

Is Marriage for White People? Incarceration and the Racial Marriage Divide

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Abstract

The differences between black and white household and family structure have been a concern for policy makers for a long time. The last few decades, however, have witnessed an unprecedented retreat from marriage among blacks. In 1970, about 89% of black females between ages 25 and 54 were ever married, in contrast to only 51% today. Wilson (1987) suggests that the lack of marriageable black men due to incarceration and unemployment is behind this decline. In this paper, we take a fresh look at the Wilson Hypothesis. We argue that the current incarceration policies and labor market prospects make black men much riskier spouses than white men. They are not only more likely to be, but also to become, unemployed or incarcerated than their white counterparts. We develop an equilibrium search model of marriage, divorce and labor supply that takes into account the transitions between employment, unemployment and prison for individuals of different race, education, and gender. We calibrate this model to be consistent with key statistics for the US economy. We then investigate how much of the racial divide in marriage is due to differences in the riskiness of potential spouses, heterogeneity in the education distribution, and heterogeneity in wages. We find that differences in incarceration and employment dynamics between black and white men can account for about 76% of the existing black-white marriage gap in the data. We also study how "The War on Drugs" in the US might have affected the structure of the black families, and find that it can account for between 13% to 41% of the black-white marriage gap.

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1 Introduction

The differences between black and white household and family structure have been a concern for policy makers for a long time – see, among others, Moynihan (1965). The last few decades, however, witnessed an unprecedented retreat from marriage among blacks. In 1970, about 94% of white and 89% of black females between ages 25 and 54 were ever married. Today, while 79% of white females between ages 25 and 54 are ever married, only 51% of black females are. The growing racial gap in marital status of the US population led some observers to question whether the marriage is only for whites after all (Banks 2011).

Blacks marry later and divorce more than whites. The lower marriage rate among blacks is primarily due to lack of entry into marriage rather than higher marital instability. In 2006-2007, almost 74% (90%) of white females were married by age 30 (40), while only 47% (64%) of black women were ever married by that age (Copen et al 2012). As a result, the median age at first marriage is higher for black than it is for whites. In 2010, black women marry four years later than their white counterparts, 30 versus 26.4 years, while in 1970 the median age at first marriage was about 24 years for both white and black females, and before 1970 black women were marrying at an earlier age than white women (Elliot et al 2012). Although blacks are more likely to divorce, differences in divorce rates are less pronounced than differences in entry into marriage. In 2002, the probability of divorce for first marriages after 5 (10) years was 22% (36%) for white and 27% (49%) for black women (Mosher et al 2010). Durations of black and white marriage are also quite comparable; the median duration for first marriages that end in divorce was 8.3 for black women and 7.9 years for white women in 2009. Upon divorce, however, blacks are again less likely to remarry. The median duration until remarriage after divorce was 4.7 years for black women and 3.6 for white women (Kreider and Ellis 2010).

One reason to be concerned about this dramatic shift in the marital structure of the population is that it has important implications for the living arrangements and well-being of children. In 2014, 70.9% of births among blacks were to unmarried women, while the fraction of out-of-wedlock births among white women was much lower, just 29.2% (Hamilton et al 2015). Today about 50% of black children live with a single mother, while the percent of white children living with a single mother is about 20%.¹ Differences in family structure

¹The US Census data on the Living Arrangements of Children, Table CH2.

is a contributing factor to differences in economic resources. In 2006, just before the recent recession, 33.4% of black children were living below the poverty line, while only 14.1% of white children were.²

A growing body of literature suggests that the initial conditions under which children grow up matter greatly for their well-being as adults. Carneiro and Heckman (2003) and Cunha, Heckman, Lochner and Masterov (2006), among others, show 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) show that pre-labor market conditions can account for almost all of the wage gap between black and white males.³ Since Neal and Johnson (1996), others have tried to uncover the factors that can explain different initial conditions that black and white children face. Badel (2010), for example, builds a model of neighborhood and school choice by parents and shows that segregation of blacks and whites into separate neighborhoods has an important impact on the achievement gap between black and white children. There is also a large literature that documents the effects of family structure on children (McLanahan and Sandefur 2009 and McLanahan, Tach, and Schneider 2013). Gayle, Golan and Soytaş (2015) point to the importance of differences in family structure between blacks and whites. They build and estimate a model of intergenerational mobility where parents invest goods and time into the human capital accumulation of their children. Their results indicate that differences in family structure between blacks and whites play a key role in accounting for differences in children's outcomes. They take, however, the differences in family structure as exogenous.

Why do blacks marry at such a low rate compared to whites? Wilson (1987) suggests that characteristics of the black male population, and in particular the lack of marriageable black men, has been an important contributing factor to the black and white differences in marital status, which is usually referred as the Wilson Hypothesis in the literature. Others, e.g. Murray (1984), point to the adverse effects of the welfare state that provides incentives for single motherhood. The empirical evidence, which, going back to Lichter, McLaughlin, and Landry (2012), relied on variations across geographical locations, suggests that the

<https://www.census.gov/hhes/families/data/children.html>

²The US Census data on Historical Poverty Tables: People and Families - 1959 to 2015. Table 3. <http://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-people.html>

³For 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).

incarceration of black males has an important effect on fertility, education and marriage behavior of black women. Mechoulan (2011) shows that male incarceration lowers the odds of black women's school attainment and non-marital fertility. More directly related to the current paper, Charles and Luoh (2010) show that higher incarceration rates of males lowers the likelihood of women ever getting married as well as lowers the quality of their husbands. These papers belong to a larger empirical literature that emphasizes the importance of local labor market conditions on marriage and divorce behavior. Autor, Dorn and Hanson (2015), who study the impact of local trade shocks, i.e. captured by import competition from China, affects household and family structure, is a recent example in this literature.

