matrix, $\Upsilon_g^{r,h}(\varepsilon'|\varepsilon)$, we interpret ε as deviations from the race-gender-education specific mean, i.e. when $\varepsilon = 1$, the individual has the mean wage. We again use data from the Merged Outgoing Rotation Group (MORG) from the CPS for the years 2000-2006 to compute yearly earnings transition probabilities by race, gender and education level to construct transition matrices $\Upsilon_g^{r,h}(\varepsilon'|\varepsilon)$ for those who are employed. We also construct a productivity distribution by race, gender and education level for those who move from non-employment to employment and use this to determine $\widetilde{\Upsilon}_g^{r,h}(e)$. We assume that ε takes five values. These five levels represent wage changes, relative to the race-gender-education specific mean, that are more than -17.5%, between -17.5% and -5%, between -5% and 5%, between 5 and 17.5%, and more than 17.5%, respectively in the data. We then set $\varepsilon_1 = 0.75, \varepsilon_2 = 0.9, \varepsilon_3 = 0, \varepsilon_4 = 1.10, \varepsilon_5 = 1.25$.[22] Finally, we compute the wage shocks for men exiting prison into employment, $\widetilde{\Upsilon}_m^{r,P}(\varepsilon)$ using the NLSY. The wage transitions are presented in Appendix Tables C.5-C.8.

Combining Labor Market, Incarceration, and Wage Transitions

For men, we combine the estimates for employment transitions with transition probabilities in and out of prison in order to complete the labor market transition matrices between the three states, i.e. employed ($\lambda = e$), non-employed ($\lambda = u$), and prison ($\lambda = p$). We adjust this matrix according to likelihood ratios presented in Table C.4 in order to construct transitions for those that have not been to prison ($P = 0$) and those that have been to prison ($P = 1$). Finally, we incorporate the wage shocks for the employed. In Appendix C we present an example calculation and the full transition matrices for black and white men in Tables C.9 and C.10.

[21] See `http://www.bjs.gov/index.cfm?ty=pbdetail&iid=2056`.

[22] Given that for some categories we do not have large sample sizes, we drop the top and bottom 0.5% of observations within each year, degree, race, and gender in order to prevent outliers from affecting the wage bins.

Women who remain employed transit between wage shocks according to the race and education specific employment transition matrices, $\Upsilon_f^{r,h}$. Women with employment opportunities have the option to work or to be non-employed.

4.2 Government

Following Guner et al (2012, 2020), the average tax rate that a household with income level Y faces is given by:

$$T(Y) = \tau_1 + \tau_2 \log(Y/\overline{Y}), \tag{6}$$

where $\overline{Y}$ is mean household income. The total tax liabilities amount to $T(Y) \times Y \times \overline{Y}$. The parameters τ_1 and τ_2 depend on marital status and whether the household has children at home.

The government runs two transfer programs. The EITC, the largest federal means-tested income security program in the US (CBO 2019), is a fixed fraction of a family's earnings until earnings reach a certain threshold. It stays at this maximum level until earnings reach a second threshold. At this point, the credit starts to decline, so that beyond a certain earnings level the household does not receive anything. The maximum credit, income thresholds, and the rate at which the credit declines depend on the tax filing status of the household (married vs. single) as well as on the presence of children.

For transfers, we follow Guner, Rauh and Ventura (2021) and assume that the effective transfer functions are given by:

$$TR(Y/\overline{Y}) = \begin{cases} e^{\beta_1} e^{\beta_2 (Y/\overline{Y})} (Y/\overline{Y})^{\beta_3} & \text{if } Y/\overline{Y} > 0 \\ \beta_0 & \text{if } Y/\overline{Y} = 0 \end{cases}. \tag{7}$$

We use the 2004 wave of the SIPP to approximate a welfare schedule as a function of labor earnings, marital status and whether there are children in the household. The SIPP is a panel surveying households every three months that asks retrospective questions on the previous three months. We compute the average amount of welfare, unemployment benefits, and labor earnings corrected for inflation for each household. The welfare payments include unemployment benefits and the main means-tested programs (except Medicaid), namely Supplemental Social Security Income (SSSI), Temporary Assistance for Needy Families (TANF formerly AFDC), Supplemental Nutrition Assistance Program (SNAP formerly food stamps), Supplemental Nutrition Program for Women, Infants, and Children (WIC), and Housing Assistance.

4.3 Estimation Strategy

We select several parameters based on available evidence or set them to standard values in the literature. These parameters are listed in Table 3. Given that a model period is one year, we let the subjective discount factor β be 0.96, which is a standard value in macroeconomic studies (e.g., Prescott 1986). The risk aversion parameter σ is set to 2, again a standard value, and robustness with respect to this choice is presented in Section 6.1. All the targets for the estimation are calculated for individuals between ages 25 and 54, which corresponds to a lifespan of 30 years. We set $(1-\rho) = 1/30 = 0.033$. Using the OECD equivalence scale, we set $\xi_1 = 0.7$ and $\xi_2 = 0.3$, so that a second adult in a household consumes 30% less than the first one, and a child consumer 70% less.[23] We assume that husbands and wives have equal weights in the household, $\varsigma = 0.5$, and discuss the implications of allowing couples to decide on this weight in Section 6.1. Finally, $\kappa_0 = 0.87$, so that when individuals enter the economy there are 0.87 black men per black woman. This is the sex ratio for the black population between ages 25-54 (Appendix Table C.1).

Table 3: Parameter values (a priori information)

Parameter	Description	Value
β	Annual discount factor	0.96 (standard)
ρ	Annual survival probability	$1/(1-\rho) = 30$
σ	Constant relative risk aversion parameter	2 (standard)
ξ_1	Economies of scale (adult)	0.7 (OECD scale)
ξ_2	Economies of scale (child)	0.3 (OECD scale)
ς	Utility weight of women in household decision	0.5
κ_0	Initial sex ratio, black population	0.87 (ACS 2006)

Notes: Parameters chosen based on a priori information. See the text for further details.

In order to proceed with the estimation of the remaining parameters, we make a few functional form assumptions. We assume that the values of q are drawn from a Gamma distribution with parameters α_1^r and α_2^r, and set $\alpha_2^r = 1$.[24] We assume that both $\gamma \sim \Gamma(\gamma)$, the permanent match quality shock, and $\phi \sim \Theta(\phi)$, transitory match quality shock come from normal distributions with parameters $(\mu_\gamma^r, \sigma_\gamma^r)$ and $(\mu_\phi^r, \sigma_\phi^r)$ with $\mu_\phi^r = 0$.

Finally, we introduce one more parameter for each race, $\mathcal{K}^r$, that scales the probabilities of birth, $\pi_K^{r,h,v}$, found in Table C.11. We choose these parameters to match the fraction of black and white women with children in the household in the model economy. Because the model is stationary by construction, while the data is not, taking transitions from Table C.11 will not necessarily imply the right fraction of women with children at different ages. By scaling transitions up or down, this parameter together with the probability with which children leave the household, ρ_K^r, provide us with additional flexibility to match the number of women with children.

With these assumptions, we have 21 parameters for each race (recall that there are four levels of education, h):

$$\{ \underbrace{\sigma_\phi, \mu_\gamma, \sigma_\gamma, \alpha_1}_{\text{heterogeneity-shocks}}, \underbrace{\varkappa, \eta, \zeta, \varphi_m^h}_{\text{marriage}}, \underbrace{\mathcal{K}, \rho_K}_{\text{fertility}}, \underbrace{\theta^h, \delta^h}_{\text{women's labor market}} \}.$$

In the model economy, a non-employed women with education h gets a job offer with probability $\theta^{r,h}$ and decides whether to accept it. Similarly, an employed women with education h loses her job with probability $\delta^{r,h}$. A woman who gets an offer can still choose not

[23]See http://www.oecd.org/els/soc/OECD-Note-EquivalenceScales.pdf.

[24]Hence, $q \sim Q(q) \equiv q^{\alpha_1 - 1}\frac{\exp(-q/\alpha_2)}{G(\alpha_1)\alpha_2^{\alpha_1}}$, where $G(\alpha_1)$ represents the Gamma function.

to work, so the $\theta^{r,h}$ parameters can differ from unemployment to employment transitions in the model. A woman might also quit her job and become non-employed even if her job is not destroyed by the exogenous shock, $\delta^{r,h}$. Single women are much less likely to decline job offers or quit their jobs than married women, because they have no other household labor income to fall back on. Therefore, we set parameters $(\theta^{r,h}, \delta^{r,h})$ directly to the unemployment to employment, and employment to unemployment transitions of single women between ages 25 and 54 by race and education, using the CPS MORG for the years 2000-2006. These eight parameters for each race are displayed in Table 4.

Table 4: Calibrated parameters

(labor market transitions, women)

	Job arrival θ		Job destruction δ	
Education	Black	White	Black	White
Less than high school	.16	.15	.20	.15
High school	.24	.24	.12	.08
Some college	.32	.30	.10	.07
College	.51	.48	.04	.04

Notes: The displayed parameters are set outside the model to match data moments for single women presented in Table 9. The data moments come from the CPS MORG 2000-2006.

The remaining 13 parameters for each race, $\mathbf{\Theta} = \{\sigma_\phi, \mu_\gamma, \sigma_\gamma, \alpha_1, \varkappa, \eta, \zeta, \varphi_m^h, \mathcal{K}, \rho_K\}$, are chosen to match the following set of moments by race:

1. Marital status of population by gender, and education level (Table 5; 8 moments).
2. Fraction of women married by ages 20, 25, 30, 35, and 40 (top panel of Table 6; 5 moments).
3. Fraction of marriages that last 1, 3, 5, and 10 years (bottom panel of Table 6; 4 moments).
4. Fraction of marriages with own education level (Table 7; 4 moments).
5. The share of women at ages 25, 30, 35, 40, and 45 that have a child in their household (Table 8; 5 moments).
6. Labor market and prison status by education and marital status for men, and employment/unemployment transitions by education level for married women (Table 9, 24 moments).

Let $\mathbf{M}$ represent the vector of these 50 moments for a given race. A vector of the analogous 50 moments can be obtained from the steady state of the model.[25] The moments for the

[25]Although marriage markets are separate for each race, we compute average household income for the entire economy. Therefore, we first guess an average household income for the economy, then solve the estimation problem separately by race, update the mean household income and repeat the process as necessary.

model are a function of the parameters to be estimated. Let $\mathcal{M}(\mathbf{\Theta})$ represent this vector of moments, where $\mathbf{\Theta}$ denotes the vector of 13 parameters to be estimated. Define the vector of deviations between the data and the model by $\mathbf{G}(\mathbf{\Theta}) \equiv \mathbf{M} - \mathcal{M}(\mathbf{\Theta})$. Minimum-distance estimation picks the parameter vector, $\mathbf{\Theta}$, to minimize the sum of the squared deviations between the data and the model, i.e.,

$$\widehat{\mathbf{\Theta}} = \arg\min \mathbf{G}(\mathbf{\Theta})'\mathbf{W}\mathbf{G}(\mathbf{\Theta}). \tag{8}$$

The estimated parameter vector $\widehat{\mathbf{\Theta}}$ is consistent for any semi-definite matrix $\mathbf{W}$. All our moments are either fractions of populations or probabilities, and are therefore between 0 and 1. We set the diagonal of the weighting matrix $\mathbf{W}$ to the inverse of the variance of each moment and the off-diagonal terms to zero. As a consequence, all targets enter into the minimization independent of the units by which they are measured. Furthermore, more precisely estimated moments receive greater weight in the minimization.

The estimation procedure operates under the assumption that the model is correctly specified. In other words, let $\mathbf{\Theta}_0$ denote the true parameter vector, and let $\mathbf{M}_0$ denote the population moments obtained from the data generating process. Then, $\mathbf{G}(\mathbf{\Theta}_0) \equiv \mathbf{M}_0 - \mathcal{M}(\mathbf{\Theta}_0) = 0$. Because we do not observe $\mathbf{M}_0$, we use $\mathbf{M}$ in the estimation, which introduces sampling error. Thus, we compute standard errors that take into account this source of error. The variance-covariance matrix for $\widehat{\mathbf{\Theta}}$ is consistently estimated as

$$var(\widehat{\mathbf{\Theta}}) = \left[D(\widehat{\mathbf{\Theta}})'\mathbf{W}D(\widehat{\mathbf{\Theta}})\right]^{-1} D(\widehat{\mathbf{\Theta}})'\mathbf{W}\widehat{\mathbf{Q}}\mathbf{W}D(\widehat{\mathbf{\Theta}}) \left[D(\widehat{\mathbf{\Theta}})'\mathbf{W}D(\widehat{\mathbf{\Theta}})\right]^{-1}, \tag{9}$$

where $D(\widehat{\mathbf{\Theta}})$ is a matrix of partial derivatives of the moments included in $\mathcal{M}(\mathbf{\Theta})$ with respect to the parameters included in $\mathbf{\Theta}$. The matrix $\widehat{\mathbf{Q}}$ is an estimate of the variance-covariance matrix of the moments in the data.[26]

5 Benchmark Economy

Tables 5 to 9 compare the model and the data. We start with marriage and divorce patterns. Table 5 shows the share of married individuals in the population. At any education level, white men and women are more likely to be married than their black counterparts. Overall, the model generates a racial-marriage gap of 27 percentage points for women, 37% vs. 64%, and 21 percentage points for men, 43% vs. 64%. While for men, the model gap is only one percentage point smaller than the gap observed in the data, for women the gap in the data is three percentage points larger. If we consider ever married instead of currently married women, the model performs better. The racial gap among ever married women is 27 percentage points in the data and 25 percentage points in the model.

In the model, as in the data, the fraction of married individuals increases with education for both races. The education-marriage gradient is generally steeper in the model than it is in the data, especially for black men. In the data and in the model, the education-marriage

[26] Our procedure follows, among others, Lee and Wolpin (2006) and Llull (2018). Further details are provided in Appendix D.

gradient is steeper for black women than white women. As a result, the racial-marriage gap for women falls with educational attainment.

Table 5: Fraction married – model vs. (data)

Education	Black	White
Women		
Less than high school	.21 (.21)	.56 (.53)
High school	.35 (.31)	.62 (.65)
Some college	.39 (.35)	.63 (.65)
College	.47 (.42)	.68 (.68)
All*	.37 (.34)	.64 (.64)
Men		
Less than high school	.13 (.25)	.48 (.48)
High school	.39 (.38)	.59 (.58)
Some college	.57 (.47)	.68 (.62)
College	.62 (.53)	.70 (.69)
All*	.43 (.40)	.64 (.62)

Notes: Each entry shows the fraction of married population conditional on education and race in the model and data. Moments denoted by "*" are not targeted directly in the estimation. The shares of married individuals aged 25-54 in the data come from the ACS 2006. The data targets are in parenthesis.

Next, we turn to entry into and exit from marriage. Panel A of Table 6 shows the probability of first marriage for black and white women by a given age in the model and in the data. In the data, 74% of white women are married by age 30, compared to only 47% of black women, a gap of 27 percentage points. The gap is persistent and remains up to age 40. The model does well matching these statistics. Panel B of Table 6 contains the probability that a marriage remains intact after a certain number of years. Black marriages on average dissolve at a faster rate, although racial differences in marital dissolutions are less pronounced than racial differences in entry into marriage. The model generally replicates the divorce dynamics that are observed in the data. It does a better job matching marriage duration for white women than for black women, because for black women these data moments are less precisely measured.

Table 7 shows the fraction of married men marrying women of the same education type. The model only has difficulty reproducing one of the observed patterns of assortative mating, the measure of black men without high school degrees married to black women without high school degrees. Very few black men are married, and therefore the precision and hence the weight on this moment in the estimation is low.

The top panel of Table 8 contains the fraction of women with children. Black women are more likely to have children at younger ages; in the model 50% of black women have a child at home at age 25, while fewer than 39% of white women do. At around age 35, black and white women are equally likely to have at least one child at home. After age 35, as children start leaving home, white women, who had their children later, are more likely to still have

Table 6: Marriage dynamics for women – model vs. (data)

Panel A: First marriage by a given age

Married by age	20	25	30	35	40
Black	.04 (.05)	.25 (.24)	.41 (.47)	.55 (.58)	.65 (.64)
White	.11 (.14)	.50 (.48)	.72 (.74)	.84 (.84)	.91 (.89)

Panel B: Marriages intact after given number of years years

Duration in years	1	3	5	10
Black	.80 (.92)	.62 (.81)	.55 (.73)	.46 (.51)
White	.92 (.95)	.79 (.86)	.70 (.78)	.58 (.64)

Notes: The data entries in the upper panel show the probability of first marriage in the 2006-2010 National Survey of Family Growth. Source: Copen et al (2012, Table 3). For the model, we compute how long it takes for women in a new birth cohort to marry. The data entries in the lower panel show the probability that a first marriage will remain intact (survive) at specified durations in the 2002 National Survey of Family Growth. Source: Goodwin et al (2010, Table 16). For the model, the numbers refer to the fraction of all marriages that last for at least a given number of years. The data targets are in parenthesis.

Table 7: Educational homogamy – model vs. (data)

Education	Black	White
Less than high school	.06 (.24)	.28 (.27)
High school	.53 (.53)	.55 (.55)
Some college	.45 (.45)	.39 (.39)
College	.63 (.63)	.68 (.68)

Notes: Each entry is the fraction of married men married to women with the same education type. The shares of men married to own education type conditional on being married aged 25-54 in the data come from the ACS 2006. The data targets are in parenthesis.

children at home.

Table 9 contains the data and model moments on employment, non-employment and prison status for men and on employment transitions for women by race, marital status, and education. Men do not make a labor supply decision in the model, and the transition matrix between employment states is exogenously given. Yet, because marriage decisions are endogenous, the model works to match the joint distribution of marital and labor market states. A key result in Table 9 is that the model is able to generate black men with less than a high school degree or with a high school degree who are married and in prison. A single-black man without a high school degree faces bleak labor market prospects: 40% are non-employed and 27% are in prison in the model. In the data these numbers are 43% and 28%, respectively.

For women, we focus on the probabilities of staying employed, $\pi_{ee}^{r,h}$, and non-employed, $\pi_{uu}^{r,h}$. As noted above, we use the observed values of $1 - \pi_{uu}^{r,h}$ and $1 - \pi_{ee}^{r,h}$ for single women

Table 8: Women with children – model vs. (data)

	Age				
Age	25	30	35	40	45
Black	.50 (.50)	.65 (.62)	.69 (.73)	.67 (.69)	.63 (.60)
White	.39 (.35)	.59 (.58)	.68 (.73)	.70 (.73)	.68 (.64)

Notes: The data entries show the fraction of women with children, under age 18, in their household. The shares of women in the data come from the ACS 2008. The data targets are in parenthesis.

to select the probability of finding, $\theta^{r,h}$, and losing a job, $\delta^{r,h}$ (which are indicated with bold numbers in Table 9). For single women, who almost always accept a job opportunity and almost never quit a job, the differences between $\theta^{r,h}$ and $\delta^{r,h}$ and the resulting transitions are negligible. The situation is different for white married women, for whom there is an active extensive labor supply decision. Note that we estimate no utility benefit of staying home for black women. As Table 9 shows, married white women generally are more likely to stay non-employed than their single counterparts, and the model captures this. This is not surprising, because married women can be more selective with job opportunities as they are able to rely on their husband's income. This difference is smaller for less educated/lower-income households. The model also does well replicating employment to employment transitions. In the data and in the model, more-educated single white women are more likely to stay employed than their married counterparts. While only targeting the labor flows of women in our estimation, Appendix Table C.16 shows the patterns of employment by marital status as seen in the data. White-married women are less likely to be employed than white-single women, and the reverse is true for black women; in the model 79% of single-white women and 78% of married-white women work, while 69% of single-black women and 76% of married-black women work.

5.1 Estimated Parameters

Table 10 contains the estimated parameters and standard errors. In the model, the permanent match quality, γ, primarily impacts entry into marriage. The distribution for the black population has a lower mean (-3.66 vs. -3.53) and a smaller variance (5.45 vs. 18.84). As a result, many matches do not result in marriages. Once a marriage is formed, the transitory match quality shocks also have a greater variance for white couples (12.85) than black couples (4.74). For both groups the divorce cost, η, converges to zero in the estimation. Black women face a lower utility cost of having a husband in prison, which in relative terms generates a larger fraction of black men who are married and in prison.[27] The estimates for the monetary cost of a new marriage, $\varkappa$, is quite small (about 8.6% of mean household income for black couples and 6.6% for white couples). The estimation sets the value of staying home, q, to zero for black women, i.e., in the absence of welfare transfers, black women

[27] Abstracting from other components of the utility function, a black woman with average consumption would be willing to give 94.6% of her consumption to keep her husband from prison. The consumption factor is 99.8% for white women.

Table 9: Labor market and marital status – model vs. (data)

Black							
Educ.	Marital st.	Men (stock)			Women (transition)	
		e	u	p	ee	uu
<HS	Single	.32 (.29)	.40 (.43)	.27 (.28)	.80 (**.80**)	.84 (**.84**)
	Married	.65 (.57)	.31 (.29)	.05 (.14)	.80 (.83)	.84 (.86)
HS	Single	.55 (.56)	.30 (.32)	.16 (.12)	.88 (**.88**)	.76 (**.76**)
	Married	.74 (.78)	.24 (.18)	.02 (.04)	.88 (.91)	.76 (.71)
SC	Single	.73 (.71)	.22 (.22)	.06 (.07)	.90 (**.90**)	.68 (**.68**)
	Married	.82 (.85)	.17 (.13)	.01 (.02)	.90 (.90)	.68 (.70)
C	Single	.84 (.82)	.13 (.16)	.03 (.02)	.96 (**.96**)	.49 (**.49**)
	Married	.88 (.92)	.12 (.07)	.01 (.01)	.96 (.95)	.49 (.65)
White						
Educ.	Marital st.	Men (stock)			Women (transition)	
		e	u	p	ee	uu
<HS	Single	.57 (.54)	.34 (.38)	.09 (.08)	.85 (**.85**)	.85 (**.85**)
	Married	.74 (.75)	.25 (.23)	.01 (.02)	.85 (.86)	.86 (.84)
HS	Single	.75 (.74)	.18 (.22)	.07 (.04)	.92 (**.92**)	.76 (**.76**)
	Married	.87 (.90)	.12 (.10)	.00 (.00)	.92 (.91)	.77 (.79)
SC	Single	.88 (.82)	.12 (.17)	.01 (.01)	.93 (**.93**)	.70 (**.70**)
	Married	.91 (.92)	.09 (.07)	.00 (.01)	.92 (.92)	.72 (.76)
C	Single	.95 (.89)	.05 (.11)	.00 (.00)	.96 (**.96**)	.52 (**.52**)
	Married	.95 (.96)	.05 (.04)	.00 (.00)	.93 (.95)	.63 (.75)

Notes: Each entry in bold is matched by construction, i.e. by choosing the job arrival and destruction rate outside the model. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C). The data for the labor market status of men comes from the ACS 2006 and for transitions for women from the CPS MORG 2000-2006. The data targets are in parenthesis.

would always work whenever they have an opportunity to do so.