There have been very few attempts to account for differences in black and white marriage rates within an equilibrium model of the marriage market. Keane and Wolpin (2010) try to understand differences in schooling, fertility and labor supply outcomes of black and white women. They focus on life-cycle decisions of women and allow for explicit marriage decisions. The marriage decision is, however, one sided, i.e. given an opportunity to marry and a pool of potential husbands, women decide whether to get married or not. Their estimates suggest that black women have a higher utility cost of getting married than white women and that this difference might reflect the characteristics of the available pool of men. Their counterfactual experiments imply that marriage market parameters, i.e. preferences for marriage as well as earnings of potential husbands, play an important role in explaining the marriage gap between black and white women. Their analysis is, however, silent on why black women might have a higher utility cost of getting married. Seitz (2009) builds and estimates a dynamic search model of marriage to study how much the lack of marriageable black men affects the marriage gap between whites and blacks. She finds that differences in the sex ratio between blacks and whites can account for about one-fifth of the marriage gender gap, and about an additional one-third is accounted for by differences in employment opportunities. There has not been any attempts in the literature, however, to explicitly account for the transitions of black males in and out of prison and how this affects the marriage decisions.

In this paper, we take a fresh look at the Wilson hypothesis. Our argument is that given current incarceration policies and labor market prospects, black men are much riskier spouses than white men. They are more likely to be unemployed or incarcerated than their white counterparts. As a result, marriage is a risky investment for black women (Oppen-

heimer 1988). Almost 11% of black men between ages 25 and 54 were incarcerated in 2010. This is almost five times as high as the incarceration rate for the white men of the same age. Cumulative effects of incarceration in the lives of less educated black men are simply astonishing. For men who were born between 1965 and 1969, the cumulative risk of imprisonment by ages 30 to 34 were 20.5% if they were black and only 2.9% if they were white (Western 2006). For a black man with less than high school education, the cumulative risk is close to 60%. Black men, between ages 25 and 54, are also less likely to be employed, 60% vs. 85%, and more likely to be unemployed, 7.3% vs. 3.6%, as compared to their white counterparts. Western (2006), Neal and Rick (2014), and Lofstrom and Raphael (2016) document the effects of the prison boom of recent decades on the economic prospects of the blacks. Fryer (2011) provides an overview of racial inequality in the U.S.

We develop an equilibrium model of marriage, divorce and labor supply that takes into account the transitions between employment, unemployment and prison. We build upon recent quantitative models of family, such as Regalia and Ríos-Rull (2001), Caucutt, Guner and Knowles (2002), Fernandez and Wong (2014), Guvenen and Rendall (2015), Greenwood et al. (2016), and Santos and Weiss (2016). Knowles and Vandenbroucke (2016) studies how changes in the male-to-female sex ratio after the WWI affected the marriage dynamics, and conclude that individuals' incentives to enter into marriages play a more important role than changes in sex ratio. Doepke and Tertilt (2016) and Greenwood, Guner and Vandenbroucke (2016) review this literature.

In the model, each period single men and women with levels of productivity are matched in a marriage market segmented by race. They decide whether or not to marry taking into account what their next best option is. Husbands and wives also decide whether to stay married and whether the wife should work in the labor market. There is a government that taxes and provides welfare benefits to poor households. As in Burdett, Lagos and Wright (2003, 2004) individuals in our model move among three labor market states (employment, non-employment and prison).⁴ In the model, faced with a pool of men whose future income prospects are highly uncertain, many single women will choose to wait for a better match instead of getting married. Since marriage is a rare event for blacks, they also have an

⁴While in our model criminal activity is not a choice and transitions to prison are exogenous, our paper is also related to the large literature, going back to Becker (1968), on economics of crime. See, among others, Imrohorglu, Merlo and Rupert (2004) and Lochner (2004).

incentive to continue their existing match.

We calibrate this model to be consistent with key marriage and labor market statistics by gender, race and educational attainment for the US economy in 2006. We then investigate how much of the racial divide in marriage is due to differences in the riskiness of potential spouses, heterogeneity in the education distribution, and heterogeneity in wages. We find differences in incarceration rates between black and white men can account for about 76% of the existing black-white marriage gap in the data. We also study how “The War on Drugs” in the US might have affected the structure of the black families, and find that it can account for between 13% to 41% of the black-white marriage gap.

2 Incarceration and Marriage

Table 1, using data from the 1970-2000 US Censuses and the 2006 and 2013 American Community Survey (ACS), documents the marital status of the female population by race since 1970. In 1970, about 94% of white females between ages 25 and 54 were ever married. Blacks married at a lower rate even back in 1970, but the race gap concerning the ever-married population was much smaller. About 89% of black females between ages 25 and 54 were ever married in 1970. Since 1970, the fraction of ever-married females declined for both races. By 2013, only 79% of white females between ages 25 and 54 were ever-married, a 15 percentage point decline from 1970. The decline for black females, however, was more pronounced. In 2013, only about 51% of black females in this age group were ever married, a decline of 38 percentage points.

Table 1: Marital Status of Females by Race, 1970-2010 (%)

	Ever Married		Never Married		Divorced		Divorce or Separated	
	Black	White	Black	White	Black	White	Black	White
1970	.89	.94	.11	.06	.08	.22	.05	.07
1980	.81	.91	.19	.09	.14	.27	.1	.12
1990	.69	.88	.31	.12	.16	.26	.13	.15
2000	.65	.86	.35	.14	.16	.24	.14	.17
2006	.57	.84	.43	.16	.15	.22	.15	.18
2013	.51	.79	.49	.21	.14	.2	.15	.17

The results in Table 1 do not change, if we also consider population cohabiting couples. Figure 1 shows the fraction of females between ages 25 and 54 who ever married or are

currently cohabiting. While cohabitation mutes the decline in marriage to some extent, the marriage gap between blacks and whites hardly changes.

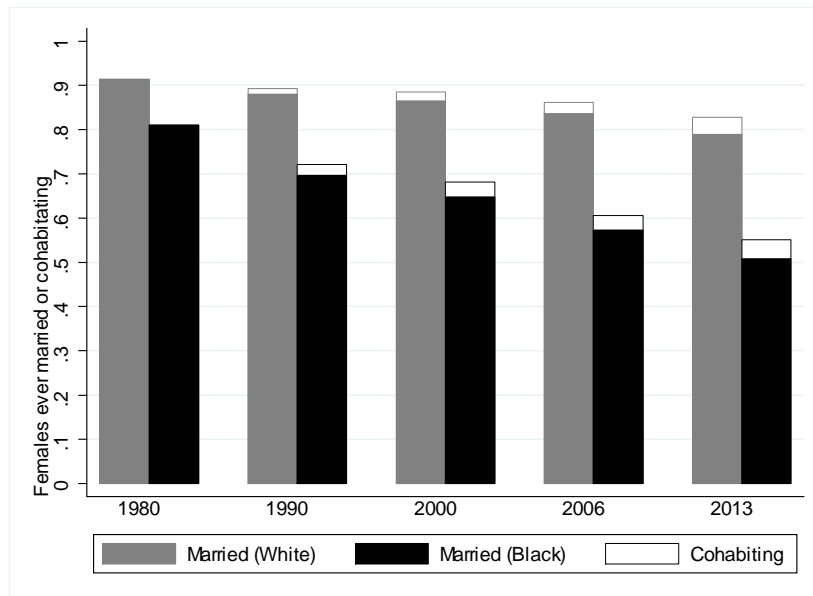


Figure 1: Ever Married or Cohabiting Females

In a press conference in 1971 president Richard Nixon declared illegal drugs as public enemy number one, which the media popularized as the “War on Drugs”. It was not until 1982 that president Ronald Reagan officially announced the War on Drugs. This led to a substantial increase in anti-drug funding and incentives for police agencies to arrest drug offenders. As part of the Comprehensive Crime Control Act of 1984, the Sentencing Reform Act and the Asset Forfeiture Program were introduced, of which the latter permitted federal and local law enforcement agencies to seize assets and cash under the suspicion of being related to illegal drug business.⁵ The Sentencing Reform Act as well as the subsequent Anti-Drug Abuse Act of 1986 included penalties such as mandatory minimum sentences for the distribution of cocaine. The federal criminal penalty for crack cocaine compared to cocaine was set to 100:1, which disproportionately affected poor black, in particular urban, neighborhoods. It was not until the Fair Sentencing Act of 2010 that Barack Obama the disparity was reduced to 18:1. In 1994 president Bill Clinton’s endorsed the “three strikes and you’re out” principal leading to multiple states’ adoption of a law sentencing offenders to life for their third offense (West, Sabol and Greenman 2010). State prisoners held for drug

⁵Baicker and Jacobson (2007) find that police agencies respond by increasing drug arrest rates.

offenses in 2006 nearly match the number of total state prisoners for any offense in 1980 (264,300 vs 304,759 (BJS 1981)).⁶ The growing number of blacks with a criminal record also made it increasingly difficult for them to find jobs after their time in prison, and as a result, unemployment rates among blacks also soared (see Page 2007).

Table 2 shows the fraction of males between ages 25 and 54 who are incarcerated or not employed (i.e. unemployed or out of the labor force). In 1970, about 8% of black men were either in prison or unemployment. The same number for whites was about 3.5%. By 2010, almost one third of all black men are either in prison or unemployed in contrast to about 12.5% of whites. During this period, there has been an almost three-folds increase in the fraction of black men who are incarcerated (from 3.5% to 11%) and a nearly five fold increase in the fraction of black men who are unemployed (from 5% to 21%).

Table 2: Incarceration and Unemployment by Race, 1970-210 (%)

	Incarceration		Unemployed	
	Black	White	Black	White
1970	3.49	0.55	4.78	2.72
1980	4.09	0.54	11.39	5.49
1990	8.92	1.35	12.93	4.90
2000	11.87	1.91	10.38	3.84
2010	10.88	2.18	21.38	10.13

The numbers in Table 2 reflect very significant differences in the risk of incarceration between black and white males. Figure 1 shows the probability that a man between ages 25 and 54 goes to prison in a given year. A black man with less than high school (high school) education has a 8% (3%) chance of going to prison. The risk is about 1.5% (0.7%) for a white man with the same level of education.

Finally we document the relationship between incarceration and marriage across US states. The left panel in Figure 2 shows the relation between the race differences in incarceration rates and marriage rates across US states in 2006. The states in which there is a larger race gap in incarceration rates, such as Pennsylvania and Wisconsin, are also the ones in which we observe a high marriage gap between blacks and white. If we look at the black-white differences in incarceration plus non-employment rates, the effects are even stronger, as can be seen in the right panel of Figure 2.

⁶95% of prisoners are held in state rather than federal correctional facilities.