Given our estimation strategy, it is not possible to associate individual parameters in $\mathbf{\Theta}$ with individual statistics in $\mathcal{M}(\mathbf{\Theta})$. Yet, particular targets play relatively more important roles in identifying certain parameters. To illustrate how different parameters are determined, we focus on $\{\sigma_\phi, \mu_\gamma, \sigma_\gamma, \alpha_1, \varkappa, \eta, \zeta, \varphi_m^h\}$, and simulate the benchmark economy increasing each parameter by half of its standard deviation while keeping all other parameters at their benchmark values.[28] We then consider how much each moment in Tables 5-9 changes. If a target is particularly helpful in identifying a given parameter, then changes in that parameter generate a larger change in the corresponding target. The results are presented in Figures E.1-E.10 in Appendix E. In a nutshell, match-quality-shock parameters are determined by entry into and exit from marriage, and the marital status of the population. The parameter that determines the value of staying at home for women has a direct impact

[28]To streamline the analysis, we set aside ρ_K and $\mathcal{K}$ as they mechanically impact fertility moments.

Table 10: Estimated parameters

Parameters	Description	Black		White	
		Value	SE	Value	SE
σ_ϕ	Standard deviation of transitory match quality shock	4.74	0.43	12.85	1.37
μ_γ	Mean of permanent match quality shock	-3.66	0.27	–3.53	0.43
σ_γ	Standard deviation of permanent match quality shock	5.45	0.25	18.84	2.39
α_1	Shape parameter of the distribution for stay-home utility q	0	-	0.77	0.01
$\varkappa$	Monetary fixed cost of getting married	0.03	0.00	0.04	0.00
η	Utility cost of divorce	0	-	0	-
ζ	Utility cost of having husband in prison	44.06	3.30	979.22	211.14
$\varphi_m^{<HS}$	Probability of man meeting own type (<HS)	0	-	0.27	0.01
φ_m^{HS}	Probability of man meeting own type (HS)	0.10	0.02	0.28	0.01
φ_m^{SC}	Probability of man meeting own type (SC)	0.22	0.01	0.03	0.01
φ_m^{C}	Probability of man meeting own type (C)	0.54	0.01	0.54	0.00
$\mathcal{K}$	Scale factor for fertility	1.35	0.04	1.27	0.02
ρ_K	Probability of kids leaving home in a period	0.02	0.00	0.02	0.00

Notes: The parameters are estimated using the simulated method of moments. The column 'SE' presents the standard errors computed using the delta method. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C). $\varphi_m^{<HS}$, η, and α_1 for the black population and α_1 for the white population are set to zero as they hit this lower bound in the estimation.

on labor market transitions for women. The fixed consumption cost of entry into marriage allows us to match how marital status changes by education, because marriage is relatively more costly for poorer (less educated) individuals. The utility cost of having a husband in prison affects the fraction of married households with an incarcerated husband and the share of low educated men married. Finally, the probabilities that single men meet women with the same education determine assortative mating by education type.

5.2 Prison and Marriage - Model vs. Micro Evidence

In the benchmark economy, prison transitions are critical for generating racial differences in marriage and labor supply behavior in line with the data. When we eliminate these differences, two things happen. There are fewer black men in prison, and black men face a lower risk of future incarceration, both of which result in more marriages. A natural question is whether the model-implied relationship between incarceration and marriage is consistent with available data. We turn to cross-state evidence in the US and micro studies that exploit this variation to address this.

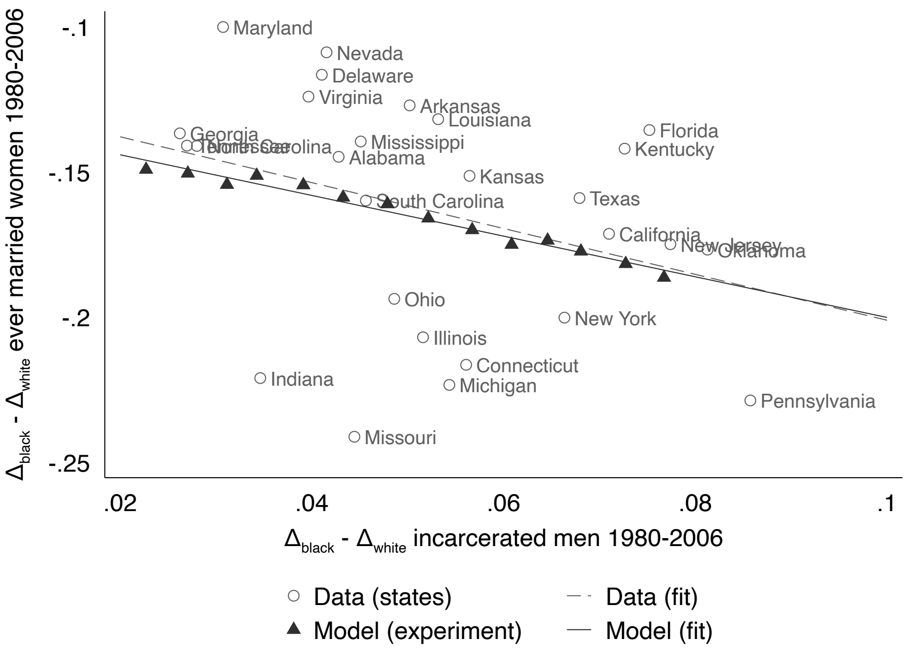
The horizontal axis of Figure 2 reports the increase in incarceration rates of black men relative to white men between 1980 and 2006 across US states. The vertical axis shows the decline in the fraction of ever married black women, again relative to white women, during the same period. Each dot in the figure represents a state, and in every US state during this period the increase in the incarceration of back men was higher than white men, while the decline in the fraction of ever married black women was larger than white women. In Pennsylvania, for instance, the incarceration rate of black men relative to white men increased by more than 8 percentage points. At the same time, the likelihood of ever being married for black women relative to white women fell by around 23 percentage points. There is a strong negative relationship between incarceration and marriage.

To construct this elasticity in our model, we conduct the following experiment. We decrease the probabilities of going to prison for black and white men, i.e. we reduce the parameters π^r_{ep} and π^r_{up}in small percentage steps, and for each new value of π^r_{ep} and π^r_{up}, we recalculate $\Lambda^r(\lambda'|\lambda)$ and solve our model economy (keeping all other parameters fixed). This procedure implies a series of counterfactual levels of marriage. In the data, we take the difference in differences between black and white individuals in 1980 and 2006 across US states, whereas for the model we take the difference in differences between black and white individuals in the benchmark model versus the outcomes that result from the stepwise reductions in π^r_{ep} and π^r_{up}.

The model relationships are represented by triangles in Figure 2. The dashed line is the regression line from the data, which has a slope of -0.79, i.e. a one percentage point increase in incarceration of men is associated with a 0.79 percentage point decline in women ever marrying.[29] The solid line has the model-implied elasticity of -0.70. Hence, the model-implied elasticity of marriage decisions with respect to incarceration is very close to the one we obtain from cross-state variation. As a non-targeted moment that exploits a very different source of variation in the data, this provides further support for our estimates.

[29]This estimate is comparable to the elasticity of -1.1 identified by Charles and Luoh (2010, Table 1), who exploit variation across time and US states in the number of incarcerated black men.

Figure 2: Black-white differences in changes in incarceration vs. marriage (model vs. data)



Notes: The x-axis shows the difference-in-difference of black and white men in the incarceration rate. The y-axis shows the difference-in-difference in ever married black and white women. The dashed line represents the elasticity implied by the data looking at the difference-in-difference from the ACS 1980 and 2006. The sample includes states with at least 5% black population. The solid line is the elasticity implied by the model obtained from simulating the model while reducing the probabilities of going to prison for black and white men in 5% steps. Each triangle is a simulated difference-in-difference from one of the 5% reduction steps in probabilities going to prison. The level, but not the slope, of the simulated difference-in-difference has been shifted to the data implied elasticity in the figure for the sake of comparison.

6 Understanding the Racial-Marriage Gap

We next analyze how much of the racial-marriage gap can be accounted for by the different elements in the Wilson hypothesis separately from differences in preferences. In particular, we focus on the role of i) differences in the sex-ratio, ii) differences in job loss and job finding probabilities, iii) differences in the probability of going to prison, and iv) different preferences for marriage. To do this, we build a sequence of counterfactual economies where we assign the appropriate inputs in the model for the white population to the black population.

In our first set of experiments, we turn to the Wilson Hypothesis, which posits that the low rates of marriage among the black population are driven by a skewed sex ratio and higher rates of incarceration and unemployment of black men. The racial-marriage gap in the model that is not generated by differences in terms of preferences or education arises due to both differential meeting probabilities and propensities to marry given a meeting. The first column of Table 11 reproduces the measures of married black women and men by education in the benchmark economy, together with all married black women, which is our main focus. The last column reproduces the same measures for white women and men. In the remaining columns, we illustrate the impact of various counterfactuals. The last two rows present the share of the gap closed and its 90% confidence interval, which is simulated by drawing parameters 100 times from the estimated variance-covariance matrix computed using the delta method.[30]

We start by examining differences in meeting opportunities, which are generated in the model through two forces. First, the exogenously given sex ratio for the black population implies that there are more single-black women than single-black men. Second, more black than white men are in prison, and out of the marriage market. In any period, 3% of single-white men and 13% of single-black men are in prison. The probability that a single woman meets a single man is the measure of single women less the measure of men missing due to incarceration and sex ratio imbalances divided by the measure of single women. With an equal sex ratio and no men in prison, this probability is one. With fewer men than women, the probability a single woman meets a potential husband is decreasing in the measure of missing men and the measure of marriages. In the extreme case, if all men are married, there is no one left for the remaining single women to meet. In the benchmark economy, the sex ratio differences alone imply the average single-black woman has a 79% chance of meeting a potential match. Adding the prison population to the number of missing black men, this chance declines to 67%. For the average single-white women, who is only impacted by the population of single-white men in prison, this chance is 97%.

Not meeting a potential mate is just one piece of the story. Conditional on meeting a man, black women have a 7% chance of marrying, while white women have a 12% chance. These differences reflect higher incarceration and unemployment probabilities along with a greater preponderance of prison histories for black men. Men, white or black, with a prison

[30]The procedure follows Krinsky and Robb (1986). We assume that our parameters come from a multivariate normal distribution with means as reported in Table 10 and with the estimated variance-covariance matrix from Equation (9). We take 100 draws from this multivariate normal distribution, and for each draw, i.e. for each set of parameters, compute the benchmark economy, run each of the experiments in Table 2 and compute the percentage of the marriage gap explained.

history are heavily penalized in the marriage market. Single, white men with a prison history have a 0.2% chance of marrying, while those without a prison history have a 13% chance. For single, black men these numbers are 2% and 10%. Because black women are more likely to meet a man with a prison history, they are less likely to begin marriages with those whom they meet.

Table 11: Accounting for the black-white marriage gap

			Fraction married						
			A	B	C	D	E	F	
Sex	Educ.	Black BM	Sex ratio	Employ-ment	Job loss	Prison	Wilson	Prefer-ences	White BM
W	<HS	.21	.26	.32	.30	.27	.50	.28	.56
	HS	.35	.41	.38	.37	.47	.57	.32	.62
	SC	.39	.45	.41	.41	.51	.59	.40	.63
	C	.47	.51	.48	.48	.56	.62	.54	.68
	All	.37	.42	.40	.40	.48	.58	.38	.64
M	<HS	.13	.12	.17	.16	.39	.45	.02	.48
	HS	.39	.39	.44	.43	.53	.56	.39	.59
	SC	.57	.56	.59	.58	.63	.64	.64	.68
	C	.62	.62	.64	.63	.66	.66	.69	.70
$\Delta^f_{b,w}$ accounted for			.193	.119	.091	.402	.780	.032	
90% CI			[.185, .194]	[.116, .123]	[.089, .096]	[.392, .406]	[.768, .783]	[.012, .062]	

Notes: The top panel refers to women (W) and the bottom to men (M). The first column 'black BM' and last column 'white BM' are the fractions of black and white populations that are married in the benchmark economy. The remaining columns are the marriage rates under counterfactual scenarios. In column A, we equalize the sex ratio; in column B, we assign employment transitions, i.e. both job loss and job finding probabilities, of white men to black men; in column C, we assign only the job loss probabilities of white men to black men; and in column D, we assign the likelihoods of going to prison of white men to black men. In column E, we combine the exercises of columns A, B, and D. Column F contains the marriage rates under the counterfactual scenario assigning parameters from the white population to the black population. We assign marriage taste parameters μ_γ, σ_γ, σ_ϕ, home benefit α_1, marriage cost $\varkappa$, and prison cost ζ. The row $\Delta^f_{b,w}$ presents the share of the racial-marriage gap accounted for by each experiment. The last row shows the 90% confidence interval of the share of the gap closed simulated by drawing parameters 100 times from the estimated variance-covariance matrix computed using the delta method.

Our first exercise is to set the sex ratio equal to one for black men and women, see column A of Table 11. Doing so increases the measures of married, black women at all education levels. The increase is driven by the meeting probabilities of black women rising from 67% in the benchmark to 85%. The measure of married, black women in the population rises from 37% to 42%, closing nearly one fifth of the marriage gap between black and white women. Note that this result is consistent with Seitz (2009), who finds that differences in the sex ratio by race accounts for about one fifth of the racial-marriage gap. In our exercise, the measures of married, black men fall, even though the absolute number of marriages rise. This is because there are now more black men in the population.

In column B of Table 11, we assign the employment transitions of white men to black men for each education category. The exercise maintains the racial-education differences as they are in the data and considers what happens if for each education level black men have the same employment transitions as white men. Marriage rates increase across the board, but in particular for less-educated black women. These women are more likely to meet less-educated black men whose employment and prison transitions are bleak in the benchmark economy. Marriage rates rise from 21% in the benchmark to 32% for women who are high school drop outs, and from 35% to 38% for women who are high school graduates. In total, this experiment accounts for 12% of the racial-marriage gap for women. In column C, we look at a particular facet of employment transitions, job loss probabilities. Assigning black men the job loss probabilities of white men accounts for 9% of the difference in marriage rates across black and white women, which suggest that differences in job loss probabilities play a relatively larger role than do differences in job finding probabilities.

As seen in Section 4.1, black men are more likely to go to prison than white men. When, for each education group, we assign the probabilities of going to prison for white men to black men, the marriage rate increases in the black population. Black women of all education levels experience between 6 and 12 percentage point increases in marriage rates. The increase in marriage rates of black men declines with their education. Black men who are high school drop outs experience a 26 percentage point increase in their marriage rate when they have the same prison transition probabilities as white men who are high school drop outs. For black men with a college degree, there is only a 4 percentage point increase in the marriage rate. This education gradient can be attributed to the strong education gradient in the likelihood of going to prison. All together, equating the likelihood of going to prison of white men and black men closes the marriage gap by 40%.

In column E, we bring all elements of the Wilson Hypothesis together by giving black men the prison probabilities and employment transitions of white men, while setting the sex ratio to one (combining the experiments of columns A, B, and D in Table 11). The racial-marriage gap declines by 78%, with relatively larger increases in marriage rates at the bottom of the education distribution. In Table 12 we further show how the Wilson experiment affects the dynamics of entry into and out of marriage. The upper panel of this table shows that black women become more likely to enter into marriage at all ages as compared to the benchmark. By age 30, only 41% of black women are ever married in the benchmark economy versus 72% of white women. In the counterfactual world, 59% of black women are married. By age 40, 82% of black women are ever married in this counterfactual world (not far from 91% for white women), while only 65% were ever married in the benchmark economy. However, the effects on divorce are less pronounced, suggesting that a primary difference between black and white individuals in the model economy is their willingness to enter into marriage.

Finally, we impose preference parameters of white men and women on black men and women. We assign the permanent and transitory match-quality shocks of white marriages to black marriages, the benefit to staying home for women, the fixed monetary cost of getting married, and the cost of having a husband in prison. All preference parameters together explain just under 3% of the racial-marriage gap in the model, with particularly low marriage rates amongst low educated black men due to the high cost of having a husband in prison.[31]

Taken together, the Wilson experiment accounts for more than three quarters of the racial-marriage gap, which is more than the sum of the three individual experiments, exhibiting important interaction effects. It is not the same to increase the probability of a

[31] In Appendix Table C.17, we further break down the changes for groups of preference parameters, finding that the match quality shocks together with the prison penalty decrease the marriage gap, the marriage cost increases the marriage gap, while the home benefit parameter has only a very small impact.

Table 12: Marriage dynamics for women – Wilson experiment vs. (benchmark)

Panel A: First marriage by a given age

Married by age	20	25	30	35	40
Black	.08 (.04)	.38 (.25)	.59 (.41)	.73 (.55)	.82 (.65)
White	(.11)	(.50)	(.72)	(.84)	(.91)

Panel B: Marriages intact after given number of years

Duration in years	1	3	5	10
Black	.82 (.80)	.69 (.62)	.65 (.55)	.62 (.46)
White	(.92)	(.79)	(.70)	(.58)

Notes: In the top panel, we compute how long it takes for women in a new birth cohort to marry. In the bottom panel, the numbers refer to the fraction of all marriages that last for a given number of years.

match for women (by equating the sex ratio) in an environment in which marriage is still risky versus one in which the men they match with are less likely to become unemployed or incarcerated. Similarly, making prison a less likely event is more important when men are also more likely to find jobs.[32] As the last row of Table 11 shows, the confidence intervals on these results are tight. For the Wilson hypothesis (column E in Table 11), for example, the 90% confidence interval for our point estimate of 78% ranges from 76.8% to 78.3%.

6.1 Sensitivity Checks

In Appendix F, we discuss the sensitivity of our results to different modeling choices. Due to data limitations, in our benchmark economy we assume that the probability of staying in prison, π_{pp}, does not vary by education. First, we allow the probability of staying in prison, π_{pp}, to be higher for less-educated individuals. Second, we turn to ς, the weight on the wife's utility in the joint household maximization problem. Instead of fixing it at $\varsigma = 0.5$ as we did in the benchmark economy, we assume that when a new marriage is formed the husband and wife choose the weight from a set, $\varsigma \in M = \{0.3, 0.4, 0.5, 0.6, 0.7\}$ and commit to it until the marriage ends.[33] Both of these sensitivity checks have negligible effects on the targets in Tables 5 to 9 (when all other model parameters are kept at their benchmark values) and counterfactuals deliver the same message: around 78% of the racial marriage gap can be accounted for by the Wilson hypothesis.

Finally, we consider how our results depend on σ, the relative risk aversion parameter. As changing σ has a significant effect on model outcomes, we re-estimate the model economy with σ=1.5 (a lower risk aversion) and conduct the same counterfactuals. The counterfactual

[32]In the Wilson experiment, we keep the education distribution of white and black population as given. If we also assume that black men have the same education distribution as white men, the racial-marriage gap declines by 87% (in contrast to 78%).

[33]Allowing for updates in ς, as in Voena (2015), would be computationally very demanding in the current set-up.

experiments find that the Wilson hypothesis accounts for 82% of the racial-marriage gap, which is slightly larger than the results with $\sigma = 2$ (78%). The larger impact is primarily accounted for by equating prison transitions. With $\sigma = 2$, this exercise accounts for 40% of the racial-marriage gap, while with $\sigma = 1.5$, it accounts for 48%. When $\sigma = 1.5$, the estimation assigns a larger cost of having a husband in prison for black women, which partly compensates for a lower risk aversion, to match the fraction of black women who marry. The higher cost of having a husband in prison makes women more responsive to changes in prison transitions.

6.2 Welfare State

In this section, we turn to the role of the welfare state as a potential factor that can account for the racial-marriage gap. Do generous welfare payments to single women encourage them to stay unmarried, and how important is this mechanism for marriage and divorce decisions? In Table 13 we present marriage rates of black women and men when welfare payments to single women are reduced or increased by 25% from their benchmark levels. To place these changes in perspective, in the median state (Nebraska) in 2018 the maximum monthly TANF cash assistance for a single mother with two children was $450. A 25% increase in generosity would correspond to the maximum monthly TANF benefits in Rhode Island ($554) or Washington ($569), states that are in the 70th percentile of the maximum benefit distribution, while a 25% decrease would correspond to Delaware ($338), which is in the 33rd percentile of the generosity distribution.[34] A reduction in welfare generosity generates only a 2% reduction in the racial-marriage gap. Similarly, an increase in the welfare payments to single women by 25% has a negligible impact on the marriage gap. In the model, this aspect of the welfare state not only has a minor effect on marriage rates, it is also not a driver of the racial-marriage gap.

[34] The Urban Institute's Welfare Rules Database, TANF Policy Tables, Table II.A.4 https://wrd.urban.org/wrd/tables.cfm. See also Congressional Research Service (2020).