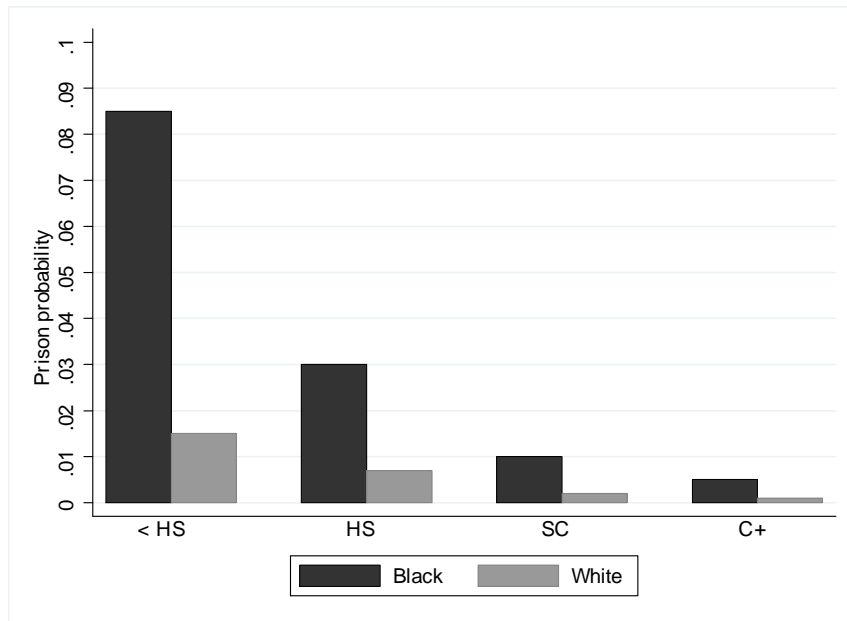


Figure 2: Probability of Going to Prison

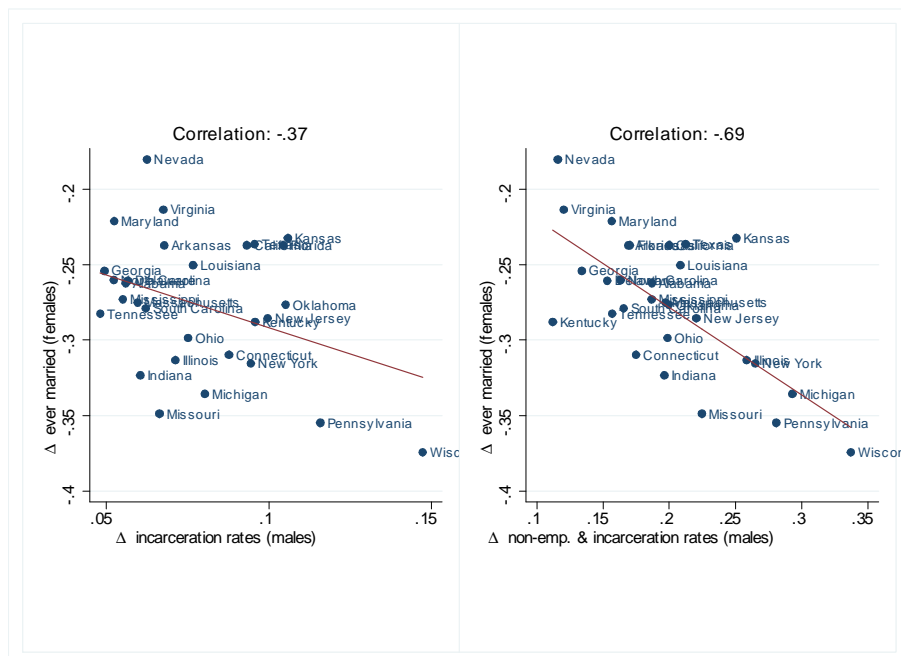


Figure 3: Black-White Differences in 2010: Incarceration versus Marriage (left panel), Incarceration plus Unemployment (right panel) versus Marriage (right panel)

The negative relationships in Figure 2 could be attributed to differences in preferences for marriage between blacks and whites. However, we find that these negative relationships also hold when we look at differences in changes between races across time, thereby removing any traits of blacks and whites, which are constant over time. In the left panel of Figure 3 we add the time dimensions to the cross-sectional dimension by taking the difference in difference between the increase in incarceration rates of black and white males between 1980 and 2006 by state and the difference in difference in black versus white females ever married. In Pennsylvania, for instance, the incarceration rate of black relative to white males increased by more than 8 percentage points, and during the same time period the likelihood of ever being married for black relative to white females fell by around 23 percentage points. In Section 6, we investigate whether a calibrated version of our model economy is able to generate an elasticity of marriage rates w.r.t. incarceration rates that is in line with the evidence provided in Figure 3. In the right panel of Figure 3, we add the non-employed to the picture. Again there remains a strong negative relationship of black relative to white between the increase in incarceration and non-employment of males versus ever married females.

3 The Economic Environment

We study a stationary economy populated by a continuum of males and a continuum of females. Let $g \in \{f, m\}$ denote the gender of an individual. Individuals also differ by race; they can be black or white, indicated by $r \in \{b, w\}$. Individuals can live forever, subject to a constant probability of survival ρ each period. Those who die are replaced by a measure $(1 - \rho)$ of newborns. Agents discount the future at rate $\tilde{\beta}$, so $\beta = \rho\tilde{\beta}$ is the discount factor taking into account the survival probabilities.

Each individual is also born with a given type (education level). We denote the type of a female by $x \in X \equiv \{x_1, x_2, \dots, x_N\}$ and that of a male by $z \in Z \equiv \{z_1, z_2, \dots, z_N\}$. The education (skill) level is a permanent characteristic of an agent that remains constant over his/her life and maps directly into a wage level, denoted by $\omega_m(z)$ and $\omega_f(x)$. Each period, individuals also receive a persistence earnings shock denoted by $\varepsilon \in \mathcal{E} \equiv \{\varepsilon_1, \varepsilon_2, \dots, \varepsilon_N\}$.

Individuals participate in the labor and marriage markets. At any point in time, males can be in one of three labor market states: employed (e), non-employed (u) or in prison

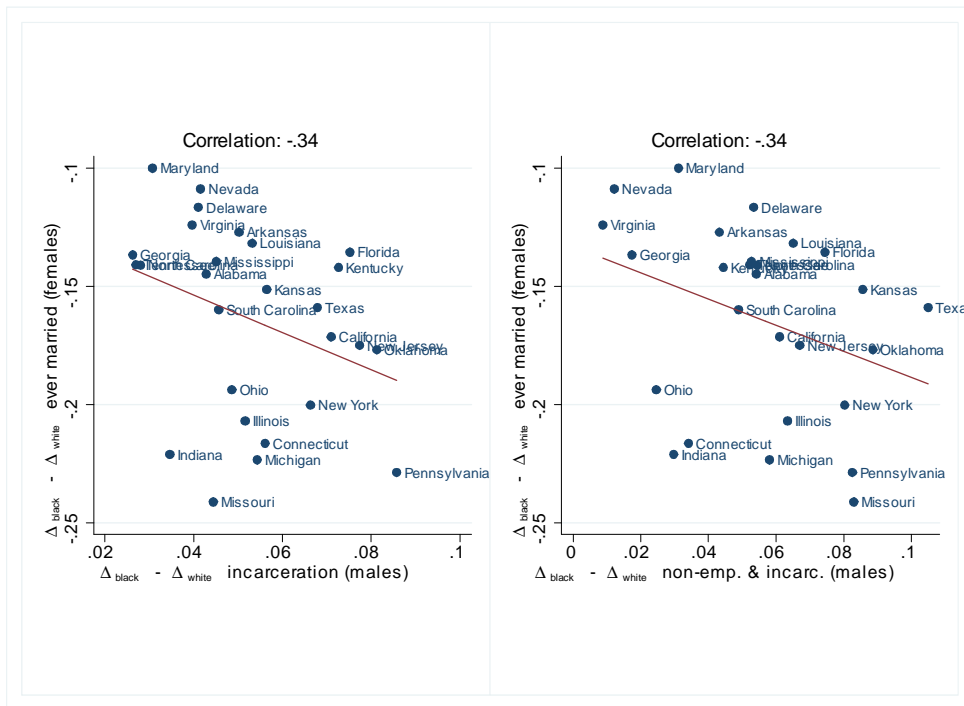


Figure 4: Black-White Differences in Changes between 1980 and 2010: Incarceration versus Marriage (left panel), Incarceration plus Unemployment (right panel) versus Marriage (right panel)