Table 13: Accounting for the black-white marriage gap - The role of the welfare state

Fraction married

	Education	Black	Welfare payments		White
		BM	75%	125%	BM
Women	Less than high school	.21	.22	.21	.56
	High school	.35	.36	.35	.62
	Some college	.39	.40	.39	.63
	College	.47	.47	.46	.68
	All	.37	.38	.37	.64
Men	Less than high school	.13	.15	.11	.48
	High school	.39	.40	.39	.59
	Some college	.57	.58	.56	.68
	College	.62	.63	.62	.70
$\Delta^f_{b,w}$ accounted for			.021	-.015	
90% Confidence interval			[0.018, 0.026]	[-.017,-.014]	

Notes: The first column 'black BM' and last column 'white BM' are the fractions of the black and white populations that are married in the benchmark economy. The remaining columns are the marriage rates under counterfactual scenarios. In the first (second) experiment, we reduce (increase) the amount of welfare single women get by 25%. We also simulate these counterfactual economies for the white population. The row $\Delta^f_{b,w}$ presents the share of the racial-marriage gap accounted for by the experiment. The last row shows the 90% confidence interval of the share of the gap closed simulated by drawing parameters 100 times from the estimated variance-covariance matrix computed using the delta method.

7 Conclusions

The racial-marriage gap in the United States is large. In this paper, we study its potential drivers in a model that allows for racial preference differences in the value of marriage. Changes in labor markets in recent decades left many low-skilled workers jobless. The number of people behind bars has increased so that the US holds around 25% of the world's prison population, while only accounting for about 5% of the world's population. Both the decline in low-skilled jobs as well as the era of mass incarceration have disproportionately affected black communities, and in particular black men. We investigate the degree to which the current bleak labor market prospects of black men and the considerable risk of being incarcerated explain why so many black women are unmarried. Using an equilibrium model of marriage, divorce and labor supply that takes into account transitions between employment, unemployment, and prison, and that allows for racial preference differences for marriage, we are able to disentangle and quantify the key contributors to the racial-marriage gap.

We conduct a range of counterfactual experiments within our estimated model, in which we assign economic and preference characteristics of the white population to the black population. Preference differences across races, which include the direct utility from marriage and the cost of having a husband in prison, account for less than 5% of the racial-marriage gap. More than three quarters of the gap is closed when all the components of the Wilson Hypothesis are equalized across races: the sex ratio, employment transitions of men, and prison transitions of men. Therefore, a majority of the racial-marriage gap arises from differences in economic circumstance as opposed to differences in preferences. This suggests policies that improve employment opportunities for and/or reduce incarceration of black men could shrink the racial-marriage gap. We also show that the impact of more generous welfare programs on the racial-marriage gap is small.

None of our findings are meant to be interpreted as normative judgements, as we neither model decisions leading to incarceration nor any negative externalities arising from those decisions. However, there is evidence of racial bias in policing (e.g. Gelman, Fagan and Kiss 2007), which has led to widespread protests and the Black Lives Matter movement. We demonstrate in this paper that the impact of policing can be far reaching, because labor incarceration affects marriage formation. There are several ways to extend the model. In particular, the trends in inter-racial marriage and questions about how incarceration and unemployment are affecting investment in children are left for future research.

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Online Appendix

A Value Functions

In this Appendix, we define the start-of-the-period value functions that we use in Section 3.

A.1 Start-of-the-Period Values

We start with the value of being a single woman at the start of the period given by Equation (5) in the text, and reproduced below for ease of exposition.

$$\begin{aligned}\widetilde{V}_f^S(h_f,q,K,\varepsilon_f,\lambda_f) &= (1-\kappa)EV_f^S(h_f,q,K,\varepsilon_f,\lambda_f)+\\ &\kappa\sum_{h_m}p_f^{h_f,h_m}\sum_{P,\lambda_m,\varepsilon_m,\gamma,\phi}\max\{EV_f^{M,n}(h_f,q,K,\varepsilon_f,\lambda_f;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi)\\ &I_m(h_f,q,K,\varepsilon_f,\lambda_f;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi),\\ &EV_f^S(h_f,q,K,\varepsilon_f,\lambda_f)\}\Gamma(\gamma)\Theta(\phi)\psi_m^S(\lambda_m,\varepsilon_m,P|h_m).\end{aligned}$$

Consider first a single woman with $\lambda_f = e$ at the start of the period. What is her expected value of staying single? This period, she can lose her job with probability δ^h, her fertility evolves according to $\mathcal{F}^{h,S}(K'|K)$, and her value function is given by $V_f^S(h,q,K',\varepsilon',\lambda = u)$. If she keeps her job, which happens with probability $1-\delta^h$, she draws a new wage shock according to $\Upsilon_f^h(\varepsilon'|\varepsilon)$, her fertility evolves according to $\mathcal{F}^{h,S}(K'|K)$, and she enjoys $V_f^S(h,q,K',\varepsilon',\lambda = e)$. As a result, for a single woman with $\lambda_f = e$, the expected value of remaining single is given by:

$$\begin{aligned}EV_f^S(h,q,K,\varepsilon,\lambda=e) &= \delta^h\sum_{K'}\mathcal{F}^{h,S}(K'|K)V_f^S(h,q,K',\varepsilon,\lambda=u)+\\ &(1-\delta^h)\sum_{K'}\mathcal{F}^{h,S}(K'|K)\sum_{\varepsilon'}\Upsilon_f^h(\varepsilon'|\varepsilon)V_f^S(h,q,K',\varepsilon',\lambda=e).\end{aligned} \tag{10}$$

A single woman who is currently non-employed, on the other hand, receives a job offer with probability θ^h and draws a wage shock from $\widetilde{\Upsilon}_f^h(\varepsilon)$. If she does not receive a job offer, then she is non-employed next period. Again her fertility evolves according to $\mathcal{F}^{h,S}(K'|K)$. Therefore, for a single woman who is non-employed at the start of the period, the expected value of remaining single is given by:

$$\begin{aligned}EV_f^S(h,q,K,\varepsilon,\lambda=u) &= \theta^h\sum_{K'}\mathcal{F}^{h,S}(K'|K)\sum_{\varepsilon'}\widetilde{\Upsilon}_f^h(\varepsilon')V_f^S(h,q,K',\varepsilon',\lambda=e)\\ &+(1-\theta^h)\sum_{K'}\mathcal{F}^{h,S}(K'|K)V_f^S(h,q,K',\varepsilon,\lambda=u).\end{aligned} \tag{11}$$

What about her value of getting married? A single woman with $\lambda_f = e$ matches with a potential partner with probability κ. She then takes a draw from $\psi_m^S(\lambda_m,\varepsilon_m,P|h_m)$, which determine her match's characteristics. The expected value of being married to a type-$(h_m, \lambda_m, \varepsilon_m, P)$ man with match qualities γ and ϕ is given by:

$$
\begin{aligned}
& EV_f^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f = e; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \\
= \; & \delta^{h_f} \sum_{K'} \mathcal{F}^{h_f,S}(K'|K) \sum_{\lambda'_m, \varepsilon'_m} \Pi^{h_m,P}(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) \\
& V_f^{M,n}(h_f, q, K', \varepsilon_f, \lambda_f = u; h_m, \lambda'_m, \varepsilon'_m, P; \gamma, \phi) \\
& + (1 - \delta^{h_f}) \sum_{K'} \mathcal{F}^{h_f,S}(K'|K) \sum_{\varepsilon'_f, \lambda'_m, \varepsilon'_m} \Upsilon_f^{h_f}(\varepsilon'_f | \varepsilon_f) \Pi^{h_m,P}(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) \\
& V_f^{M,n}(h_f, q, K', \varepsilon'_f, \lambda_f = e; h_m, \lambda'_m, \varepsilon'_m, P; \gamma, \phi),
\end{aligned} \tag{12}
$$

with $V_f^{M,n}$ defined as in Section 3. Note that for a single woman, the expected value of being married is determined by the labor market transitions of her potential husband, $\Pi^{h_m}(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m)$, her own labor market transitions, δ^{h_f} and $\Upsilon_f^{h_f}(\varepsilon'_f | \varepsilon_f)$, and her fertility transitions, $\mathcal{F}^{h_f,S}(K'|K)$.

Finally, for a single woman with $\lambda_f = u$, the expected value of being married to a type-$(h_m, \lambda_m, \varepsilon_m, P)$ man with match qualities γ and ϕ is given by:

$$
\begin{aligned}
& EV_f^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f = u; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \\
= \; & \theta^{h_f} \sum_{K'} \mathcal{F}^{h_f,S}(K'|K) \sum_{\varepsilon'_f, \lambda'_m, \varepsilon'_m} \widetilde{\Upsilon}_f^{h_f}(\varepsilon'_f) \Pi^{h_m,P}(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) \\
& V_f^{M,n}(h_f, q, K', \varepsilon_f, \lambda_f = e; h_m, \lambda'_m, \varepsilon'_m, P; \gamma, \phi) \\
& + (1 - \theta^{h_f}) \sum_{K'} \mathcal{F}^{h_f,S}(K'|K) \sum_{\lambda'_m, \varepsilon'_m} \Pi^{h_m,P}(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) \\
& V_f^{M,n}(h_f, q, K', \varepsilon_f, \lambda_f = u; h_m, \lambda'_m, \varepsilon'_m, P'; \gamma, \phi).
\end{aligned} \tag{13}
$$

A.2 Start-of-the-Period Value for a Single Man

For a single man, we define the start-of-the-period value functions conditional on whether or not he is in prison.

A.2.1 In Prison

If a single man starts the period in prison, his current state is $(h, \lambda = p, \varepsilon, P = 1)$. Next period, with probability $\pi_{pu}^{h,P}$ he is released as an unemployed person and $\lambda' = u$, while he becomes employed with probability $\pi_{pe}^{h,P}$. In that case, he takes a draw from $\widetilde{\Upsilon}_m^P(\cdot)$. Finally, with the remaining probability, $\pi_{pp}^{h,P}$, he stays in the prison. If a man moves to unemployment or employment from prison, he remains single for one period before he participates again in the marriage market. Therefore, his continuation value is given by:

$$\widetilde{V}_m^S(h,\lambda=p,\varepsilon,P=1) = \pi_{pu}^{h,,P} V_m^S(h,\lambda=u,\varepsilon,P=1) + \pi_{pe}^{h,P}\sum \widetilde{\Upsilon}_m^P(\varepsilon')V_m^S(h,\lambda=e,\varepsilon',P=1) + \pi_{pp}^{h,P}V_m^S(h,\lambda=p,\varepsilon,P=1). \quad (14)$$

A.2.2 Not in Prison

A single man, who is not in the prison meets a single woman, draws γ and ϕ, and decides whether to get married. His decisions are based on expected values of being single and married. The expected value of staying a single man is given by:

$$EV_m^S(h,\lambda,\varepsilon,P) = \sum_{\varepsilon',\lambda'} \Pi^{h,P}(\lambda',\varepsilon'|\lambda,\varepsilon)V_m^S(h,\lambda',\varepsilon',P). \quad (15)$$

The expected value of being married to a woman who is employed at the start of the period is:

$$\begin{aligned} & EV_m^{M,n}(h_f,q,K,\varepsilon_f,\lambda_f=e;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi) \quad (16)\\ = \; & \delta^{h_f}\sum_{K'}\mathcal{F}^{h_f,S}(K'|K)\sum_{\lambda'_m,\varepsilon'_m}\Pi^{h_m,P}(\lambda'_m,\varepsilon'_m|\lambda_m,\varepsilon_m)\\ & V_m^{M,n}(h_f,q,K',\lambda_f=u,\varepsilon_f;h_m,\lambda'_m,\varepsilon'_m,P;\gamma,\phi)\\ & +(1-\delta^{h_f})\sum_{K'}\mathcal{F}^{h_f,S}(K'|K)\sum_{\varepsilon'_f,\lambda'_m,\varepsilon'_m}\Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f)\Pi^{h_m,P}(\lambda'_m,\varepsilon'_m|\lambda_m,\varepsilon_m)\\ & V_m^{M,n}(h_f,q,K',\varepsilon'_f,\lambda=e;h_m,\lambda'_m,\varepsilon'_m,P;\gamma,\phi). \end{aligned}$$

Finally, the expected value of being married to a woman who is non-employed at the start of the period is defined as:

$$\begin{aligned} & EV_m^{M,n}(h_f,q,K,\varepsilon_f,\lambda_f=u;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi) \quad (17)\\ = \; & \theta^{h_f}\sum_{K'}\mathcal{F}^{h_f,S}(K'|K)\sum_{\varepsilon'_f,\lambda'_m,\varepsilon'_m}\widetilde{\Upsilon}_f^{h_f}(\varepsilon'_f)\Pi^{h_m,P}(\lambda'_m,\varepsilon'_m|\lambda_m,\varepsilon_m)\\ & V_m^{M,n}(h_f,q,K',\varepsilon'_f,\lambda_f=e;h_m,\lambda'_m,\varepsilon'_m,P;\gamma,\phi)\\ & +(1-\theta^{h_f})\sum_{K'}\mathcal{F}^{h_f,S}(K'|K)\sum_{\lambda'_m,\varepsilon'_m}\Pi^{h_m,P}(\lambda'_m,\varepsilon'_m|\lambda_m,\varepsilon_m)\\ & V_m^{M,n}(h_f,q,K',\varepsilon_f,\lambda_f=u;h_m,\lambda'_m,\varepsilon'_m,P;\gamma,\phi). \end{aligned}$$

The start-of-the period value function for a single man can be written as:

$$\begin{aligned} \widetilde{V}_m^S(h_m,\lambda_m,\varepsilon_m,P) = & \sum_{h_f} p_m^{h_m,h_f}\sum_{K,\varepsilon_f,\lambda_f,\gamma,\phi}\max\{EV_m^{M,n}(h_f,q,K,\varepsilon_f,\lambda_f;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi)\\ & I_f(h_f,q,K,\varepsilon_f,\lambda_f;h_m,\lambda_m,\varepsilon_m,P;\gamma,\phi),\\ & EV_m^S(h_m,\lambda_m,\varepsilon_m,P)\}\Gamma(\gamma)\Theta(\phi)\psi_f^S(q,K,\varepsilon_f,\lambda_f|h_f), \quad (18) \end{aligned}$$

where, $\psi_f^S(q,K,\varepsilon_f,\lambda_f|h_f)$ is the endogenous distribution of single women.

A.3 Indicators for Marriage

For a single man who is contemplating marriage, the indicator function is defined as

$$I_m(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) = \begin{cases} 1, \text{ if } EV_m^{M,n}(\cdot) \geq EV_m^S(\cdot) \\ 0, \text{ otherwise.} \end{cases} \tag{19}$$

Similarly for women, we have

$$I_f(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) = \begin{cases} 1, \text{ if } EV_f^{M,n}(\cdot) \geq EV_f^s(\cdot) \\ 0, \text{ otherwise.} \end{cases} \tag{20}$$

A.4 Start-of-the-Period Value for a Married Woman

Now consider the value of being married at the start of a period for a married women, before she observes her and her partner's new labor market status and fertility transitions. We will refer to existing marriages with the superscript o for old. She has the option to stay married (if her husband wishes to as well) or get a divorce. Her problem is given by:

$$\begin{aligned} \widetilde{V}_f^{M,o}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \;\; &= \;\; \max\{EV_f^{M,o}(\cdot) I_m^D(\cdot), \\ & \qquad EV_f^S(\cdot) - \eta\}, \end{aligned}$$

where $EV_f^S(\cdot)$, is the expected value of being single, is defined above by Equations (10) and (11), and her expected value of continuing with the current marriage, $EV_f^{M,o}(\cdot)$, is defined by versions of Equations (12) and (13) for existing marriages. The only differences between an existing and a new marriage is the fixed consumption cost, $\varkappa$, of forming a new marriage, which appears in Equation (3) in Section 3.3. Note that $I_m^D(\cdot)$ indicates whether her husband wants to continue the current marriage. If there is a divorce, then she suffers the utility cost η.

A.5 Start-of-the-Period Value for a Married Man

Similarly, given the state $(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$, a married man decides whether to remain married. He makes this decision based on the following comparison:

$$\begin{aligned} \widetilde{V}_m^{M,o}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \;\; &= \;\; \max\{EV_m^{M,o}(\cdot) I_f^D(\cdot), \\ & \qquad EV_m^S(\cdot) - \eta\}, \end{aligned}$$

where $EV_m^S(\cdot)$ is defined by Equations (14) and (15), and $EV_m^{M,o}(\cdot)$ is defined by versions of Equations (16) and (17) for existing marriages. Let $I_f^D(\cdot)$ indicate whether his wife wants to stay married. A married man who is in prison can decide to continue his marriage if his wife agrees. If there is a divorce, then he is a single man the next period.

A.6 Indicators for Divorce

For a married man who is contemplating a divorce, the indicator function is given by:

$$I_m^D(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) = \begin{cases} 1, \text{ if } EV_m^{M,o}(\cdot) \geq EV_m^S(\cdot) - \eta \\ 0, \text{ otherwise.} \end{cases} \tag{21}$$

Similarly for women, we have:

$$I_f^D(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) = \begin{cases} 1 \text{ if } EV_f^{M,o}(\cdot) \geq EV_f^S(\cdot) - \eta \\ 0, \text{ otherwise.} \end{cases} \tag{22}$$

These are identical to the indicators for single men and women, except that divorce involves a one-time utility cost η.

B Equilibrium

In order to define a stationary equilibrium, we first construct the matching function μ. We do this in two stages. In the first stage, a fraction φ_m^h of each type-h man meets a woman with the same education. The measure of single men and women who are matched with their own type in the first stage is then given by $\min\{\varphi_m^h S_m^h, \kappa S_f^h\}$. As a result, $S_m^h - \min\{\varphi_m^h S_m^h, \kappa S_f^h\}$ and $\kappa S_f^h - \min\{\varphi_m^h S_m^h, \kappa S_f^h\}$ are the measures left as single. In the second stage, all remaining singles meet each other randomly. In the random matching stage, the probability that a man of type$-h_m$ meets of a woman of type-h_f is $\frac{[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}{\sum_{h_f}[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}$. Then, $p_m^{h_m,h_f}$ is given by:

$$p_m^{h_m,h_f} = \begin{cases} \dfrac{\frac{[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}{\sum_{h_f}[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]} S_m^{h_m}}{S_m^{h_m}} & \text{if } h_m \neq h_f \\ \dfrac{\frac{[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}{\sum_{h_f}[\kappa S_f^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]} S_m^{h_m} + \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}}{S_m^h} & \text{if } h_m = h_f \end{cases}. \tag{23}$$

Similarly, $p_f^{h_f,h_m}$ is given by:

$$p_f^{h_f,h_m} = \begin{cases} \dfrac{\frac{[S_m^{h_m} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}{\sum_{h_m}[\kappa S_m^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]} \kappa S_f^{h_f}}{\kappa S_f^{h_f}} & \text{if } h_f \neq h_m \\ \dfrac{\frac{[S_m^{h_m} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]}{\sum_{h_m}[S_m^{h_f} - \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}]} \kappa S_f^h + \min\{\varphi_m^{h_m} S_m^{h_m}, \kappa S_f^{h_f}\}}{\kappa S_f^{h_f}} & \text{if } h_f = h_m \end{cases}. \tag{24}$$

Distribution of individuals across states Recall that the state vectors for a single woman, a single man and a married couple are $(h_f, q, K, \varepsilon_f, \lambda_f)$, $(h_m, \lambda_m, \varepsilon_m, P)$, and $(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$, respectively. Below, whenever it does not cause any confusion, we do not refer to these states explicitly. In order to define a stationary equilibrium, we first introduce some additional notation to capture the underlying heterogeneity. First, let $\widehat{\psi}_f^S(h_f, q, K, \varepsilon_f, \lambda_f)$ and $\widehat{\psi}_m^S(h_m, \lambda_m, \varepsilon_m, P)$ denote the measure of single women and single men in the marriage market, and define the marginal distributions conditional on h_f and h_m as $\widehat{\psi}_f^S(q, K, \varepsilon_f, \lambda_f|h_f)$ and $\widehat{\psi}_m^S(\lambda_m, \varepsilon_m, P|h_m)$. Note that $S_m^{h_m}$ and $S_f^{h_f}$, the measure of type-h_m single men and type-h_f single women in the marriage market, are given by:

$$S_m^{h_m} = \sum_{\lambda_m, \varepsilon_m, P} \widehat{\psi}_m^S(\lambda_m, \varepsilon_m, P|h_m),$$

and,

$$S_f^{h_f} = \sum_{q, K, \lambda_f, \varepsilon_f} \widehat{\psi}_f^S(q, K, \varepsilon_f, \lambda_f|h_f).$$

The total measure of single men and women are then given $S_m = \sum_{h_m} S_m^{h_m}$ and $S_f^h = \sum_{h_f} S_f^{h_f}$, respectively. These measures are used to define matching probabilities in Section 2.3.

Also, note that conditional on h_f the normalized distribution of single women is defined by:

$$\psi_f^S(q, K, \varepsilon_f, \lambda_f|h_f) = \frac{\widehat{\psi}_f^S(q, K, \varepsilon_f, \lambda_f|h_f)}{S_f^{h_f}},$$

while the normalized distribution of single men is given by:

$$\psi_m^S(\lambda_m, \varepsilon_m, P|h_m) = \frac{\widehat{\psi}_m^S(\lambda_m, \varepsilon_m, P|h_m)}{S_m^{h_m}}.$$

Define the distribution functions $\psi_f^S(h_f, q, K, \varepsilon_f, \lambda_f)$ and $\psi_m^S(h_m, \lambda_m, \varepsilon_m, P)$ accordingly.

Second, let $\widehat{\psi}^{M,n}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$ be the measure of newly-married individuals, and define $\widehat{\psi}^{M,o}(\cdot)$ similarly. Then, the total measure of married individuals is given by:

$$M_f^{h_f} = \sum_{h_f, q, K, \lambda_f, \varepsilon_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi} \sum_y \widehat{\psi}^{M,y}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$$

where $y \in \{n, o\}$. Hence, for each h_f, $S_f^{h_f} + M_f^{h_f}$ is the total measure of h_f types, while $\sum_{h_f} S_f^{h_f} + \sum_{h_f} M_f^{h_f} = 1$. A similar accounting identity holds for men.

Equilibrium We are now ready to define an equilibrium. Given exogenous processes $\Pi^{r,h,P}(\lambda', \varepsilon'|\lambda, \varepsilon)$ for (λ, ε) and $\mathcal{F}^{r,h,v}(K'|K)$ for K, and an exogenous government spending G, and tax and transfer functions ($T_m^S(Y)$, $T_f^S(Y, K)$ and $T^M(Y, K)$ for taxes and $TR_m^S(Y)$, $TR_f^S(Y, K)$ and $TR^M(Y, K)$ for transfers), a *stationary equilibrium* consists of i) a set of value functions, $V_f^S(\cdot)$, $V_m^S(\cdot)$, $V_f^{M,o}(\cdot)$, $V_m^{M,o}(\cdot)$, $V_f^{M,n}(\cdot)$ and $V_m^{M,n}(\cdot)$; ii) a set of marriage decisions

$I_m(\cdot)$, $I_f(\cdot)$, $I_m^d(\cdot)$ and $I_m^d(\cdot)$; iii) a set of labor supply decisions for single and married women, $N_f^S(\cdot)$, $N_f^{M,n}(\cdot)$ and $N_f^{M,o}(\cdot)$; iv) measures of single and married individuals, $\widehat{\psi}_f^S(\cdot)$, $\widehat{\psi}_m^S(\cdot)$, $\widehat{\psi}^M(\cdot)$ such that:

1. Married and single individuals behave optimally and the value functions are defined by equations (1), (2), and (4).
2. Marriage and divorce decisions are optimal and defined by equations (19), (20), (21), and (22).
3. Labor supply decisions of women maximize the associated value functions defined by (1) and (4).
4. The government budget balances. Let $Y_f^S(\cdot)$, $Y_m^S(\cdot)$, and $Y^{M,y}(\cdot)$ for $y \in \{n, o\}$ be total household income before taxes and transfer as defined in Section 2. Then total tax collection of the government, $\mathbf{T}$, is given by:

$$\begin{aligned} \mathbf{T} &= \sum \widehat{\psi}_f^S(\cdot) T^S(Y_f^S(\cdot), K) + \sum \widehat{\psi}_m^S(\cdot) T^S(Y_m^S(\cdot), 0) + \\ &\quad \sum \widehat{\psi}^{M,n}(\cdot) T^M(Y^{M,n}(\cdot), K) + \\ &\quad \sum \widehat{\psi}^{M,o}(\cdot) T^M(Y^{M,o}(\cdot), K). \end{aligned}$$

   Similarly, define the total transfers, $\mathbf{TR}$, as:

$$\begin{aligned} \mathbf{TR} &= \sum \widehat{\psi}_f^S(\cdot) TR_f^S(Y_f^S(\cdot), K) + \\ &\quad \sum \widehat{\psi}_m^S(\cdot) TR_m^S(Y_m^S(\cdot), 0) + \\ &\quad \sum \widehat{\psi}^{M,n}(\cdot) TR^M(Y^{M,n}(\cdot), K) + \\ &\quad \sum \widehat{\psi}^{M,o}(\cdot) TR^M(Y^{M,o}(\cdot), K). \end{aligned}$$

   The government budget is given by $\mathbf{TR} + G = \mathbf{T}$.

5. The measures of single and married individuals, $\widehat{\psi}_f^S(h_f, q, K, \varepsilon_f, \lambda_f)$, $\widehat{\psi}_m^S(h_m, \lambda_m, \varepsilon_m, P)$, $\widehat{\psi}^M(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$ are consistent with marriage and divorce deci-

sions and the exogenous shocks, i.e., for $K' \in \{1,2\}$,

$$
\begin{aligned}
& \widehat{\psi}_f^S(h_f, q, K', \varepsilon'_f, \lambda'_f) && (25)\\
= \;& \rho \left[\begin{array}{c} \sum_{h_m} p_f^{h_f,h_m} \sum_{\gamma,\phi} \sum_{\lambda_m,\varepsilon_m,P} \kappa \widehat{\psi}_f^S(h_f, q, K, \varepsilon_f, \lambda_f) \psi_m^S(\lambda_m, \varepsilon_m, P|h_m) \times \\ (1 - I_f^n(\cdot;\gamma,\phi))(1 - I_m^n(\cdot;\gamma,\phi))\Gamma(\gamma)\Theta(\phi) \end{array} \right] \times \\
& \Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f) \mathcal{F}^{h_f,S}(K'|K) Prob(\lambda'_f|\lambda_f) \\
& + \rho(1-\kappa) \widehat{\psi}_f^S(h_f, q, K, \varepsilon_f, \lambda_f) \Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f) \mathcal{F}^{S,h_f}(K'|K) Prob(\lambda'_f|\lambda_f) && (26)\\
& + \rho \left[\begin{array}{c} \sum_{h_m,\lambda_m,\varepsilon_m,P} \widehat{\psi}^M(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \times \\ (1 - I_f^D(\cdot;\gamma,\phi))(1 - I_m^D(\cdot;\gamma,\phi))\Gamma(\gamma)\Theta(\phi) \end{array} \right] \times \\
& \Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f) \mathcal{F}^{h_f,S}(K'|K) Prob(\lambda'_f|\lambda_f)
\end{aligned}
$$

where

$$
Prob(\lambda'_f|\lambda_f) = \begin{cases} \delta^{h_f}, \text{ if } \lambda'_f = u,\ \lambda_f = e \text{ and } N_f^S(h_f, q, K, \varepsilon, \lambda_f) > 0 \\ (1-\delta^{h_f}), \text{ if } \lambda'_f = e,\ \lambda_f = e \text{ and } N_f^S(h_f, q, K, \varepsilon, \lambda_f) > 0 \\ \theta^{h_f}, \text{ if } \lambda'_f = e,\ \lambda_f = u \text{ or } \lambda_f = e \text{ and } N_f^S(h_f, q, K, \varepsilon, \lambda_f) = 0 \\ (1-\theta^{h_f}),\ \lambda'_f = u,\ \lambda_f = u \text{ or } \lambda_f = e \text{ and } N_f^S(h_f, q, K, \varepsilon, \lambda_f) = 0. \end{cases},
$$

and $p_f^{h_f,h_m}$ is given by Equation (24).

The first two lines in Equation (25) sums all single women of type-(h_f, q) who are matched with a man and remain single. While h_f and q are fixed, K, ε_f and λ_f change from one period to the next. Transitions in K and ε are exogenous, while transitions in λ_f are partly endogenous. The term $Prob(\lambda'_f|\lambda_f)$ captures λ_f transitions. In particular, if a woman is in state e today and works, i.e. if $N_f^S > 0$, then she again has an opportunity to work next period with probability $1 - \delta^{h_f}$ but can loose her job with probability δ^{h_f}. On the other hand, if she is in state u today or she has an opportunity to work but chooses not to do so, she has an opportunity to work next period with probability θ^{h_f} or remain in state u next period with probability $1 - \theta^{h_f}$.

For $K' = 0$, in addition to childless women who remain single, we include a term that captures the newborn childless women who replace women who die. The measure of these women is given by:

$$
\begin{aligned}
& (1-\rho) \sum_K \widehat{\psi}_f^S(h_f, q, K, \varepsilon_f, \lambda_f) \Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f) Prob(\lambda'_f|\lambda_f) \\
& + (1-\rho) \sum_{h_m,\lambda_m,\varepsilon_m,P,\gamma,\phi} \sum_K \widehat{\psi}^M(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi) \Upsilon_f^{h_f}(\varepsilon'_f|\varepsilon_f) Prob(\lambda'_f|\lambda_f).
\end{aligned}
$$

Similar recursions define $\widehat{\psi}_m^S(h_m, \lambda_m, \varepsilon_m, P)$ and $\widehat{\psi}^M(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$.

Solution algorithm In order to find an equilibrium, a computational fixed point problem is solved. For an initial guess of $\widehat{\psi}^S_f(\cdot)$, $\widehat{\psi}^S_m(\cdot)$, $\widehat{\psi}^M(\cdot)$, all value function and decision rules for labor supply of women and marriage and divorce are solved. Given these decision rules, the distributions are updated and the process continues until the distributions converge. While it is not possible to establish a fixed point result theoretically, the solution algorithm converged to the same steady state from several different initial guesses, as long as we start with distributions that are not uniformly zero, i.e. agents expect that there will some single individuals in the marriage market. On the other hand, if we start from an initial guess of no single agents in the marriage market, everyone can choose to be married. If the parameters are such that even if there are no single individuals in future marriage markets, some individuals chose to be single today, then such a degenerate equilibrium is avoided.

C Quantitative Analysis – Details

In this Appendix, we provide further details about the model inputs presented in Section 4.

Population by Race, Gender and Educational Attainment

Table C.1 documents the distribution of population for each race by gender and education. White individuals on average are more educated than black individuals, and women are more educated than men. The college-education gap between black women and men is particularly striking. About 10% of the black population consists of college-educated women while only 6.5% are college-educated men. This gap is smaller for white women and men (17% versus 15.5%).

Table C.1: Population distribution

Education	Black		White	
	Women	Men	Women	Men
Less than high school	5.64	6.57	2.53	3.38
High school	22.67	22.84	17.76	19.72
Some college	14.95	10.54	12.96	11.35
College	10.26	6.52	16.82	15.48
Total	53.53	46.47	50.07	49.93

Notes: The population shares for non-immigrant black and white men and women age 25-54 come from the ACS 2006.

Wages

Table C.2 shows hourly wages in the data, which map directly to $\omega_f^{r,h}$ and $\omega_m^{r,h}$ for $r \in \{b, w\}$ in the model. We compute mean hourly wages conditional on gender and race from the 2006 American Community Survey (ACS). We then normalize mean hourly wages for each group by the overall mean of hourly wages in the economy ($20.70). For each gender and education level, white individuals have greater average hourly wages than black individuals. Men have higher wages than women, but the gender wage gap is much smaller for the black population than it is for the white population.[35]

Table C.2: Hourly wages

(normalized by mean wages)

Education	Black		White	
	Women	Men	Women	Men
Less than high school	0.496	0.561	0.510	0.682
High school	0.624	0.757	0.654	0.900
Some college	0.710	0.846	0.796	0.993
College	1.062	1.183	1.200	1.679

Notes: The mean hourly wages normalized by mean wages (conditional on working) are computed using the ACS 2006.

Hours worked

Table C.3 shows hours worked per week from the ACS 2006 (conditional on working) by gender, race and marital status. White men tend to work more than black men, irrespective of marital status. For women the relationship flips with marital status as black married women tend to work more hours than white married women.

Table C.3: Usual hours worked per week

(conditional on working)

	Black			White	
	Women	Men		Women	Men
Single	38.8	40.5	Single	39.8	42.8
Married	39.3	43.5	Married	36.7	46.0

Notes: Mean hours worked (conditional on working) are computed using the ACS 2006.

[35]See Neal (2004) for an analysis of racial differences in the gender wage gap.

Table C.4: Likelihood ratios depending on whether an individual has been to prison or not

Race	Educ.	P	Likelihood ratio of transition $\frac{\pi_{ij}^{r,h}\|P}{\pi_{ij}^{r,h}}$					
			ee	en	ep	ne	nn	np
Black	<HS	0	1.027	.877	.34	1.146	1.001	.901
	<HS	1	.851	1.682	2.144	.742	.998	2.837
	HS	0	1.012	.927	.289	1.038	1.009	1.207
	HS	1	.897	1.61	3.698	.867	.969	5.326
	SC	0	1.011	.899	.287	1.054	.991	1.657
	SC	1	.841	2.455	6.928	.798	1.035	5.453
	C	0	1.003	.962	.286	1.058	.964	3.799
	C	1	.917	2.071	12.166	.624	1.237	4.964
White	<HS	0	1.01	.925	.273	1.078	.993	1.488
	<HS	1	.838	2.202	5.361	.644	1.031	6.137
	HS	0	1.003	.958	.409	1.034	.997	1.317
	HS	1	.887	2.862	13.129	.662	1.028	26.325
	SC	0	1.002	.943	.299	1.031	.995	4.166
	SC	1	.889	3.736	8.982	.696	1.049	28.649
	C	0	1.002	.943	.299	1.031	.995	4.166
	C	1	.889	3.736	8.982	.696	1.049	28.649

Notes: The likelihood ratios are computed using the NLSY and reflect the relative likelihood of a transition depending on whether a man has been to prison P compared to the pooled sample. For instance, 0.8 (1.2) in the 'ee' column means that the employment to employment transition is 20% less (more) likely than for the pooled sample. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Wage Shocks

Table C.5: Wage transitions, men

Educ.		Black					White				
		ε_1	ε_2	ε_3	ε_4	ε_5	ε_1	ε_2	ε_3	ε_4	ε_5
< HS	ε_1	.209	.313	.239	.164	.075	.361	.234	.197	.102	.107
	ε_2	.076	.418	.271	.138	.098	.094	.484	.206	.123	.093
	ε_3	.057	.208	.371	.201	.163	.051	.178	.445	.224	.101
	ε_4	.038	.173	.269	.375	.144	.025	.101	.198	.501	.175
	ε_5	.008	.093	.217	.217	.465	.033	.071	.133	.179	.584
HS	ε_1	.385	.294	.161	.095	.065	.464	.251	.134	.085	.067
	ε_2	.128	.418	.229	.145	.081	.123	.481	.216	.11	.071
	ε_3	.072	.183	.389	.217	.139	.058	.162	.482	.204	.094
	ε_4	.063	.123	.212	.389	.213	.041	.099	.187	.51	.162
	ε_5	.048	.13	.131	.224	.467	.038	.088	.119	.191	.564
SC	ε_1	.392	.267	.122	.136	.083	.459	.268	.127	.084	.062
	ε_2	.134	.39	.192	.159	.126	.108	.509	.216	.103	.064
	ε_3	.088	.174	.419	.204	.115	.066	.167	.471	.214	.082
	ε_4	.067	.15	.19	.388	.205	.046	.097	.169	.516	.171
	ε_5	.06	.129	.131	.225	.454	.047	.077	.094	.172	.609
C	ε_1	.403	.266	.162	.097	.071	.518	.239	.113	.085	.046
	ε_2	.176	.403	.195	.131	.096	.136	.49	.211	.109	.055
	ε_3	.105	.197	.352	.223	.123	.073	.166	.452	.228	.081
	ε_4	.062	.121	.179	.429	.208	.052	.091	.167	.522	.168
	ε_5	.057	.082	.13	.209	.522	.043	.069	.102	.209	.577

Notes: Wage shocks are computed using the CPS MORG 2000-2006. The five levels represent wage changes relative to the race-gender-education specific mean, that are more than -17.5%, between -17.5% and -5%, between -5% and 5%, between 5 and 17.5%, and more than 17.5%. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Complete Transitions for Men

Before presenting the full transition tables, we provide an example of how the likelihood ratios are used to adapt transitions depending on prison history. Consider a black man who is a high school dropout (second quadrant of the top of Table 1). According to Table 1, his probability of going to prison is 0.085. As we mentioned above, we adapt this according to likelihood ratios as determined using the NLSY. In Table C.4 we see that the likelihood ratio $\frac{\pi_{ep}^{b,<HS}|P=0}{\pi_{ep}^{b,<HS}} = 0.340$. Therefore, $\pi_{ep}^{b,<HS} = 0.34 \times 0.085 = 0.029$. Then correcting for the fact

Table C.6: Wage transitions, women

Educ.		Black					White				
		ε_1	ε_2	ε_3	ε_4	ε_5	ε_1	ε_2	ε_3	ε_4	ε_5
< HS	ε_1	.365	.282	.200	.094	.059	.392	.265	.114	.136	.093
	ε_2	.104	.377	.251	.126	.142	.120	.427	.201	.160	.091
	ε_3	.042	.170	.420	.231	.137	.075	.175	.410	.253	.087
	ε_4	.052	.117	.240	.403	.188	.044	.118	.169	.504	.165
	ε_5	.043	.148	.174	.113	.522	.054	.099	.127	.203	.517
HS	ε_1	.310	.268	.149	.134	.139	.456	.241	.138	.108	.057
	ε_2	.110	.400	.205	.161	.124	.117	.456	.230	.135	.061
	ε_3	.068	.234	.353	.213	.132	.060	.135	.480	.219	.076
	ε_4	.049	.157	.207	.394	.193	.051	.105	.190	.501	.153
	ε_5	.070	.169	.140	.191	.429	.044	.099	.126	.238	.493
SC	ε_1	.346	.210	.198	.156	.091	.450	.246	.146	.104	.055
	ε_2	.175	.392	.186	.166	.082	.121	.457	.230	.132	.059
	ε_3	.080	.250	.362	.225	.083	.072	.174	.462	.218	.074
	ε_4	.043	.153	.185	.403	.216	.048	.102	.191	.504	.155
	ε_5	.068	.114	.117	.203	.498	.036	.078	.108	.223	.555
C	ε_1	.377	.266	.178	.103	.075	.483	.264	.124	.085	.045
	ε_2	.175	.385	.246	.124	.069	.141	.478	.223	.104	.053
	ε_3	.113	.194	.329	.232	.132	.075	.177	.464	.206	.077
	ε_4	.071	.133	.210	.409	.177	.048	.095	.183	.496	.179
	ε_5	.054	.099	.150	.165	.533	.043	.070	.095	.225	.566

Notes: Wage shocks are computed using the CPS MORG 2000-2006. The five levels represent wage changes relative to the race-gender-education specific mean, that are more than -17.5%, between -17.5% and -5%, between -5% and 5%, between 5 and 17.5%, and more than 17.5%. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Table C.7: Initial wage shocks coming out of unemployment

		Black					White				
	Educ.	ε_1	ε_2	ε_3	ε_4	ε_5	ε_1	ε_2	ε_3	ε_4	ε_5
Women	< HS	.110	.362	.178	.209	.141	.181	.316	.204	.173	.127
	HS	.210	.299	.219	.156	.115	.316	.310	.178	.112	.085
	SC	.221	.351	.188	.137	.103	.301	.292	.181	.118	.108
	C	.304	.240	.179	.118	.160	.353	.219	.162	.141	.125
Men	< HS	.184	.218	.299	.126	.172	.212	.320	.138	.193	.138
	HS	.230	.302	.159	.183	.127	.267	.256	.203	.158	.117
	SC	.196	.314	.209	.150	.131	.305	.210	.234	.171	.080
	C	.310	.239	.197	.120	.134	.354	.241	.171	.131	.104

Notes: Wage shocks coming out of non-employment are computed using the CPS MORG 2000-2006. The five levels represent wage changes relative to the race-gender-education specific mean, that are more than -17.5%, between -17.5% and -5%, between -5% and 5%, between 5 and 17.5%, and more than 17.5%. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

that transitions need to sum to one after having adapted using the likelihood ratios, we end up with $\pi_{ep}^{b,<HS} = 0.031$.