(p). Females do not go to prison.⁷ Hence, they can be employed (e) or non-employed (u). Single females and single males who are not in prison meet each other in a marriage market, and decide whether or not to get married. Similarly, each period married couples decide whether they should stay married or get a divorce. Let S and M denote single and married individuals, respectively.

As a result of the underlying heterogeneity and decisions some households in the model economy consist of married couples, while others are single-male or single-female households. In some married households both the husband and the wife work, while in others one or both members are unemployed, yet in others the husband is in prison. Similarly, some single females work, while others don't, and some single males might be in prison. Among individuals who work some are lucky and enjoy a high ε , while other are unlucky and have a low ε .

3.1 Labor Markets and Prison Transitions for Males

At any point in time, a male can be in one of three labor market states: employed (e), non-employed (u) or in prison (p). There is an exogenous Markov process among these three states, which depends on an individual's race and education. Furthermore, all males who are employed also receive a persistent productivity shock, ε , and, as a result, their earnings per hour worked is given by $\omega_m(z)\varepsilon$. Males do not make a labor supply decision, whenever they are employed, they supply an exogenous amount of hours, denoted by \bar{n}_m^S and \bar{n}_m^M for single and married males, respectively.

Let $\Pi_m^{r,z}(\lambda', \varepsilon' | \lambda, \varepsilon)$ be the probability that a male with current labor market status $\lambda \in \{e, u, p\}$ and labor market shock $\varepsilon \in \mathcal{E}$ moves to state (λ', ε') next period. We construct these transitions in three steps, which turns out to be convenient for our quantitative analysis in Section 5. First, let $\Lambda_m(\lambda' | \lambda)$ be the transition matrix on labor market status λ

$$\Lambda_m(\lambda' | \lambda) = \begin{array}{c} p \quad u \quad e \\ \begin{array}{l} p \\ u \\ e \end{array} \left[\begin{array}{ccc} \pi_{pp} & \pi_{pu} & \pi_{pe} \\ \pi_{up} & \pi_{uu} & \pi_{ue} \\ \pi_{ep} & \pi_{eu} & \pi_{ee} \end{array} \right], \end{array}$$

which determines how males move between prison, non-employment and employment (where,

⁷According to Bureau of Justice Statistics, only about 7% of prison and 9% of jail populations were females (<http://www.bjs.gov/content/pub/pdf/cpus13.pdf>).

for ease of exposition, we suppress the dependence of these transitions on race, r , and education level, x). Next, we define a transition matrix on idiosyncratic productivity shocks ε , conditional upon employment, given by

$$\Upsilon_m(\varepsilon'|\varepsilon) = \begin{array}{c} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_N \end{array} \begin{array}{c} \varepsilon_1 \quad \varepsilon_2 \quad \dots \quad \varepsilon_N \\ \left[\begin{array}{cccc} \pi_{11} & \pi_{12} & \dots & \pi_{1N} \\ \pi_{21} & \pi_{22} & \dots & \pi_{2N} \\ \vdots & \vdots & \vdots & \vdots \\ \pi_{N1} & \pi_{N2} & \dots & \pi_{NN} \end{array} \right] \end{array},$$

where $\pi_{i1} + \pi_{i2} + \dots + \pi_{iN} = 1 - \pi_{ep} - \pi_{eu} = \pi_{ee}$ for each i . Hence, an employed individual can become unemployed with probability π_{eu} or go to prison with probability π_{ep} . With the remaining probability he stays employed and draws a new productivity shock according to $\Upsilon_m(\varepsilon'|\varepsilon)$ (where again we suppress the dependence of this transition on education and race). Finally, we assume that all males who move from prison to employment receive ε_1 (the lowest wage shock), while those who move from unemployment to employment draw ε from a distribution denoted by $\tilde{\Upsilon}_m(\cdot)$.

Then $\Pi_m(\lambda', \varepsilon'|\lambda, \varepsilon)$ is simply given by a composite of these three pieces

$$\Pi_m(\lambda', \varepsilon'|\lambda, \varepsilon) = \begin{array}{c} p \\ u \\ \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_N \end{array} \begin{array}{c} p \quad u \quad \varepsilon_1 \quad \varepsilon_2 \quad \dots \quad \varepsilon_N \\ \left[\begin{array}{cccccc} \pi_{pp} & \pi_{pu} & 1 & 0 & \dots & 0 \\ \pi_{up} & \pi_{uu} & \tilde{\Upsilon}_m(\varepsilon_1) & \tilde{\Upsilon}_m(\varepsilon_2) & \dots & \tilde{\Upsilon}_m(\varepsilon_N) \\ \pi_{ep} & \pi_{eu} & \pi_{11} & \pi_{12} & \dots & \pi_{1N} \\ \pi_{ep} & \pi_{eu} & \pi_{21} & \pi_{22} & \dots & \pi_{2N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \pi_{ep} & \pi_{eu} & \pi_{N1} & \pi_{N2} & \dots & \pi_{NN} \end{array} \right] \end{array}.$$

Upon getting out of prison, for example, an individual moves to unemployed with probability π_{pu} or gets a job with probability π_{pe} . If he gets a job, then his productivity shock is equal to ε_1 . Similarly, an unemployed individual goes to prison with probability π_{up} or finds a job with probability $\pi_{ue} = \tilde{\Upsilon}_m(\varepsilon_1) + \dots + \tilde{\Upsilon}_m(\varepsilon_N)$. Finally, an employed worker with current productivity shock ε_i can go to prison with probability π_{ep} or become unemployed with probability π_{eu} . Otherwise, the worker moves to another labor market shock ε_j next period with probability π_{ij} . In the quantitative analysis below, differences in labor market conditions between blacks and whites will be determined by differences in $\Lambda_m(\lambda'|\lambda)$ and $\Upsilon_m(\varepsilon'|\varepsilon)$.

If a male has ever been to prison he faces a wage penalty. Let $P \in \{0, 1\}$ denote whether a male has ever been in prison, and let $\psi(P)$ be the associated wage penalty.⁸ Hence, earnings of a married (or single) type- z male with a current productivity shock ε and prison history P is given by $\omega_m(z)\varepsilon\psi(P)\bar{n}_m^M$ (or $\omega_m(z)\varepsilon\psi(P)\bar{n}_m^S$).

3.2 Labor Market Transitions for Females

Since females do not go to prison, each period they can be employed (e) or non-employed (u). Unlike males, females make a labor force participation decision. We assume that each period an unemployed female receives an opportunity to work with a probability $\theta^r(x)$. A female can then decide whether to work or not. If she works, then depending on her marital status, she supplies \bar{n}_f^S or \bar{n}_f^M hours. Each period an employed female faces a probability $\delta^r(x)$ of losing her job and becoming unemployed.

Like males, each period females also receive a productivity shock ε . Hence, if a married (or single) female decides to work, her earnings are given by $\omega_f(x)\varepsilon\bar{n}_f^M$ (or $\omega_f(x)\varepsilon\bar{n}_f^S$). As long as a female is employed, her productivity shock ε follows a Markov process denoted by $\Upsilon_f^{r,x}(\varepsilon'|\varepsilon)$. When an unemployed female becomes employed, she draws a new productivity shock from $\tilde{\Upsilon}_f^x(\varepsilon)$.

Working for females is costly. If a female 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 distributed among females according to $q \sim Q(q)$. Females draw q at the start of their lives and it remains constant afterwards. This captures additional heterogeneity in female labor force participation decisions.⁹ Hence, the labor supply decision of a woman depends on her type, her marital status and her husband's characteristics, her current labor market shocks, as well as on the value of staying at home.

⁸There is a large literature that documents the effects of incarceration on future wages. See, among others, Waldfoegel (1994), Western (2006) and Kling (2006).

⁹Guner, Kaygusuz and Ventura (2012) and Greenwood et al. (2015) follow a similar strategy to model female labor force participation.

3.3 Marriage and Divorce

We assume that there is a marriage market in which single agents from each race meet others from the same race.¹⁰ Within each marriage market, an agent meets someone with the same education with probability φ^r , $r \in \{b, w\}$, and with the remaining probability $1 - \varphi^r$ he/she meets other singles randomly. The parameter φ captures forces that generate assortative mating by education, but that are not explicitly modeled here.¹¹

Upon a meeting, couples observe a permanent match quality γ , with $\gamma \sim \Gamma(\gamma)$. The value of γ remains constant as long as the couple remains married. Couples also observe a transitory match quality shock ϕ , with $\phi \sim \Theta(\phi)$. Unlike γ , couples draw a new value of ϕ each period. A marriage is feasible if and only if both parties agree.

Besides, γ and ϕ , individuals observe their partner's permanent characteristics, i.e. z , x , and q , their labor market status (λ), labor market shocks (ε), as well as the prison history of the male party (P) at *the start of a period*, and decide whether to get married based on this information. Once marriage decisions are made, the labor market status and labor market shocks for *the current period* are realized, and agents, married or single, make consumption and labor supply decisions. We assume that a married female whose husband is in prison, suffers a utility cost, ζ .

Since labor market status and labor market shocks are revealed only after marriage decisions are made, agents decide whether to get married or not based on the expected value of being married conditional on their partners' current labor market status and labor market shocks. As a result, after getting married, the husband or the wife might lose his/her job, or the husband might go to prison.

Each period currently married couples decide whether or not to remain married or get a divorce. These decisions are 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 . Note that given this information structure, a wife whose husband ends up in prison in a period can opt for divorce only at the start of the next period, if she decides to do so.

¹⁰We abstract from inter-racial marriages. Chiappori, Oreficce and Quintana-Domeque (2011) 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 factors behind the low level of black-white marriages in the US.

¹¹Fernandez and Rogerson (2001) follow a similar strategy to generate assortative mating.

Finally, we assume that married agents must finance a fixed consumption commitment, c , each period. This consumption commitment captures expenditures, such as fixed cost of a larger house and basic furniture or costs associated with children, that a married couple cannot avoid. This model feature follows Santos and Weiss (2016) who argue that an important factor for the decline and delay of marriage in the US was the rise in idiosyncratic labor income volatility. In their model, consumption commitments make marriage less attractive when there is higher income volatility. In the current model, consumption commitments play a similar role. Blacks who face more labor market uncertainty, both in terms of transitions to unemployment and prison, as well as productivity shocks, will tend to marry less frequently to avoid incurring this fixed cost.

3.4 Government

There is a government that taxes labor earnings at a proportional rate τ and finances transfers to households. These transfers depend on household income. Let $T_f^S(I)$, $T_m^S(I)$ and $T^M(I)$ denote the transfers received by single female, single male and married couple households with total household income I , respectively. We assume that these transfer functions take the following form (where we suppress the dependence on gender and marital status)

$$T(I) = \begin{cases} b_0 & \text{if } I = 0 \\ \max\{0, b_1 - b_2 I\} & \text{if } I > 0 \end{cases} .$$

If a household has zero earnings, they receive b_0 . If they have positive earnings, transfers decline at rate b_2 . As a result, there is an income level above which transfers are zero.

4 Household Problems

4.1 Single Females

Consider the problem of a single female whose current state is $(x, q, \lambda, \varepsilon)$. Since marriage markets are segregated by race, we do not indicate explicitly the race of an agent with the understanding that exogenous labor market and prison transitions for males and arrival of employment opportunities and job destruction probabilities for females differ by race.