We also know that the chances a black man leaves prison is 0.667. When leaving prison, NLSY tells us that with probability 0.464 a black man with less than high school education enters non-employment and employment with probability 0.536. Putting all these pieces together, and noting that the transition matrix for u and e considers only the non-prison population, and therefore needs to be multiplied by the share of population not transitioning into prison in a given year, for a black man, who is a high school dropout and who has not been to prison we have

$$\Pi^{b,<HS,P=0}(\lambda',\varepsilon'|\lambda,\varepsilon) = \begin{array}{c} State \\ p \\ u \\ \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{array} \begin{array}{c} \begin{array}{ccccccc} p & u & \varepsilon_1 & \varepsilon_2 & \varepsilon_3 & \varepsilon_4 & \varepsilon_5 \end{array} \\ \begin{pmatrix} .667 & .214 & .077 & .009 & .006 & .009 & .018 \\ .076 & .759 & .03 & .036 & .049 & .021 & .028 \\ .031 & .127 & .307 & .238 & .169 & .079 & .05 \\ .031 & .127 & .087 & .318 & .212 & .106 & .12 \\ .031 & .127 & .036 & .143 & .354 & .195 & .115 \\ .031 & .127 & .044 & .098 & .202 & .339 & .159 \\ .031 & .127 & .037 & .125 & .139 & .095 & .447 \end{pmatrix} \end{array}.$$

As a comparison, for a white man, who is a high school dropout and who has not been to prison we have:

Table C.8: Wage shocks conditional on exiting prison into employment

Race	Education	ε_1	ε_2	ε_3	ε_4	ε_5
Black	Less than high school	.643	.071	.048	.071	.167
	High school	.564	.103	.141	.051	.141
	Some college	.55	.1	.2	.1	.05
	College	.429	.143	.286	0	.143
White	Less than high school	.382	.235	.118	.088	.176
	High school	.538	.231	.077	.154	0
	Some college	.545	.182	.091	.182	0
	College	.545	.182	.091	.182	0

Notes: Wages shocks when exiting from prison into employment are computed using the NLSY and the five levels represent wage changes relative to the race-gender-education specific mean, that are more than -17.5%, between -17.5% and -5%, between -5% and 5%, between 5 and 17.5%, and more than 17.5%. For white men leaving prison with some college we have too few observations such that we use the probabilities of white college-educated men for this educational category.

$$\Pi^{w,<HS,P=0}(\lambda',\varepsilon'|\lambda,\varepsilon) = \begin{array}{c} State \\ p \\ u \\ \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{array} \begin{array}{c} \begin{array}{ccccccc} p & u & \varepsilon_1 & \varepsilon_2 & \varepsilon_3 & \varepsilon_4 & \varepsilon_5 \end{array} \\ \begin{pmatrix} .667 & .153 & .074 & .037 & .021 & .011 & .037 \\ .021 & .773 & .044 & .066 & .028 & .039 & .028 \\ .004 & .08 & .359 & .243 & .106 & .125 & .084 \\ .004 & .08 & .109 & .391 & .185 & .148 & .083 \\ .004 & .08 & .067 & .16 & .377 & .231 & .081 \\ .004 & .08 & .041 & .108 & .155 & .46 & .152 \\ .004 & .08 & .05 & .09 & .116 & .185 & .474 \end{pmatrix} \end{array}.$$

Table C.9: Full transition matrix for black men

Educ	P	State	p	n	ε_1	ε_2	ε_3	ε_4	ε_5
<HS	0	p	.667	.214	.077	.009	.006	.009	.018
	0	n	.076	.759	.03	.036	.049	.021	.028
	0	ε_1	.031	.127	.307	.238	.169	.079	.05
	0	ε_2	.031	.127	.087	.318	.212	.106	.12
	0	ε_3	.031	.127	.036	.143	.354	.195	.115
	0	ε_4	.031	.127	.044	.098	.202	.339	.159
	0	ε_5	.031	.127	.037	.125	.139	.095	.447
<HS	1	p	.667	.214	.077	.009	.006	.009	.018
	1	n	.217	.686	.018	.021	.029	.012	.017
	1	ε_1	.17	.214	.224	.174	.123	.058	.036
	1	ε_2	.17	.214	.064	.232	.155	.077	.087
	1	ε_3	.17	.214	.026	.105	.258	.142	.084
	1	ε_4	.17	.214	.032	.072	.148	.248	.116
	1	ε_5	.17	.214	.027	.091	.102	.07	.326
HS	0	p	.667	.169	.104	.009	.022	.004	.025
	0	n	.035	.726	.055	.072	.038	.044	.03
	0	ε_1	.009	.093	.279	.241	.134	.12	.125
	0	ε_2	.009	.093	.099	.36	.184	.145	.111
	0	ε_3	.009	.093	.061	.21	.317	.192	.118
	0	ε_4	.009	.093	.044	.14	.186	.355	.173
	0	ε_5	.009	.093	.063	.152	.126	.172	.386
HS	1	p	.667	.169	.104	.009	.022	.004	.025
	1	n	.148	.662	.044	.057	.03	.035	.024
	1	ε_1	.105	.151	.231	.199	.111	.1	.103
	1	ε_2	.105	.151	.082	.298	.152	.12	.092
	1	ε_3	.105	.151	.05	.174	.263	.159	.098
	1	ε_4	.105	.151	.036	.116	.154	.294	.143
	1	ε_5	.105	.151	.052	.126	.104	.142	.32
SC	0	p	.667	.156	.097	.018	.035	.018	.009
	0	n	.016	.647	.066	.106	.071	.051	.044
	0	ε_1	.003	.071	.32	.194	.183	.145	.084
	0	ε_2	.003	.071	.162	.363	.173	.153	.076
	0	ε_3	.003	.071	.074	.231	.336	.208	.076
	0	ε_4	.003	.071	.04	.142	.172	.373	.2
	0	ε_5	.003	.071	.063	.105	.108	.188	.462
SC	1	p	.667	.156	.097	.018	.035	.018	.009
	1	n	.053	.687	.051	.081	.054	.039	.034
	1	ε_1	.066	.188	.258	.157	.147	.117	.068
	1	ε_2	.066	.188	.13	.292	.139	.123	.061
	1	ε_3	.066	.188	.06	.187	.27	.168	.062
	1	ε_4	.066	.188	.032	.114	.138	.301	.161
	1	ε_5	.066	.188	.051	.085	.087	.152	.372
C	0	p	.667	.098	.101	.034	.067	0	.033
	0	n	.018	.604	.117	.09	.074	.045	.05
	0	ε_1	.001	.048	.358	.253	.17	.098	.072
	0	ε_2	.001	.048	.168	.365	.234	.118	.066
	0	ε_3	.001	.048	.106	.185	.316	.22	.125
	0	ε_4	.001	.048	.067	.127	.198	.388	.169
	0	ε_5	.001	.048	.053	.094	.143	.157	.505
C	1	p	.667	.098	.101	.034	.067	0	.033
	1	n	.024	.759	.067	.052	.043	.026	.029
	1	ε_1	.058	.1	.317	.224	.15	.087	.063
	1	ε_2	.058	.1	.149	.324	.207	.104	.058
	1	ε_3	.058	.1	.094	.164	.28	.194	.111
	1	ε_4	.058	.1	.06	.113	.175	.344	.15
	1	ε_5	.058	.1	.047	.083	.126	.139	.447

Notes: Combined transitions from Tables 1, 2, C.4, C.5, C.7, and C.8 constructed using the NLSY and the CPS MORG. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Table C.10: Full transition matrix for white men

Educ	P	State	p	n	ε_1	ε_2	ε_3	ε_4	ε_5
<HS	0	p	.667	.153	.074	.037	.021	.011	.037
	0	n	.021	.773	.044	.066	.028	.039	.028
	0	ε_1	.004	.08	.359	.243	.106	.125	.084
	0	ε_2	.004	.08	.109	.391	.185	.148	.083
	0	ε_3	.004	.08	.067	.16	.377	.231	.081
	0	ε_4	.004	.08	.041	.108	.155	.46	.152
	0	ε_5	.004	.08	.05	.09	.116	.185	.474
<HS	1	p	.667	.153	.074	.037	.021	.011	.037
	1	n	.087	.792	.026	.039	.017	.023	.017
	1	ε_1	.076	.186	.29	.196	.085	.1	.067
	1	ε_2	.076	.186	.088	.315	.149	.119	.067
	1	ε_3	.076	.186	.054	.129	.304	.186	.065
	1	ε_4	.076	.186	.033	.087	.125	.371	.123
	1	ε_5	.076	.186	.04	.073	.093	.149	.382
HS	0	p	.667	.169	.114	.013	.013	.025	0
	0	n	.009	.677	.083	.081	.064	.049	.037
	0	ε_1	.003	.049	.432	.227	.131	.103	.054
	0	ε_2	.003	.049	.111	.432	.218	.128	.059
	0	ε_3	.003	.049	.057	.156	.455	.208	.072
	0	ε_4	.003	.049	.048	.099	.181	.475	.145
	0	ε_5	.003	.049	.041	.094	.12	.227	.466
HS	1	p	.667	.169	.114	.013	.013	.025	0
	1	n	.166	.647	.049	.048	.038	.029	.022
	1	ε_1	.084	.136	.355	.187	.108	.085	.044
	1	ε_2	.084	.136	.091	.355	.179	.105	.048
	1	ε_3	.084	.136	.047	.128	.374	.171	.059
	1	ε_4	.084	.136	.039	.081	.148	.391	.119
	1	ε_5	.084	.136	.034	.077	.099	.186	.383
SC	0	p	.667	.11	.122	.041	.02	.02	.02
	0	n	.006	.622	.115	.078	.086	.063	.03
	0	ε_1	0	.041	.431	.236	.139	.1	.053
	0	ε_2	0	.041	.116	.438	.221	.127	.056
	0	ε_3	0	.041	.068	.166	.443	.21	.071
	0	ε_4	0	.041	.046	.097	.184	.483	.148
	0	ε_5	0	.041	.034	.075	.104	.213	.532
SC	1	p	.667	.11	.122	.041	.02	.02	.02
	1	n	.046	.69	.081	.056	.061	.045	.021
	1	ε_1	.013	.159	.372	.204	.12	.086	.046
	1	ε_2	.013	.159	.1	.378	.19	.11	.049
	1	ε_3	.013	.159	.059	.144	.382	.182	.061
	1	ε_4	.013	.159	.04	.084	.159	.417	.128
	1	ε_5	.013	.159	.03	.064	.09	.184	.46
C	0	p	.667	.183	.082	.027	.014	.014	.013
	0	n	.002	.516	.171	.116	.082	.063	.05
	0	ε_1	0	.023	.472	.257	.122	.083	.044
	0	ε_2	0	.023	.139	.467	.217	.102	.052
	0	ε_3	0	.023	.074	.173	.454	.201	.076
	0	ε_4	0	.023	.047	.093	.179	.484	.175
	0	ε_5	0	.023	.042	.069	.093	.22	.553
C	1	p	.667	.183	.082	.027	.014	.014	.013
	1	n	.018	.615	.13	.088	.063	.048	.038
	1	ε_1	.005	.094	.435	.237	.112	.077	.041
	1	ε_2	.005	.094	.128	.431	.201	.094	.048
	1	ε_3	.005	.094	.068	.16	.418	.185	.07
	1	ε_4	.005	.094	.043	.085	.165	.447	.161
	1	ε_5	.005	.094	.039	.064	.086	.203	.51

Notes: Combined transitions from Tables 1, 2, C.4, C.5, C.7, and C.8 constructed using the NLSY and the CPS MORG. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Fertility

Children are born exogenously in the model but the arrival rate depends on household characteristics. Using the IPUMS ACS 2006 we compute the share of women with no previous children aged 20-40 by race, marital status, and education that had their firstborn in the past year. We use the resulting probabilities displayed in Table C.11 as the exogenous probability of a household transitioning from no children to having children. In order to match our targets in terms of the share of women with children in their household by a certain age, we scale this probability by $\mathcal{K}^r$ for each race.

Table C.11: Exogenous child-arrival probabilities by household type, education, and race

Race	Education	Single	Married
Black	Less than high school	.116	.096
	High school	.103	.139
	Some college	.067	.162
	College	.040	.178
White	Less than high school	.106	.140
	High school	.058	.152
	Some college	.024	.162
	College	.010	.173

Notes: The probabilities of a previously childless woman aged 20-40 having a child in a year are computed using the ACS 2006.

Childcare Costs

Using the SIPP from 2001, 2004, and 2008, we compute the average amount of money spent on childcare by maternal marital status. We restrict the sample to black and white working mothers aged 25-54 who were born in the US and are non-Hispanic. We compute total expenditures for care provided for children aged 0-15 paid to childcare/daycare centers, relatives, and non-relatives. Additionally, for children aged 0-5 we include expenditures on preschool and head start and for children aged 5-15 expenditures on clubs, lessons, after school care, and sports. In Table C.12, we present the average expenditures normalized by average household income for single (third column), denoted by $d^{r,h,S}$ in the model, and married (fourth column) mothers, denoted by $d^{r,h,M}$ in the model. We see that, with some exceptions, expenditures tend to be increasing in education and are higher for married than single mothers.

Income Taxes

We borrow the parameters τ_1 and τ_2 from Guner, Kaygusuz and Ventura (2020, Appendix Table A10). It is important to note that these estimates are based on tax liabilities in the absence of tax credits, such as the EITC. For married households, the estimated tax functions correspond to the legal category married filing jointly. For singles without children, tax

Table C.12: Childcare expenditures by household type

		Expenditures	
Race	Education	Single	Married
Black	Less than high school	.011	.006
	High school	.008	.061
	Some college	.021	.026
	College	.030	.046
White	Less than high school	.017	.013
	High school	.006	.008
	Some college	.023	.022
	College	.048	.056

Notes: The childcare expenditures normalized by mean household earnings are computed using the SIPP from 2001, 2004, and 2008.

functions correspond to the legal category of single households; for singles with children, tax functions correspond to the legal category head of household. To estimate the tax functions for a household with a certain number of children, married or not, the sample is further restricted by the number of dependent children for tax purposes. Estimates for τ_1 and τ_2 are contained in Table C.13.

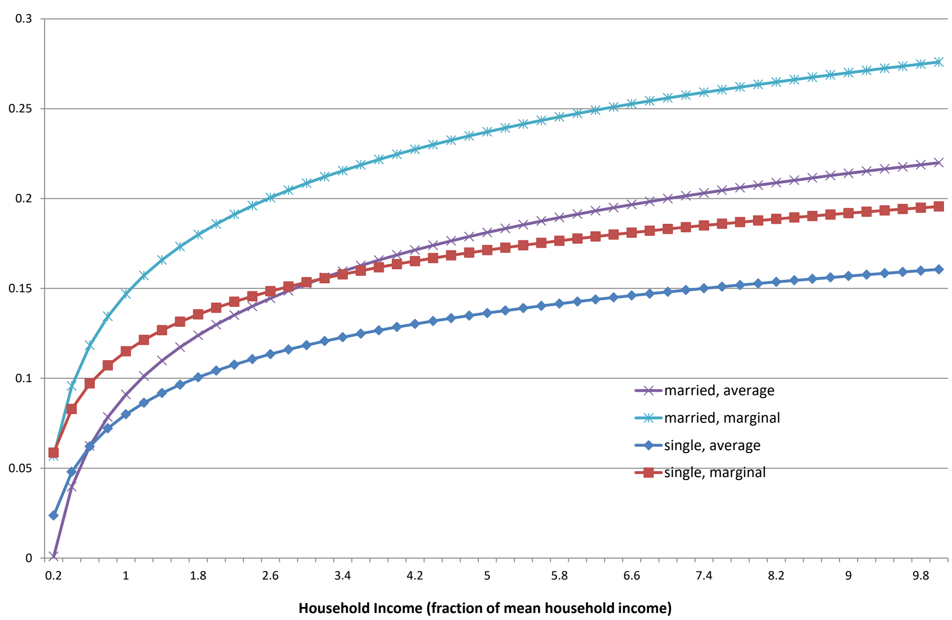
Table C.13: Tax functions

Estimates	Married			Single		
	(no child)	(2 child.)	(3 child.)	(no child)	(2 child.)	(3 child.)
τ_1	0.096	0.091	0.082	0.121	0.080	0.069
τ_2	0.053	0.056	0.056	0.035	0.035	0.032

Notes: Parameters of the tax function in Equation (6). Source: Guner, Kaygusuz and Ventura (2020, Appendix Table A10).

Figure C.1 displays the estimated average and marginal tax rates for different multiples of household income for married and single households with two children. The estimates imply that a married household at around mean income faces an average tax rate of about 9.1% and marginal tax rate of 14.7%. As a comparison, a single household around mean income faces average and marginal tax rates of 8.0% and 11.5%, respectively. At twice the mean income level, the average and marginal rates for a married household amount to 20.3% and 25.3%, respectively, while a single household at the mean income level has an average tax rate of 15% and a marginal tax rate of 18.5%.

Figure C.1: Average and marginal tax rates (married and single household with two children)



Source: Guner et al (2020).

Earned Income Tax Credits (EITC)

The Earned Income Tax Credit is a fully refundable tax credit that subsidizes low income working families. The EITC amounts to a fixed fraction of a family's earnings until earnings reach a certain threshold. Then, it stays at a maximum level, and when the earnings reach a second threshold, the credit starts to decline, so that beyond a certain earnings level the household does not receive any credit. The amount of maximum credits, income thresholds, as well as the rate at which the credits declines depend on the tax filing status of the household (married vs. single) as well as on the number of children. To qualify for the EITC, the capital income of a household must also be below a certain threshold, which was $2,650 in 2004.

In 2004, for a married couple with 0 (2 or 3) children, the EITC started at $2 ($10) and increased by 7.6 (39.9) cents for each extra $ in earnings up to a maximum credit of $3,900 ($4,300). Then the credit stays at this level until the household earnings are $7,375 ($15,025). After this level of earnings, the credit starts declining at a rate of 7.6 (21) cents for each extra $ in earnings until it becomes zero for earrings above $12,490 ($35,458). The formulas for a single household with 0 (2 or 3) children are very similar.

We calculate the level of $EITC$ as a function of earnings with the following formula,

$$\begin{aligned} EITC = \max\{CAP\text{-}\max\{slope_1 \times (bend_1 - earnings), 0\} \\ - \max\{slope_2 \times (earnings - bend_2), 0\}, 0\}, \end{aligned} \tag{27}$$

where CAP, the maximum credit level, $bend_1$ and $bend_2$, the threshold levels, and $slope_1$ and $slope_2$, the rate at which credit increase and decline are given by Table C.14 (as a fraction of mean household income in 2014):

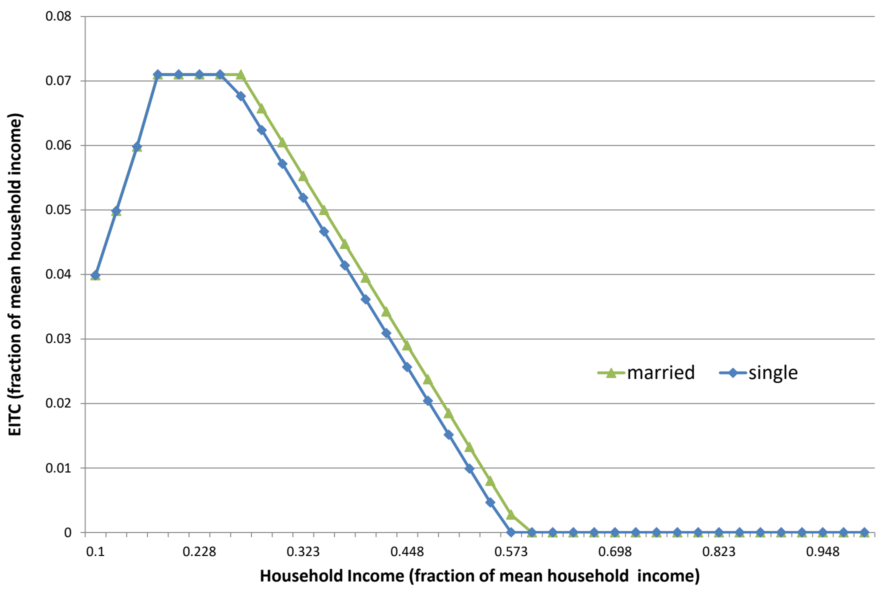
Table C.14: EITC

	CAP	$slope_1$	$bend_1$	$slope_2$	$bend_2$
Married					
No children	0.006	0.076	0.085	0.076	0.122
2 or 3 children	0.071	0.399	0.178	0.21	0.248
Single					
No children	0.006	0.076	0.085	0.076	0.105
2 or 3 children	0.071	0.399	0.178	0.21	0.232

Notes: The parameters of Equation (27) for the EITC schedule normalized by mean household income are adopted from Guner et al (2020).

Figure C.2 shows the EITC as a function of household income and the tax filing status.

Figure C.2: Earned Income Tax Credit by household type



Source: Guner et al (2020).

Transfers and Unemployment Benefits

To estimate transfers, we follow Guner, Rauh and Ventura (2021) and rely on the Survey of Income and Program Participation (SIPP). The sample covers the time period from February 2004 to January 2008. Restricted to black and white household heads aged 25-54, the sample spans 911,273 observations across 34,367 households. Per household, there are between 1 and 48 monthly observations with an average of nearly 27 monthly observations.

The SIPP is a panel surveying households every three months retrospectively for each of the past three months. We compute the average amount of welfare, unemployment benefits, and labor earnings corrected for inflation for each household. The welfare payments include unemployment benefits and the main means-tested programs (except Medicaid), namely Supplemental Social Security Income (SSI), Temporary Assistance for Needy Families (TANF formerly AFDC), Supplemental Nutrition Assistance Program (SNAP formerly food stamps), Supplemental Nutrition Program for Women, Infants, and Children (WIC), and Housing Assistance.

The SIPP only provides information of whether households received Housing Assistance but no information about value or amounts. We use the methodology of Scholz, Moffitt and Cowan (2009) to impute the value of receiving Housing Assistance. For all other transfer programs the SIPP provides information on the actual amount received.

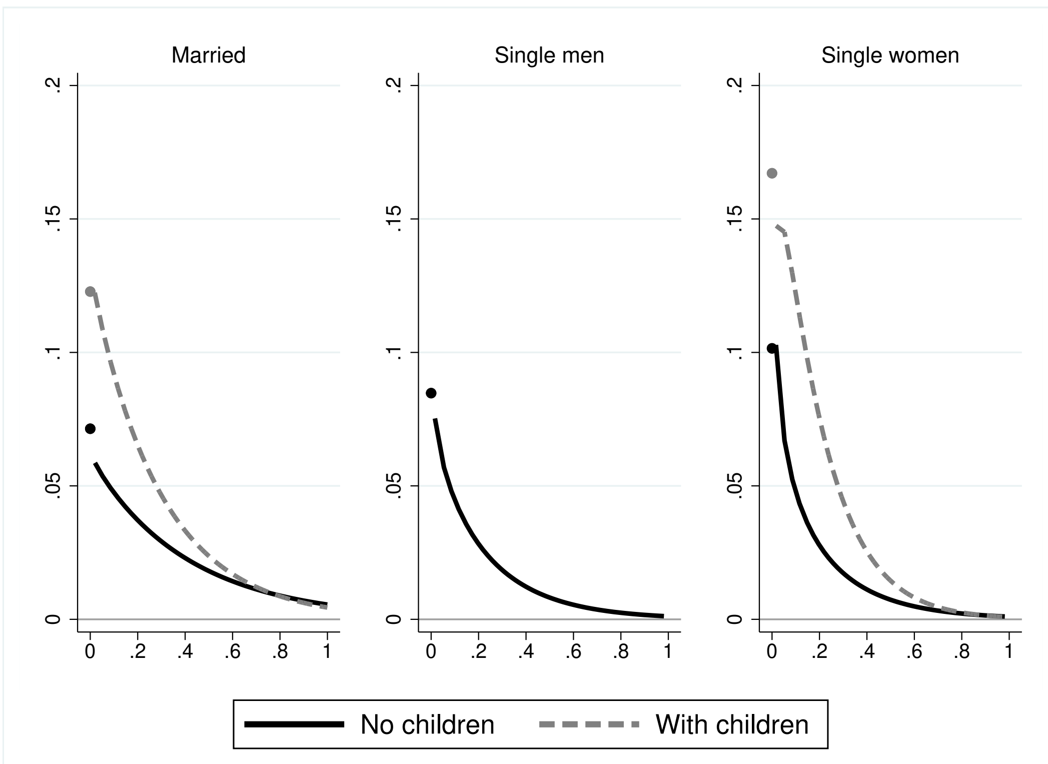
The estimated parameters are presented in Table C.15 for married, single men, and single women depending on whether they have children or not. The first row contains the amount β_0, normalized by average household income, received by households without any labor income. The following rows present the parameters β_1, β_2, and β_3, which together give the schedules presented in Figure C.3.