Given her current state, a single female decides whether or not to work. If $\lambda = e$, she can choose to work \bar{n}_f^S or decide not to work. If $\lambda = u$, she is non-employed and does not have any labor income. Recall that females do not go to prison. A single female receives a

transfer of $T_f^S(\omega_f(x)\bar{n}_f^S\varepsilon)$ from the government if she works, and $T_f^S(0)$ if she does not. As a result, her income is given by $\omega_f(x)\bar{n}_f^S\varepsilon(1-\tau) + T_f^S(\omega_f(x)\bar{n}_f^S\varepsilon)$ if she works and by $T_f^S(0)$ if she does not. Finally, if she chooses not to work, she enjoys the utility of staying home, q .

At the start of next period, a single female will match with a single male and might get married. Let the value of being in the marriage market at the start of the next period be denoted by the value function $\tilde{V}_f^S(x, \varepsilon, \lambda', q)$. This value, which we define below, will depend on the distribution of single males that are available in the marriage market next period. Note that her labor market status at the start of next period, λ' , is determined by her current labor market status and her labor supply decisions his period. If $\lambda = u$, then $\lambda' = u$ as well, while if $\lambda = e$, λ' is determined whether she decides to work or not.

Given $\tilde{V}_f^S(x, \varepsilon, \lambda', q)$, the value of being a single female in the current period is given by

$$V_f^S(x, q, \lambda, \varepsilon) = \max_{n_f^S} \left\{ \frac{c^{1-\sigma}}{1-\sigma} + \chi(n_f^S = 0)q + \beta\tilde{V}_f^S(x, q, \lambda', \varepsilon) \right\},$$

subject to

$$c = \begin{cases} \omega_f(x)n_f^S\varepsilon(1-\tau) + T_f^S(\omega_f(x)n_f^S\varepsilon) & \text{if } \lambda = e \\ T_f^S(0) & \text{if } \lambda = u \end{cases}, \quad n_f^S = \begin{cases} \in \{0, \bar{n}_f^S\} & \text{if } \lambda = e \\ 0 & \text{if } \lambda = u \end{cases}, \quad \lambda' = \begin{cases} e & \text{if } n_f^S > 0 \\ u, & \text{otherwise} \end{cases},$$

where χ is an indicator function such that $\chi(n_f^S = 0) = 1$.

4.2 Single Males

Consider the problem of a single male whose current state is $(z, P, \lambda, \varepsilon)$. Like single females, a single male's state consists of his type, his current labor market status and labor market shock. Furthermore, P indicates whether he has ever been to prison.

If $\lambda = e$, a single male works \bar{n}_m^S and enjoys $c = \omega_m(z)\bar{n}_m^S\psi(P)\varepsilon(1-\tau) + T_m^S(\omega_m(z)\bar{n}_m^S\psi(P))$, where the second term represents transfers from the government. Recall that criminal history results in a wage penalty of $\psi(P)$. If a male is unemployed, he does not work, and his only income are government transfers so that $c = T_m^S(0)$. Finally, when a male is in prison we assume that he simply consumes an exogenously given level of consumption c_p .¹²

Again let $\tilde{V}_m^S(z, P, \lambda, \varepsilon)$ denote the start of the period value function for a single male. The value of being a single male in the current period is then given by

$$V_m^S(z, P, \lambda, \varepsilon) = \frac{c^{1-\sigma}}{1-\sigma} + \beta\tilde{V}_m^S(z, P', \lambda, \varepsilon),$$

¹²Since we do not conduct any normative analysis, and also do not finance c_p by taxes, its exact value do not matter for the quantitative analysis.

subject to

$$c = \begin{cases} \omega_m(z)\bar{n}_m^S\psi(P)\varepsilon(1-\tau) + T_m^S(\omega_m(z)\bar{n}_m^S\psi(P)) & \text{if } \lambda = e \\ T_m^S(0) & \text{if } \lambda = u \\ c_p & \text{if } \lambda = p \end{cases} \quad \text{and } P' = \begin{cases} 1 & \text{if } \lambda = p \\ P & \text{otherwise.} \end{cases} .$$

Note that if a male is in prison this period, then next period P is 1 (independent of his criminal history). Otherwise, P does not change and his criminal record is not updated.

4.3 Married Couples

Consider now the problem of a married couple with current state $(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi)$, which combines the characteristics of the wife, $(x, q, \lambda_f, \varepsilon_f)$, those of the husband, $(z, P, \lambda_m, \varepsilon_m)$, and the match qualities γ and ϕ . We assume that a married household maximizes the weighted sum of their utilities, with exogenous weight on the female given by μ .

The only decision a married couple makes is whether the wife should work or not, and this is relevant only when $\lambda_f = e$. In all other cases, household income is simply given by husband's earnings plus the government transfers. If, for example, $\lambda_f = \lambda_m = u$, then each household member simply consumes $\frac{1}{1+\kappa}(T^M(0) - \underline{c})$ where $\kappa < 1$ captures economies of scale in household consumption. On the other hand, if $\lambda_f = u$ and $\lambda_m = p$, the wife's consumption is given by $(T^M(0) - \underline{c})$, while the husband consumes c_p . Note that whatever the labor market status of its members are (even if the husband is in prison), the household still has to pay the fixed costs \underline{c} . Also note that as long as the wife does not work, both the wife and the husband enjoy q .

Once this period's decisions are made, at the start of the next period, a married couple will decide whether to get a divorce or stay married. Recall that agents make their marriage/divorce decisions after they observe the new value of the match quality ϕ , but before their labor market status are updated. Hence, at the start of the next period, a married couple will only observe the new match quality ϕ and the updated value of P , and then will decide whether to continue with the current marriage or get a divorce.

Let $\tilde{V}_g^m(x, q, \lambda_f', \varepsilon_f; z, P', \lambda_m, \varepsilon_m; \gamma, \phi)$ for $g \in \{f, m\}$ be the value of being married, with an option to divorce, at the start of a period. Again the labor market status of the wife at the start of next period is determined by her labor supply choice in the current period.