Table C.15: Welfare functions

	Married		Single men	Single women	
	No kids	With kids	No kids	No kids	With kids
With zero income					
β_0	.071	.123	.085	.102	.167
With positive income					
β_1	-2.843	-2.077	-2.982	-3.272	-1.092
β_2	-2.355	-3.343	-3.808	-3.643	-6.043
β_3	-0.014	-0.010	-0.110	-0.258	0.177

Notes: The parameters of the welfare function are estimated according to Equation (7) using the SIPP 2004. Amounts are normalized by mean household labor income.

Figure C.3: Government transfer schedule by household type



Notes: The dots represent the amounts received by those without any labor income. Amounts are normalized by mean household labor income and are computed using the SIPP 2004. Single men do not have children in the model.

Additional Tables

Table C.16: Employment rate of women by marital status – model vs (data)

	Single	Married
Black	.69 (.68)	.76 (.74)
White	.79 (.78)	.78 (.72)

Notes: The data moments come from the ACS 2006.

Table C.17: Accounting for the black-white marriage gap - Preferences

	Fraction married						
	Educ.	Black BM	Match and prison	Home benefit	Marriage cost	All preferences	White BM
Women	Less than high school	.21	.29	.24	.20	.28	.56
	High school	.35	.33	.35	.30	.32	.62
	Some college	.39	.39	.39	.35	.40	.63
	College	.47	.53	.47	.47	.54	.68
	All	.37	.38	.37	.34	.38	.64
Men	Less than high school	.13	.02	.13	.12	.02	.48
	High school	.39	.40	.40	.34	.39	.59
	Some college	.57	.64	.57	.52	.64	.68
	College	.62	.69	.62	.62	.69	.70
$\Delta^f_{b,w}$ accounted for			.034	.010	-.134	.032	
90% confidence interval			[.016, .065]	[.008, .011]	[-.153,-.099]	[.012, .062]	

Notes: The first column 'black BM' and last column 'white BM' are the fractions of the black and white populations that are married in the benchmark economy. In the column 'preference experiment' are the marriage rates under counterfactual scenarios assigning parameters from the white population to the black population. We assign marriage taste parameters μ_γ, σ_γ, σ_ϕ, and prison cost ζ for Match and prison column; and home benefit α_1, marriage cost $\varkappa$, and the combination of them all in the remaining columns. The row $\Delta^f_{b,w}$ presents the share of the racial-marriage gap accounted for by the experiment. The last row shows the 90% confidence interval of the share of the gap closed simulated by drawing parameters 100 times from the estimated variance-covariance matrix computed using the delta method.

D Standard Errors

In this Appendix, we present further details on the estimation of model parameters and their standard errors. Consider an $M \times 1$ vector of random variables $[m^1, m^2, ..., m^M]'$. Suppose we observe a data set for $i = 1, \ldots, N$ individuals of these variables. Based on the data set, we can estimate the first moments of these variables as

$$\mathbf{M} = [\widehat{m}^1, \widehat{m}^2, ..., \widehat{m}^M]' \text{ where } \widehat{m}^m = \frac{1}{N}\sum_{i=1}^{N} m_i^m.$$

The model produces population moments which are counterparts to the estimated data moments. These model population moments are functions of the $K \times 1$ parameter vector, $\mathbf{\Theta}$, that is $\mathcal{M}^j(\mathbf{\Theta})$ for $j = \{1, ..., M\}$

$$\mathcal{M}^j(\mathbf{\Theta}) = [\mathcal{M}^1(\mathbf{\Theta}), \mathcal{M}^2(\mathbf{\Theta}), ..., \mathcal{M}^m(\mathbf{\Theta})]'.$$

The identifying assumption is that there exists a parameter vector $\mathbf{\Theta}_0$ such that

$$E(\mathbf{M}) = \mathcal{M}(\mathbf{\Theta}_0).$$

The minimum distance estimator is given by

$$\widehat{\mathbf{\Theta}} = \arg\min \mathbf{G}(\mathbf{\Theta})'\mathbf{W}\mathbf{G}(\mathbf{\Theta}), \tag{28}$$

where $\mathbf{G}(\mathbf{\Theta}) \equiv \mathbf{M} - \mathcal{M}(\mathbf{\Theta})$ and $\mathbf{W}$ is a $M \times M$ positive definite weighting matrix.

D.1 The Case of One Data set

Assume, as above, that data moments come from a single data set of size N. The rescaled FOC associated to equation (28) is

$$D(\widehat{\mathbf{\Theta}})'\mathbf{W}\sqrt{N}[\mathbf{M} - \mathcal{M}(\mathbf{\Theta})] = \mathbf{0}_{K\times 1},$$

where

$$D(\mathbf{\Theta}) = \frac{\partial G(\mathbf{\Theta})}{\partial \mathbf{\Theta}} = -\frac{\mathcal{M}(\mathbf{\Theta})}{\partial \mathbf{\Theta}}$$

is a $M \times K$ matrix of derivatives

$$D(\mathbf{\Theta}) = -\begin{bmatrix} \frac{\mathcal{M}^1(\mathbf{\Theta})}{\partial \mathbf{\Theta}_1} & \cdots & \frac{\mathcal{M}^1(\mathbf{\Theta})}{\partial \mathbf{\Theta}_K} \\ \vdots & \ddots & \vdots \\ \frac{\mathcal{M}^M(\mathbf{\Theta})}{\partial \mathbf{\Theta}_1} & \cdots & \frac{\mathcal{M}^M(\mathbf{\Theta})}{\partial \mathbf{\Theta}_K} \end{bmatrix}.$$

Following a central limit theorem

$$\sqrt{N}(G(\widehat{\mathbf{\Theta}}) - 0) \to^d N(0, \mathbf{Q}_0)$$

where

$$\mathbf{Q}_0 = E(G(\widehat{\mathbf{\Theta}})G(\widehat{\mathbf{\Theta}})') = Var(\mathbf{M}) = \begin{bmatrix} Var(m^1) & \dots & Cov(m^1, m^M) \\ \vdots & \ddots & \vdots \\ Cov(m^M, m^1) & \dots & Var(m^M) \end{bmatrix}$$

is the $M \times M$ population variance-covariance matrix for the estimated data moments.

A first order Taylor approximation of $G(\widehat{\mathbf{\Theta}})$ at $\mathbf{\Theta}_0$ is

$$G(\widehat{\mathbf{\Theta}}) = G(\mathbf{\Theta}_0) + D(\mathbf{\Theta}_0)(\widehat{\mathbf{\Theta}} - \mathbf{\Theta}_0).$$

Rescaling, we have

$$\sqrt{N}G(\widehat{\mathbf{\Theta}}) = \sqrt{N}G(\mathbf{\Theta}_0) + D(\mathbf{\Theta}_0)\sqrt{N}(\widehat{\mathbf{\Theta}} - \mathbf{\Theta}_0).$$

Substituting into the FOC,

$$\sqrt{N}(\widehat{\mathbf{\Theta}} - \mathbf{\Theta}_0) = [D(\widehat{\mathbf{\Theta}})'\mathbf{W}D(\mathbf{\Theta}_0)]^{-1}D(\widehat{\mathbf{\Theta}})'\mathbf{W}\sqrt{N}G(\mathbf{\Theta}_0).$$

Then, the asymptotic distribution of the estimator $\widehat{\mathbf{\Theta}}$ is given by

$$\widehat{\mathbf{\Theta}} \sim^a N(\mathbf{\Theta}_0, \frac{[D_0'\mathbf{W}D_0]^{-1} D_0'\mathbf{W}\mathbf{Q}_0\mathbf{W}D_0 \, [D_0'\mathbf{W}D_0]^{-1}}{N}),$$

where

$$D_0 = -E(\frac{\partial\mathcal{M}(\mathbf{\Theta}_0)}{\partial\mathbf{\Theta}}) = -\frac{\partial\mathcal{M}(\mathbf{\Theta}_0)}{\partial\mathbf{\Theta}},$$

because $\mathcal{M}(\mathbf{\Theta}_0)$ is constant with respect to the data.

Standard errors are consistently estimated as

$$\widehat{SE}(\widehat{\mathbf{\Theta}}) = \{diag(\frac{\left[D(\widehat{\mathbf{\Theta}})'WD(\widehat{\mathbf{\Theta}})\right]^{-1} D(\widehat{\mathbf{\Theta}})'\mathbf{W}\widehat{Q}\mathbf{W}D(\widehat{\mathbf{\Theta}}) \left[D(\widehat{\mathbf{\Theta}})'\mathbf{W}D(\widehat{\mathbf{\Theta}})\right]^{-1}}{N})\}^{1/2}$$

where

$$D(\widehat{\mathbf{\Theta}}) = -\frac{\partial\mathcal{M}(\widehat{\mathbf{\Theta}})}{\partial\mathbf{\Theta}}$$

and

$$\widehat{\mathbf{Q}} = \widehat{Var}(x) = \begin{bmatrix} \widehat{Var}(m^1) & \dots & \widehat{Cov}(m^1, m^M) \\ \vdots & \ddots & \vdots \\ \widehat{Cov}(m^M, m^1) & \dots & \widehat{Var}(m^M) \end{bmatrix},$$

is an estimate of $\mathbf{Q}_0$ with

$$\widehat{Var}(m^m) = \frac{1}{N}\sum_{i=1}^{N}\{(m_i^m - \frac{1}{N}\sum_{j=1}^{N} m_j^m)^2\}$$

and

$$\widehat{Cov}(m^m, m^{m'}) = (\frac{1}{N}\sum_{i=1}^{N}(m_i^m m_i^{m'})) - (\frac{1}{N}\sum_{j=1}^{N} m_j^m)(\frac{1}{N}\sum_{k=1}^{N} m_k^{m'}).$$

Hence, if we had one data set, for instance the Current Population Survey (CPS), then we would compute $\widehat{\mathbf{Q}}$ by bootstrapping.

D.2 Multiple Data Sets

Suppose now we have three different data sources of moments: the Current Population Survey (e.g. Table 4 in the paper), and the American Community Survey (e.g. Table 7 in the paper) and moments we take from published sources based on the National Survey of Family Growth (e.g. Table 6 in the paper). Let N_{cps} and N_{acs} be the sample sizes of the CPS and ACS and let $\widehat{\mathbf{Q}}_{CPS}$ and $\widehat{\mathbf{Q}}_{ACS}$ be bootstrapped standard errors.

For the moments from the NSFG provided in published reports, denote the probabilities as $p_{NSFG,j}$ for $j = 1, ..., 18$ (we have 18 of these moments). We are also given standard errors (se) of the probabilities. By definition the standard error is $se = \frac{\sigma}{\sqrt{N}}$, where σ is the standard deviation. For a binomial distribution

$$\sigma^2 = p(1-p).$$

Then, for each moment from the NSFG we have

$$se_{NSFG,j} = \frac{\sqrt{p_{NSFG,j}(1-p_{NSFG,j})}}{\sqrt{N_{NSFG,j}}}, \tag{29}$$

which allows us to compute $N_{NSFG,j}$ (given $se_{NSFG,j}$ and $p_{NSFG,j}$ from the reports). Furthermore, the estimate of $\sigma^2_{NSFG,j} = p_{NSFG,j}(1-p_{NSFG,j})$.

Then $\widehat{\mathbf{Q}}$ has 3 blocks, $\widehat{\mathbf{Q}}_{CPS}$, $\widehat{\mathbf{Q}}_{ACS}$, which are variance-covariance matrices, and $\sigma^2_{NSFG,j}$, which are only variances for $j = 1, .., 18$. Let

$$N = N_{CPS} + N_{ACS} + N_{NSFG,1} + ... + N_{NSFG,18}.$$

The standard errors are given by

$$\widehat{SE}(\widehat{\mathbf{\Theta}}) = \{diag(\frac{\left[D(\widehat{\mathbf{\Theta}})'WD(\widehat{\mathbf{\Theta}})\right]^{-1} D(\widehat{\mathbf{\Theta}})'\mathbf{W}\widehat{Q}\mathbf{W}D(\widehat{\mathbf{\Theta}}) \left[D(\widehat{\mathbf{\Theta}})'\mathbf{W}D(\widehat{\mathbf{\Theta}})\right]^{-1}}{N})\}^{1/2},$$

where each block in $\widehat{\mathbf{Q}}$ will be divided by a factor, N_{CPS}, N_{ACS}, $N_{NSFG,1}, .., N_{NSFG,18}$, i.e. each block is divided by its own sample size.

E Identification

In this Appendix, we show the sensitivity of model targets to changes in parameters. We focus on the parameters $\{\sigma_\phi,\ \mu_\gamma, \sigma_\gamma, \alpha_1, \varkappa, \zeta, \varphi_m^{<HS}, \varphi_m^{HS}, \varphi_m^{SC}, \varphi_m^{C}\}$, and simulate the benchmark economy when we increase each parameter by half of its standard deviation while keeping all other parameters at their benchmark values. We then check how much each moment in Tables 5-9 changes. If a target is particularly helpful in identifying a given parameter, then changes in that parameter should generate larger changes in the corresponding target. The results are presented in Figures E.1-E.10 using heat maps where darker areas indicate larger percentage changes relative to the benchmark values. If a cell is red (blue), then the moment increased (decreased) relative to the benchmark.

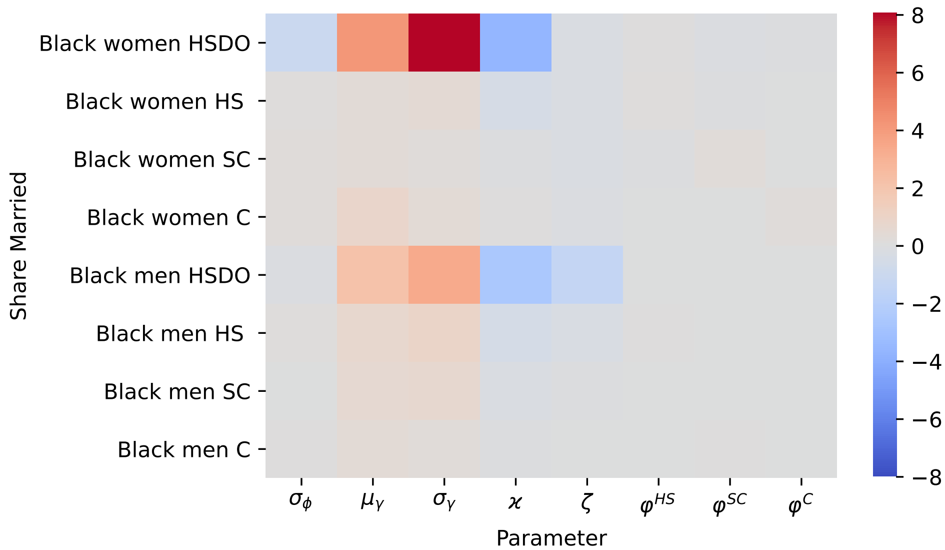
Consider first the mean and the standard deviation of the permanent match quality distribution, μ_γ and σ_γ. Entry into marriage (Figures E.7 and E.8), and the fraction of married population (Figures E.1 and E.2), help us pin down these parameters. Similarly, the fractions of white and black men who are married as well as their labor market status (Figures E.5 and E.6) also help us determine these parameters (especially σ_γ). In the model, black men with low education are relatively unattractive matches, hence a good permanent match quality is key in order for them to marry as much as they do in the data. A larger dispersion provides more matches with random large shocks and, therefore, brings otherwise potentially less attractive unemployed partners above the threshold. Similarly, marriage rates for high school dropouts react to the prison cost ζ as the employed (unemployed) are less (more) likely to go to prison.

The standard deviation of the transitory match quality distribution σ_ϕ affects marriage dynamics (Figures E.7 and E.8), i.e. both entry and exit from marriages.

For white women, the parameter α_1 determines how much a household values women staying at home. As a result, changes in α_1 have a direct affect on labor market transitions of married women (Figure E.4). Couples wanting to marry in the model economy face a one-time fixed cost of marriage, $\varkappa$. This cost is important for the share of low educated men marrying low educated women (Figures E.9 and E.10) and for the age of entry into marriage (Figures E.7 and E.8).

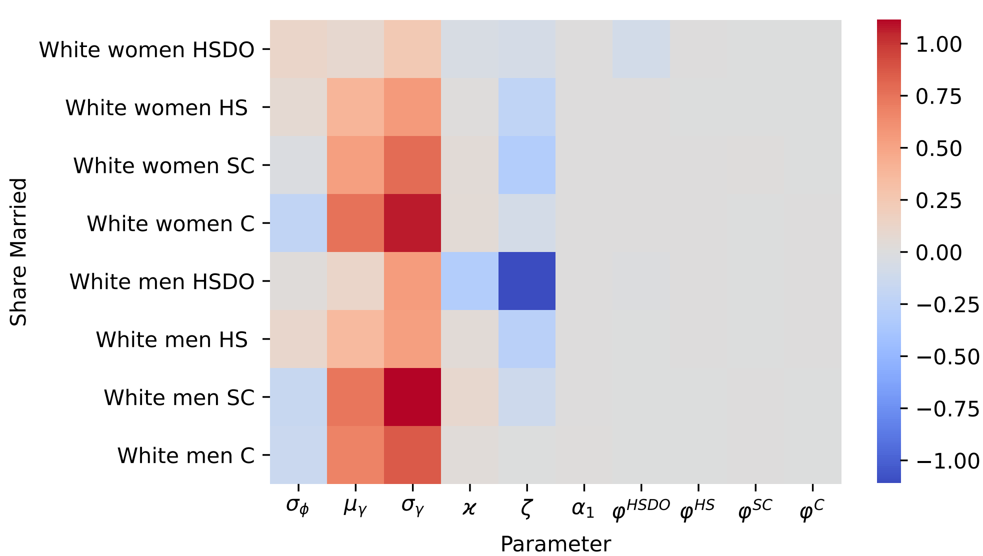
The utility cost of having a husband in prison ζ is higher for white women than for black women. A higher value of ζ lowers the attractiveness of low educated men, which can be seen in Figures E.1 and E.2. Finally, the probability of matching by own education type, φ_m^h, is mostly determined by the probability of marriage with the same education type in Table 7 as can be seen in Figures E.9 and E.10.

Figure E.1: Changes in marriage rates in response to changes in parameters



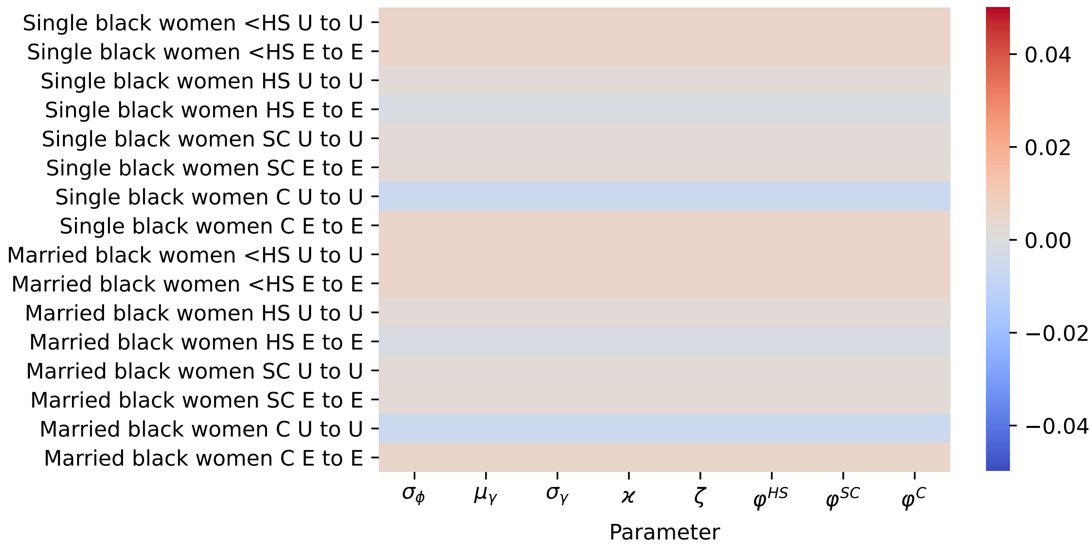
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

Figure E.2: Changes in marriage rates in response to changes in parameters



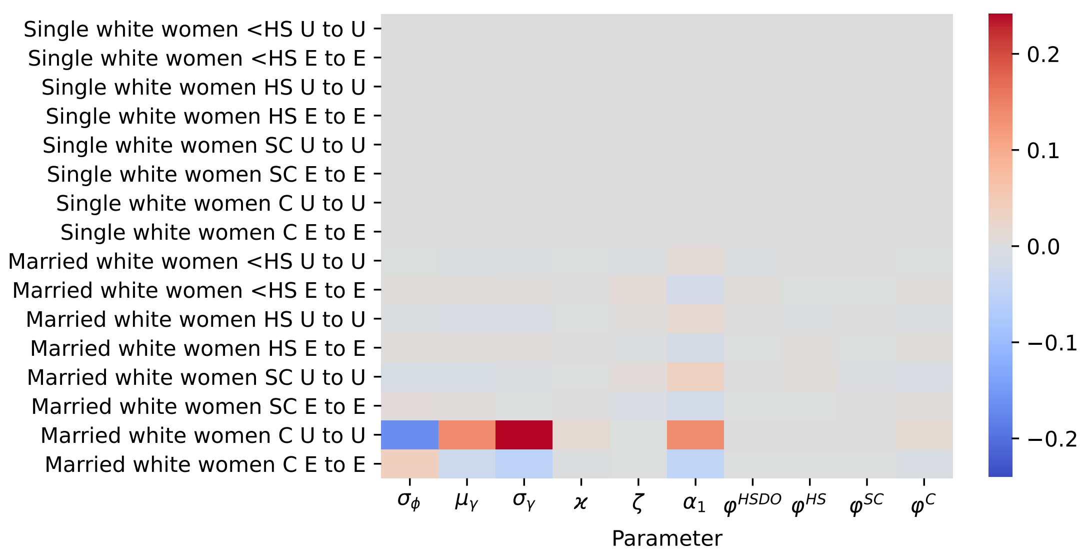
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

Figure E.3: Changes in employment transitions amongst women in response to changes in parameters



Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C). 'U' stands for non-employment and 'E' for employment.

Figure E.4: Changes in employment transitions amongst women in response to changes in parameters

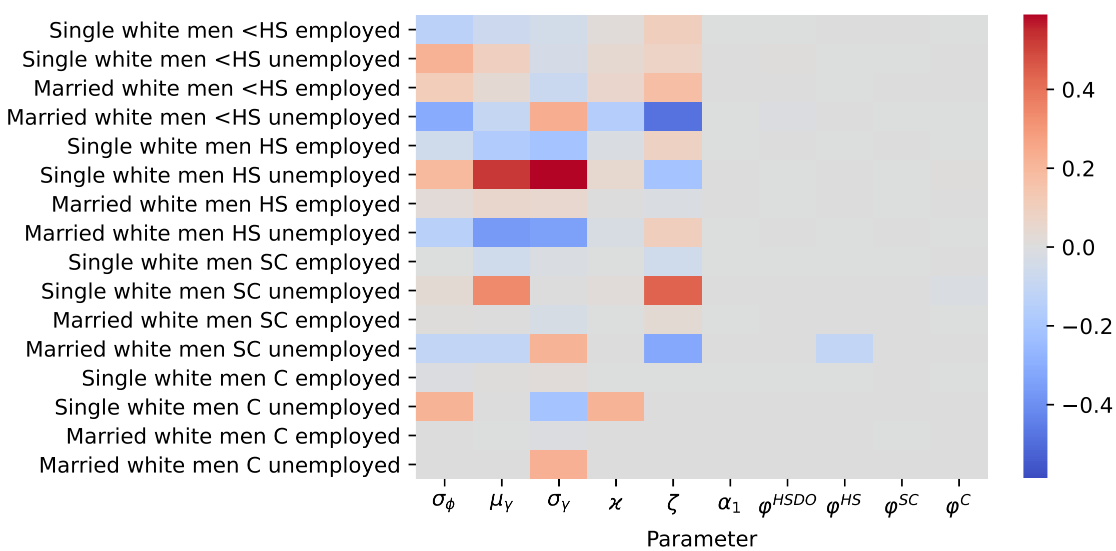


Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C). 'U' stands for non-employment and 'E' for employment.

Figure E.5: Changes in employment status amongst men in response to changes in parameters

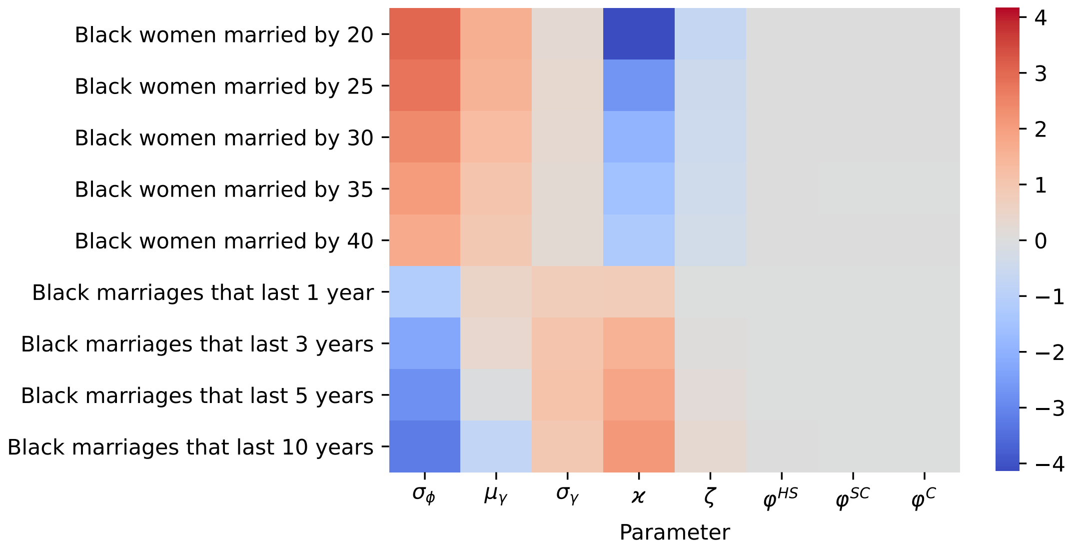
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

Figure E.6: Changes in employment status amongst men in response to changes in parameters



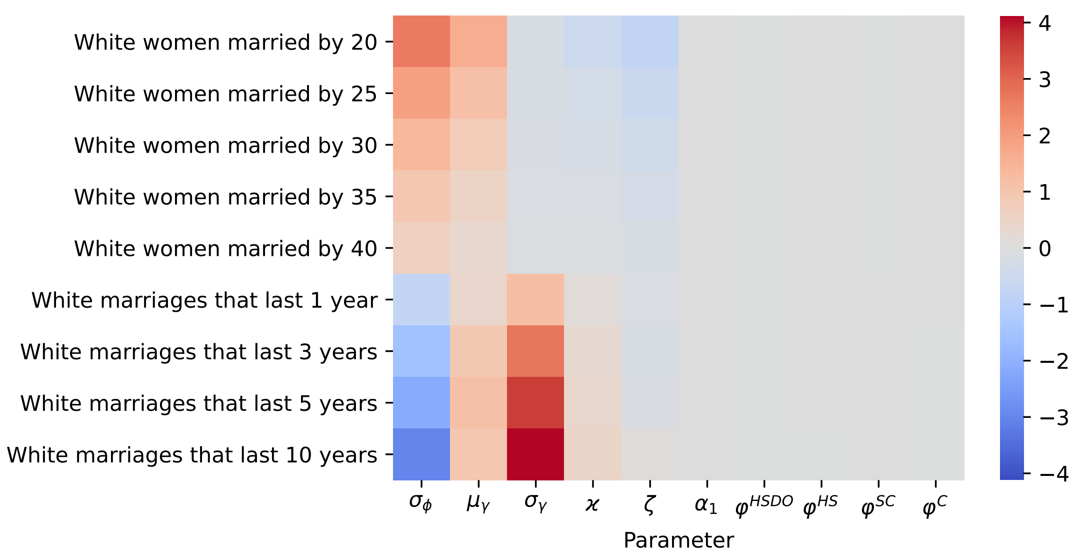
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

Figure E.7: Changes in marriage dynamics in response to changes in parameters



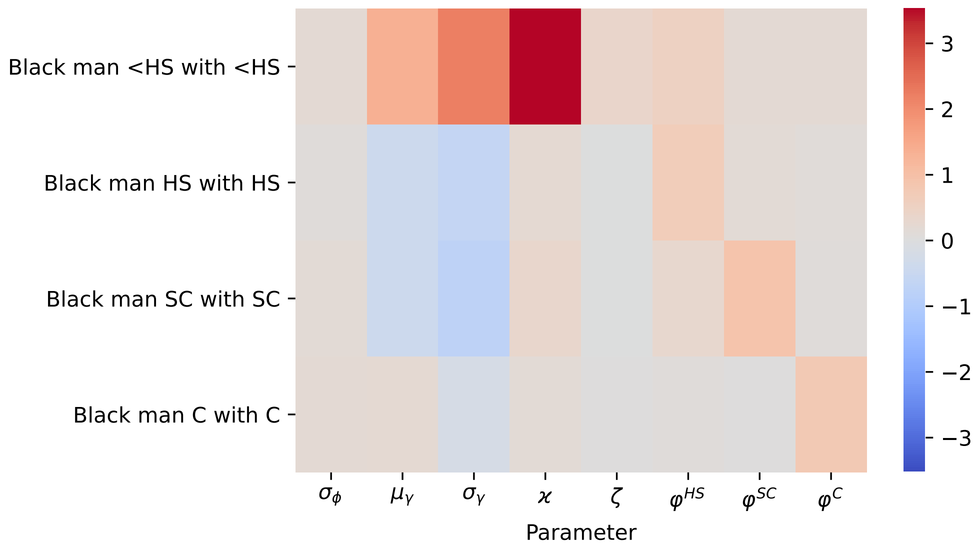
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment.

Figure E.8: Changes in marriage dynamics in response to changes in parameters



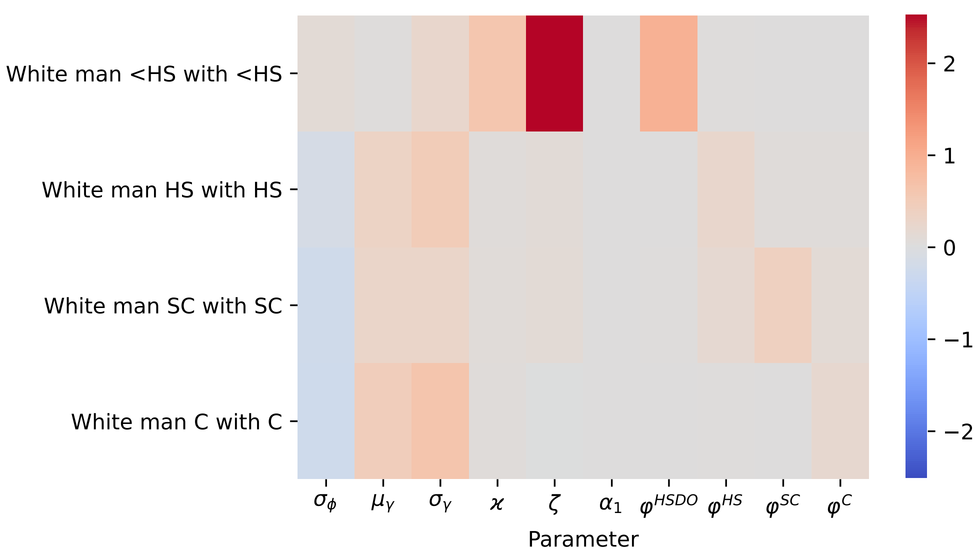
Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment.

Figure E.9: Changes in marital sorting in response to changes in parameters



Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

Figure E.10: Changes in marital sorting in response to changes in parameters



Notes: The heat map displays how moments (left) respond to 0.5 standard deviation increases in parameters (bottom). The scale on the right indicates the percentage change relative to the benchmark model moment. Education levels are less than high school (HSDO), high school (HS), some college (SC), and college or more (C).

F Sensitivity Checks

In this Appendix, we present further details of the results discussed in Section 6.1 of the paper. Section F.1 documents the results when prison-persistence probabilities π_{pp} are decreasing in education, Section F.2 discusses the impact of allowing couples to bargain over ς, and Section F.3 shows the results for a reduction in the risk aversion parameter to $\sigma = 1.5$.

F.1 Sensitivity to Prison-Persistence Probability π_{pp}

Due to data limitations, we assume that the probability of staying in prison, π_{pp}, does not vary by education. Given that less-educated individuals are more likely to go to prison one could imagine that they also experience longer prison terms. In the benchmark estimation, we assume that the prison-persistence probability does not depend on education, i.e. it is the same for all ($\pi_{pp} = 0.667$). In order to assess the impact of this assumption, we conduct experiments in which we set the prison-persistence probability π_{pp} 20% higher (i.e. $\pi_{pp} = 0.8$) for the the lower levels of education (high school and less than high school), and 20% lower (i.e. $\pi_{pp} = 0.533$) for those with college or some college education.[36] We keep all other model inputs and parameter estimates at their benchmark values.

In Tables F.1-F.4 we present the model fit with the adapted π_{pp}, and in Table F.5 we present the outcomes of the Wilson experiments. Overall, the effects on model moments of allowing π_{pp} values to be education dependent are very small.[37] We see very minor increases in marriage durations and marriages of educated black men. Given the small changes as compared to the benchmark economy, the counterfactuals also deliver a very similar message: the Wilson hypothesis again accounts for 78% of the racial-marriage gap.

[36] When setting $\pi_{pp}^{<HS} = \pi_{pp}^{HS} = 0.80$ and $\pi_{pp}^{SC} = \pi_{pp}^{C} = 0.53$ we reconstruct the transition probabilities $\Pi^{r,h,P}(\lambda', \varepsilon' | \lambda, \varepsilon)$.

[37] Due to the fact that the targets in Tables 5 to 9 are affected only marginally, we did not re-estimate the entire model.

Table F.1: Fraction married when changing prison-exit probability

Benchmark, [alternative π_{pp}], (data)

	Education	Black	White
Women	Less than high school	.21 [.21] (.21)	.56 [.56] (.53)
	High school	.35 [.35] (.31)	.62 [.62] (.65)
	Some college	.39 [.39] (.35)	.63 [.63] (.65)
	College	.47 [.47] (.42)	.69 [.68] (.68)
	All	.37 [.37] (.34)	.64 [.64] (.66)
Men	Less than high school	.13 [.13] (.25)	.48 [.48] (.48)
	High school	.39 [.39] (.38)	.59 [.59] (.58)
	Some college	.57 [.57] (.47)	.68 [.68] (.62)
	College	.62 [.63] (.53)	.70 [.70] (.69)

Notes: The numbers in normal font are from the benchmark estimation with $\pi_{pp} = 0.67$ for all levels of education, while those in square brackets are from letting $\pi_{pp} = 0.8$ for those with high school or less than high school education, and $\pi_{pp} = 0.533$ for those with college or some college education.

Table F.2: Marriage dynamics for women when changing prison-exit probability

Panel A: First marriage by a given age

Benchmark, [alternative π_{pp}], (data)

Married by age	20	25	30	35	40
Black	.04 [.04] (.05)	.25 [.24] (.24)	.41 [.41] (.47)	.55 [.54] (.58)	.65 [.64] (.64)
White	.11 [.11] (.14)	.50 [.50] (.48)	.72 [.72] (.74)	.84 [.84] (.84)	.91 [.91] (.89)

Panel B: Marriages intact after given number of years

Benchmark, [alternative π_{pp}], (data)

Duration	1 year	3 years	5 years	10 years
Black	.80 [.80] (.92)	.62 [.63] (.81)	.55 [.56] (.73)	.46 [.47] (.51)
White	.92 [.92] (.95)	.79 [.79] (.86)	.70 [.70] (.78)	.58 [.58] (.64)

Notes: The numbers in normal font are from the benchmark estimation with $\pi_{pp} = 0.67$ for all levels of education, while those in square brackets are from letting $\pi_{pp} = 0.8$ for those with high school or less than high school education, and $\pi_{pp} = 0.533$ for those with college or some college education. The data moments are in parenthesis.

Table F.3: Assortative mating by education when changing prison-exit probability

Benchmark, [alternative π_{pp}], (data)		
Education	Black	White
Less than high school	.06 [.06] (.24)	.28 [.28] (.27)
High school	.53 [.52] (.53)	.55 [.55] (.55)
Some college	.45 [.45] (.45)	.39 [.39] (.39)
College	.63 [.62] (.63)	.68 [.68] (.68)

Notes: The numbers in normal font are from the benchmark estimation with $\pi_{pp} = 0.667$ for all levels of education, while those in square brackets are from letting $\pi_{pp} = 0.8$ for those with high school or less than high school education, and $\pi_{pp} = 0.533$ for those with college or some college education. The data moments are in parenthesis.

Table F.4: Women with children in their household when changing prison-exit probability

Benchmark, [alternative π_{pp}], (data)					
With children by age	25	30	35	40	45
Black	.50 [.50] (.50)	.65 [.65] (.62)	.69 [.69] (.73)	.67 [.67] (.69)	.63 [.63] (.60)
White	.39 [.39] (.35)	.59 [.59] (.58)	.68 [.68] (.73)	.70 [.70] (.73)	.68 [.68] (.64)

Notes: The numbers in normal font are from the benchmark estimation with $\pi_{pp} = 0.667$ for all levels of education, while those in square brackets are from letting $\pi_{pp} = 0.8$ for those with high school or less than high school education, and $\pi_{pp} = 0.533$ for those with college or some college education. The data moments are in parenthesis.

Table F.5: Accounting for the black-white marriage gap when changing prison-exit probability - Wilson hypothesis

Fraction married									
	Educ.	Black BM	Sex ratio	Employ-ment	Job loss	Prison	Wilson	Prefer-ences	White BM
W	<HS	.21 **.21**	.26 **.26**	.32 **.32**	.30 **.30**	.27 **.27**	.50 **.50**	.28 **.28**	.56 **.56**
	HS	.35 **.35**	.41 **.41**	.38 **.38**	.37 **.37**	.47 **.47**	.57 **.57**	.32 **.32**	.62 **.62**
	SC	.39 **.39**	.45 **.45**	.41 **.41**	.41 **.41**	.51 **.51**	.59 **.59**	.40 **.40**	.63 **.63**
	C	.47 **.47**	.51 **.51**	.48 **.48**	.48 **.48**	.56 **.56**	.62 **.62**	.54 **.54**	.68 **.68**
	All	.37 **.37**	.42 **.42**	.40 **.40**	.40 **.40**	.48 **.48**	.58 **.58**	.38 **.38**	.64 **.64**
M	<HS	.13 **.13**	.12 **.12**	.17 **.17**	.16 **.16**	.39 **.38**	.45 **.44**	.02 **.02**	.48 **.48**
	HS	.39 **.39**	.39 **.39**	.44 **.44**	.43 **.43**	.53 **.53**	.56 **.56**	.39 **.39**	.59 **.59**
	SC	.57 **.57**	.56 **.57**	.59 **.59**	.58 **.59**	.63 **.63**	.64 **.65**	.64 **.64**	.68 **.68**
	C	.62 **.63**	.62 **.63**	.64 **.64**	.63 **.64**	.66 **.66**	.66 **.66**	.69 **.69**	.70 **.70**
$\Delta^f_{b,w}$ accounted for			.193 **.193**	.119 **.119**	.090 **.090**	.402 **.402**	.780 **.779**	.032 **.032**	

Notes: The numbers in normal font are from experiments with the parameters from the benchmark estimation with $\pi_{pp} = 0.67$ for all education levels, while those in **bold** are from letting $\pi_{pp} = 0.8$ for those with high school or less than high school education, and $\pi_{pp} = 0.533$ for those with college or some college education.

F.2 Sensitivity to Bargaining Over ς

Here we turn to household decision making. In the benchmark economy, couples solve a joint maximization problem with a fixed weight of $\varsigma = 0.5$. i.e. women and men receive equal shares of the joint utility. Instead, imagine a world where when a new marriage is formed the husband and wife choose its value from a set, $\varsigma \in \mathcal{M}$, and commit to it until the marriage ends. For a given ς, let the value functions associated with problem (4) be denoted by $V_f^{M,n,\varsigma}(\cdot)$ and $V_m^{M,n,\varsigma}(\cdot)$. When a new marriage is formed the household decides on ς by solving

$$\max_{\varsigma \in \mathcal{M}} \varsigma V_f^{M,n,\varsigma}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi)$$
$$+(1-\varsigma) V_m^{M,n,\varsigma}(h_f, q, K, \varepsilon_f, \lambda_f; h_m, \lambda_m, \varepsilon_m, P; \gamma, \phi).$$

We simulate an economy in which $\varsigma \in \mathcal{M} = \{0.3, 0.4, 0.5, 0.6, 0.7\}$, while not re-estimating the model and leaving all other parameters as in the benchmark economy. Recall that the only decision that couples make is about whether the wife should work if she has an opportunity to do so. Why would a couple disagree about this decision? The disagreement arises as the husband might prefer his partner stay home so they can both enjoy q, while the wife might choose to work as this affects her future job opportunities. In particular, if there is a likely divorce next period, the wife has a much stronger incentive to stay attached to the labor market. For white couples, we find that the majority (78%) choose $\varsigma = 0.5$. There are more marriages where women receive a lower share: in 7% and 9% of new marriages, couples choose 0.3 and 0.4, respectively, while 4% and 2% choose 0.6 and 0.7. Because the benchmark parameters (Table 10) set $q = 0$ for black women, allowing households to choose ς does not have any effect as black households are indifferent between values of ς in set $\mathcal{M}$.[38] Due to the fact that the targets in Tables 5 to 9 are hardly affected, we did not re-estimate the entire model and do not present further results of the experiment.

F.3 Sensitivity to Risk Aversion Parameter σ

In Table F.6 we present the parameters resulting from a estimation in which the risk aversion parameter takes the value $\sigma = 1.5$ rather than $\sigma = 2$ as in the benchmark estimation. There are significant changes to parameters. In Tables F.7-F.10 we present the model fit with $\sigma = 1.5$, and in Table F.11 we present the outcomes of the Wilson experiments.

[38] Even with $q = 0$, there could be disagreement between husbands and wives over whether wives should work due to the welfare state. A husband might want his wife to stay home to get higher benefits (if her labor market productivity is low), while she might prefer to work and remain connected to the labor market. Quantitatively, this effect is negligible.

Table F.6: Estimated parameters for benchmark $\sigma = 2$ and alternative $\sigma = 1.5$

Parameters	Description	Black		White	
σ	Relative risk aversion (fixed)	2	1.5	2	1.5
σ_ϕ	Standard deviation of transitory match quality shock	4.74	16.53	12.85	7.05
μ_γ	Mean of permanent match quality shock	-3.66	10.38	-3.53	-1.90
σ_γ	Standard deviation of permanent match quality shock	5.45	23.63	18.84	10.79
α_1	Shape parameter of the distribution for stay-home utility q	0	0	0.77	0.31
$\varkappa$	Monetary fixed cost of getting married	0.03	0.04	0.04	0.04
η	Utility cost of divorce	0	0	0	0.03
ζ	Utility cost of having husband in prison	44.06	459.62	979.22	630.42
$\varphi_m^{<HS}$	Probability of man meeting own type (<HS)	0	0	0.27	0.26
φ_m^{HS}	Probability of man meeting own type (HS)	0.10	0.18	0.28	0.28
φ_m^{SC}	Probability of man meeting own type (SC)	0.22	0.28	0.03	0.03
φ_m^{C}	Probability of man meeting own type (C)	0.54	0.57	0.54	0.55
$\mathcal{K}$	Scale factor for fertility	1.35	1.39	1.27	1.28
ρ_K	Probability of kids leaving home in a period	0.02	0.02	0.02	0.02

Notes: The parameters are estimated using the simulated method of moments. The parameters in the first and third columns are from the benchmark estimation with $\sigma = 2$ and in the second and fourth columns are from the estimation with $\sigma = 1.5$. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C). $\varphi_m^{<HS}$, η, and α_1 for blacks, and η when $\sigma = 2$ for whites are set to zero as they hit this lower bound in the estimation.

Table F.7: Fraction married when changing risk aversion

Benchmark $\sigma = 2$, [alternative $\sigma = 1.5$], (data)

	Education	Black	White
Women	Less than high school	.21 [.33] (.21)	.56 [.56] (.53)
	High school	.35 [.35] (.31)	.62 [.62] (.65)
	Some college	.39 [.38] (.35)	.63 [.63] (.65)
	College	.47 [.45] (.42)	.69 [.67] (.68)
	All	.37 [.38] (.34)	.64 [.64] (.66)
Men	Less than high school	.13 [.14] (.25)	.48 [.48] (.48)
	High school	.39 [.40] (.38)	.59 [.59] (.58)
	Some college	.57 [.57] (.47)	.68 [.69] (.62)
	College	.62 [.63] (.53)	.70 [.70] (.69)

Notes: The numbers in normal font are from the benchmark estimation with $\sigma = 2$, while those in square brackets are from the estimation with $\sigma = 1.5$. The data moments are in parenthesis. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Table F.8: Marriage dynamics for women when changing risk aversion

Panel A: First marriage by a given age

Benchmark $\sigma = 2$, [alternative $\sigma = 1.5$], (data)

Married by age	20	25	30	35	40
Black	.04 [.04] (.05)	.25 [.24] (.24)	.41 [.41] (.47)	.55 [.55] (.58)	.65 [.65] (.64)
White	.11 [.11] (.14)	.50 [.50] (.48)	.72 [.72] (.74)	.84 [.84] (.84)	.91 [.91] (.89)

Panel B: Marriages intact after given number of years

Benchmark $\sigma = 2$, [alternative $\sigma = 1.5$], (data)

Duration	1 year	3 years	5 years	10 years
Black	.80 [.84] (.92)	.62 [.67] (.81)	.55 [.58] (.73)	.46 [.48] (.51)
White	.92 [.92] (.95)	.79 [.80] (.86)	.70 [.71] (.78)	.58 [.59] (.64)

Notes: The numbers in normal font are from the benchmark estimation with $\sigma = 2$, while those in square brackets are from the estimation with $\sigma = 1.5$. The data moments are in parenthesis.

Table F.9: Assortative mating by race and education when changing risk aversion

Benchmark $\sigma = 2$, [alternative $\sigma = 1.5$], (data)

Education	Black			White		
Less than high school	.06	[.14]	(.24)	.28	[.28]	(.27)
High school	.53	[.53]	(.53)	.55	[.55]	(.55)
Some college	.45	[.48]	(.45)	.39	[.39]	(.39)
College	.63	[.65]	(.63)	.68	[.68]	(.68)

Notes: The numbers in normal font are from the benchmark estimation with $\sigma = 2$, while those in square brackets are from the estimation with $\sigma = 1.5$. The data moments are in parenthesis. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

Table F.10: Women with children in their household when changing risk aversion

Benchmark $\sigma = 2$, [alternative $\sigma = 1.5$], (data)

With children by age	25	30	35	40	45
Black	.50 [.51] (.50)	.65 [.66] (.62)	.69 [.68] (.73)	.67 [.66] (.69)	.63 [.61] (.60)
White	.39 [.39] (.35)	.59 [.59] (.58)	.68 [.68] (.73)	.70 [.70] (.73)	.68 [.68] (.64)

Notes: The numbers in normal font are from the benchmark estimation with $\sigma = 2$, while those in square brackets are from the estimation with $\sigma = 1.5$. The data moments are in parenthesis.

Table F.11: Accounting for the black-white marriage gap when changing risk aversion from $\sigma = 2$ (benchmark) to $\boldsymbol{\sigma} = \mathbf{1.5}$ - Wilson hypothesis

Fraction married

	Educ.	Black BM	Sex ratio	Employment	Job loss	Prison	Wilson	Preferences	White BM
W	<HS	.21 **.33**	.26 **.38**	.32 **.36**	.30 **.35**	.27 **.46**	.50 **.57**	.28 **.28**	.56 **.56**
	HS	.35 **.35**	.41 **.40**	.38 **.38**	.37 **.37**	.47 **.48**	.57 **.58**	.32 **.32**	.62 **.62**
	SC	.39 **.38**	.45 **.44**	.41 **.41**	.41 **.40**	.51 **.51**	.59 **.60**	.40 **.40**	.63 **.63**
	C	.47 **.45**	.51 **.50**	.48 **.47**	.48 **.47**	.56 **.55**	.62 **.62**	.54 **.51**	.68 **.67**
	All	.37 **.38**	.42 **.43**	.40 **.40**	.40 **.40**	.48 **.50**	.58 **.59**	.38 **.38**	.64 **.64**
M	<HS	.13 **.14**	.12 **.12**	.17 **.19**	.16 **.17**	.39 **.45**	.45 **.48**	.02 **.00**	.48 **.48**
	HS	.39 **.40**	.39 **.40**	.44 **.44**	.43 **.43**	.53 **.56**	.56 **.57**	.39 **.39**	.59 **.59**
	SC	.57 **.57**	.56 **.56**	.59 **.58**	.58 **.58**	.63 **.65**	.64 **.66**	.64 **.64**	.68 **.69**
	C	.62 **.63**	.62 **.63**	.64 **.64**	.63 **.64**	.66 **.66**	.66 **.66**	.69 **.68**	.70 **.70**
$\Delta^f_{b,w}$ accounted for			.193 **.196**	.119 **.100**	.090 **.076**	.402 **.481**	.780 **.823**	.032 **.003**	

Notes: The numbers in normal font are from experiments with the parameters from the benchmark estimation with $\sigma = 2$, while those in **bold** are from experiments using the parameters estimated with $\sigma = 1.5$. Education levels are less than high school (<HS), high school (HS), some college (SC), and college or more (C).

G Data Appendix

In this Appendix we provide details on the datasources used, sample selection criteria, and sample characteristics.

National Longitudinal Survey of Youth 1979

For the transitions between employment and non-employment we rely on the CPS MORG. However, the CPS MORG does not contain information about incarceration. Therefore, we also use the the National Longitudinal Survey of Youth 1979 (NLSY). The NLSY is a panel which began in 1979 with a sample of 12,686 men and women born between 1957-64. Sample members were interviewed annually from 1979-1994 and every two years thereafter. We restrict the sample to non-Hispanic US-born black and white men aged 25-54 years who are not in full-time education. We use the NLSY sampling weights in order to correct for oversampling of certain groups.

We reconstruct weekly work histories including hours worked and define two labor market statuses: employed and non-employed. The non-employed encompass both the unemployed and those out of the labor force. Similar to Blandin (2018), we consider as employed any individual working at least 500 hours and 25 weeks in a given calendar year. All others are considered non-employed.

Survey of Inmates in State and Federal Correctional Facilities

In this Appendix, we present further details on our sample from the Survey of Inmates in State and Federal Correctional Facilities (SISCF). Table G.1 summarizes key characteristics for state (left columns) and federal (right columns) prisoners that entered prison within the last twelve months. As in our quantitative study, we restrict the sample to 25-54 year olds. The average age is 36 for both state and federal prisoners, while the average sentence length is substantially longer in federal prison (nine vs. six years). While in state prison the sample is nearly balanced in terms of race, in federal prison inmates are predominantly black (63%). In terms of education, in state prison 36% did not complete high school, 52% completed at most high school, 10% have some college education, while 3% have completed college. Federal prisoners, on average, are more educated than state prisoners.

One common fallacy is that predominantly young men enter prison. Figure G.1 plots the age distribution of male inmates that report having entered into prison within the last twelve months. The gray bars represent the share of black men, whereas the white bars represent the share of white men by age. The left panel displays the distribution for state and the right panel for federal prison. It is important to note that only about 14% of the prison population is in federal prison. The probability of entering into prison is declining with age and nearly tampers off above the age of 60. However, a substantial fraction of recent new entries into (state) prison are in their forties for both black and white men, and the age distribution, in particular in state prisons, is rather uniform between ages 20 and 50.

In Figure G.2, we plot the probability of transitioning into prison at a given age by race and education using the methodology described in Section 4.1. Each panel is dedicated to

Table G.1: Descriptive statistics of inmate sample

	State		Federal	
	Mean	[SD]	Mean	[SD]
Age	36.07	[7.53]	35.71	[7.21]
Sentence (years)	6.37	[9.13]	9.38	[8.06]
Race				
White	.48	[.5]	.37	[.48]
Black	.52	[.5]	.63	[.48]
Education				
Less than high school	.36	[.48]	.19	[.39]
High school	.51	[.5]	.56	[.5]
Some college	.1	[.30]	.17	[.37]
College	.03	[.18]	.08	[.27]
Observations	1652		311	

Notes: Descriptive statistics are computed using the SISCF 2004. In general, 14% (86%) of the total inmate population is held in federal (state) prison.

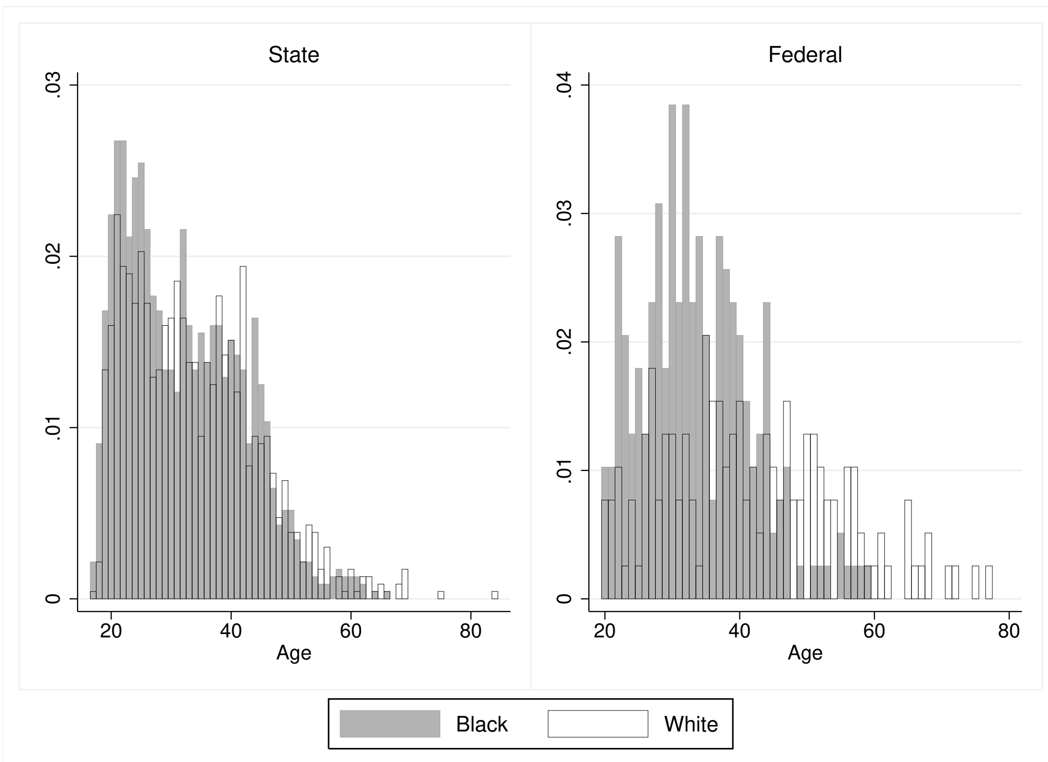
one of the levels of education, while the solid line refers to black men and the dashed line to white men. Black men are more likely to transition into prison than white men at all ages within each level of education.

In Figure G.3 we plot the distribution of sentence lengths for black men (gray bars) and white men (white bars) for state (left) and federal (right) inmates in our restricted sample. In state prison the modal sentence length for black and white men is two years and more than 50% have sentences of less than five years. In federal prison we see that, in particular for black men, the share of inmates with lengthy sentences is higher. Almost 10% of black inmates face sentences of more than 25 years and about 30% of at least 10 years. For white inmates these shares are less than half of what they are for black inmates.

The distribution of offenses by race is displayed in Figure G.4. For black men in state prisons (black bars in left panel) the most frequent offense is drug trafficking, followed by burglary, armed robbery, and aggravated assault. For white men in state prison (white bars in left panel), the three most frequent offenses are burglary, theft, and driving under the influence of alcohol. In federal prison (right panel), the three most frequent offenses for black men are cocaine/crack trafficking, offenses involving illegal possession of weapons, and drug trafficking. For white men, drug trafficking, weapon offenses, and trafficking of controlled substances are the most frequent offenses.[39]

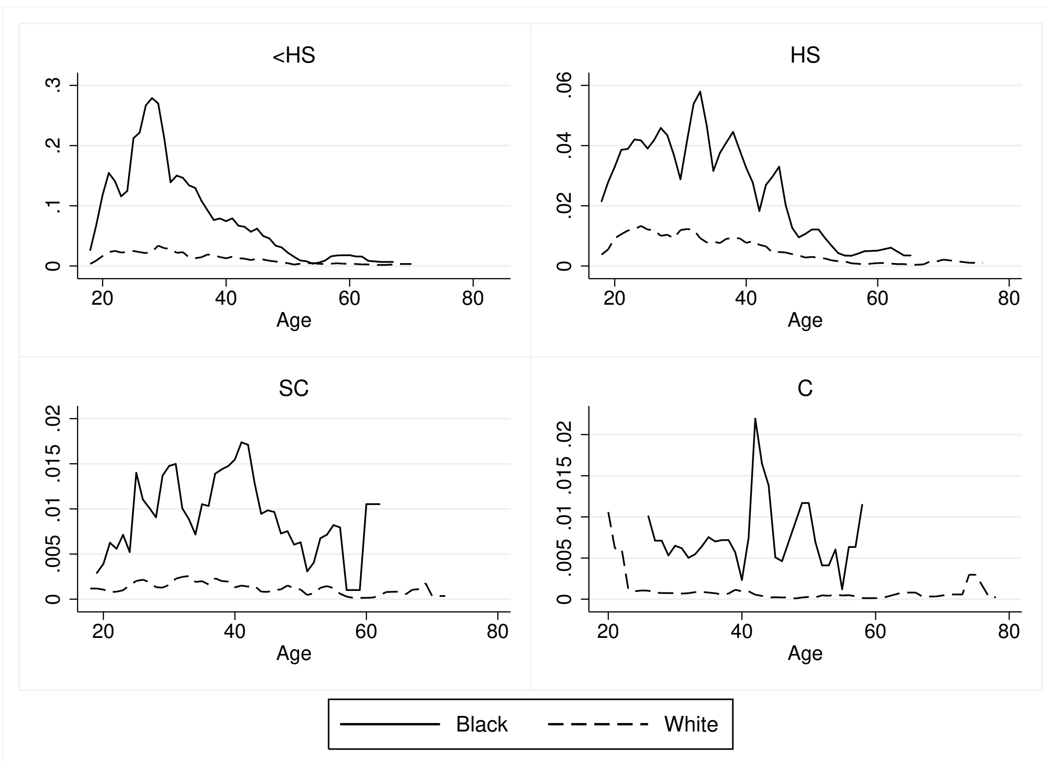
[39]In many cases the type of illegal drug is not specified. Surprisingly, cocaine and crack are bunched in the same category even though under mandatory sentence lengths under federal law the sentencing disparity was 100:1 for crack versus cocaine in 2004. For black men, crack is likely to be the dominant substance within the crack/cocaine category. For white men, methamphetamines and "crystal meth" are likely to be the dominant substances within the controlled substances category.

Figure G.1: Age distribution of inmates by race that entered prison within last year



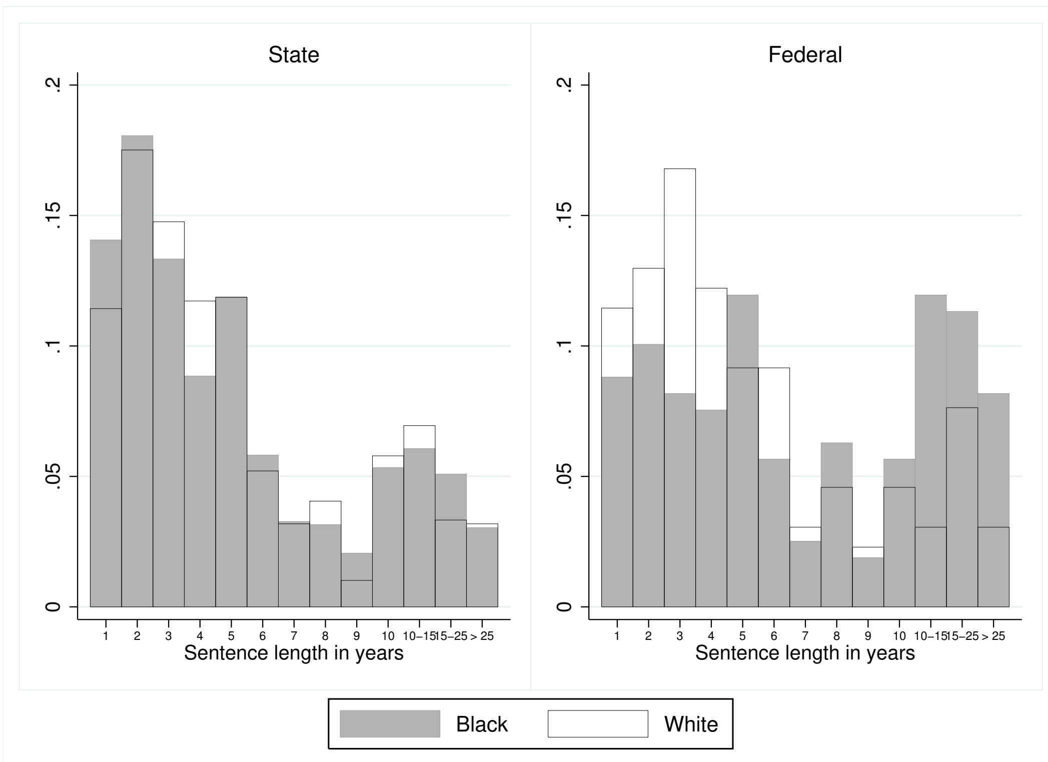
Notes: The age distributions of inmates that entered prison within last year are computed using the SISCF 2004.

Figure G.2: Probability of transitioning into prison by age, education, and race



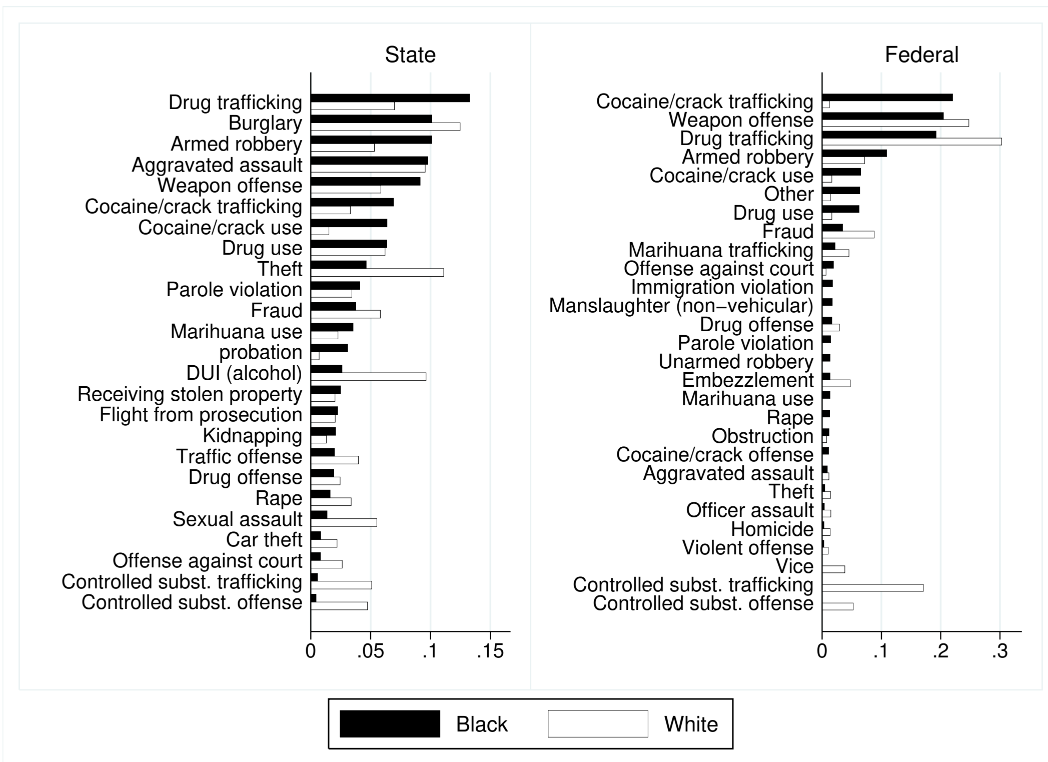
Notes: The age distributions of inmates that entered prison within last year are computed using the SISCF 2004. Then, using the total number of admissions and population statistics from the CPS 2004, the probability of going to prison at a certain age is computed.

Figure G.3: Sentence distribution of inmates by race that entered prison within the last year



Notes: The sentence distributions of inmates that entered prison within last year are computed using the SISCF 2004.

Figure G.4: Offenses of inmates by race that entered prison within the last year



Notes: The distributions of offenses of inmates that entered prison within last year are computed using the SISCF 2004.

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