Then the problem of a married couple in the current period is

$$\begin{aligned} & \max_{n_f^M} \left[\mu \frac{c_f^{1-\sigma}}{1-\sigma} + (1-\mu) \frac{c_m^{1-\sigma}}{1-\sigma} + \chi(n_f^M = 0)q + \gamma + \phi \right. \\ & \quad \left. + \mu \beta E_{\phi'} \tilde{V}_f^M(x, q, \lambda'_f, \varepsilon_f; z, P', \lambda_m, \varepsilon_m; \gamma, \phi') \right. \\ & \quad \left. + (1-\mu) \beta E_{\phi'} \tilde{V}_m^M(x, q, \lambda'_f, \varepsilon_f; z, P', \lambda_m, \varepsilon_m; \gamma, \phi') \right], \end{aligned}$$

subject to

$$c_f = \begin{cases} \frac{1}{1+\kappa} [(\omega_f(x)n_f^M \varepsilon_f + \omega_m(z)\psi(P)\bar{n}_m^M \varepsilon_m)(1-\tau) + T^M(\cdot) - \underline{c}] & \text{if } \lambda_f = \lambda_m = e \\ \frac{1}{1+\kappa} [\omega_f(x)n_f^M \varepsilon_f(1-\tau) + T^M(\cdot) - \underline{c}] & \text{if } \lambda_f = e, \lambda_m = u \\ \frac{1}{1+\kappa} [w(z)\psi(P)\bar{n}_m^M \varepsilon_m(1-\tau) + T^M(\cdot) - \underline{c}] & \text{if } \lambda_f = u, \lambda_m = e \\ \frac{1}{1+\kappa} [T^M(0) - \underline{c}] & \text{if } \lambda_f = \lambda_m = u \\ \omega_f(x)n_f^M \varepsilon_f(1-\tau) + T^M(\cdot) - \underline{c} & \text{if } \lambda_f = e, \lambda_m = p \\ T^M(0) - \underline{c} & \text{if } \lambda_f = u, \lambda_m = p \end{cases},$$

and

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

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

Let the value functions associated with this problem be given by

$$V_f^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi),$$

and

$$V_m^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi).$$

4.4 Start-of-the-Period Value for a Single Female

Consider now the value of being a single female at the start of a period. A single female meets a single male, observes his start-of-the-period state, i.e. $\lambda_m \in \{e, u\}$, ε_m and P . Upon a match, the couple draws γ (the permanent match quality) and ϕ (the transitory match quality). Then she decides whether to get married or not. A marriage is, however, feasible only if the other party also agrees.

Let $EV_f^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi)$ be the expected value of entering into a marriage for a female *before* the labor market shocks are updated, and let the function $I_m(\cdot)$ indicate

whether this marriage is acceptable for the male. Finally, let $\Omega(z, P, \lambda_m, \varepsilon_m)$ be the distribution of single males in the marriage market, which is an *endogenous* object. In the marriage market, a female of type x meets males of the same type, $x = z$, with probability φ , and matches randomly with probability $(1 - \varphi)$.

The value of being a single female at the start of the period (before the matching takes place) is then given by

$$\begin{aligned} \tilde{V}_f^S(x, q, \lambda_f, \varepsilon_f) = & \varphi \sum_{P, \lambda_m, \varepsilon_m, \gamma, \phi} \max\{EV_f^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ & I_m(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ & EV_f^S(x, q, \lambda_f, \varepsilon_f)\} \Gamma(\gamma) \Theta(\phi) \Omega(z, P, \lambda_m \in \{e, u\}, \varepsilon_m | z = x) \\ & + (1 - \varphi) \sum_{P, \lambda_m, \varepsilon_m, \gamma, \phi} \max\{EV_f^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ & I_m(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ & EV_f^S(x, q, \lambda_f, \varepsilon_f)\} \Gamma(\gamma) \Theta(\phi) \Omega(z, P, \lambda_m \in \{e, u\}, \varepsilon_m). \end{aligned}$$

For a single female who is employed at the start of this period, i.e. $\lambda_f = e$, the expected value of remaining single is given by

$$EV_f^S(x, q, e, \varepsilon_f) = \delta(x) V_f^S(x, q, u, 0) + (1 - \delta(x)) \sum_{\varepsilon'_f} \Upsilon_f^x(\varepsilon'_f | \varepsilon_f) V_f^S(x, q, e, \varepsilon'_f). \quad (1)$$

A single female who is currently employed can lose her job with probability $\delta(x)$. Then she is unemployed next period and her value function is given $V_f^S(x, q, u, 0)$. If she keep her job, which happens with probability $(1 - \delta(x))$, she draws a new wage shock according to $\Upsilon_f^x(\varepsilon'_f | \varepsilon_f)$, and enjoys $V_f^S(x, q, e, \varepsilon'_f)$.

Similarly, for a single female who is unemployed, it is given by

$$EV_f^S(x, q, u, \varepsilon_f) = \theta(x) \sum_{\varepsilon'_f} \tilde{\Upsilon}_f^x(\varepsilon'_f) V_f^S(x, q, e, \varepsilon'_f) + (1 - \theta(x)) V_f^S(x, q, u, 0). \quad (2)$$

A single female who is currently unemployed receives a job offer with probability $\theta(x)$ and draws a wage shock from $\tilde{\Upsilon}_f^x(\varepsilon'_f)$. On the other hand, if she does not receive a job offer, then she will be unemployed next period.

What about the expected values of entering into a marriage? For a female who is currently employed, the expected value of being married to a type- $(z, P, \lambda_m, \varepsilon_m)$ male with match

qualities γ and ϕ is given by

$$\begin{aligned}
& EV_f^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\
= & \delta(x) \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_f^M(x, q, u, 0; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi) \\
& + (1 - \delta(x)) \sum_{\varepsilon'_f} \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Upsilon_f^x(\varepsilon'_f | \varepsilon_f) \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_f^M(x, q, e, \varepsilon'_f; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi),
\end{aligned} \tag{3}$$

where

$$P' = \begin{cases} 1 & \text{if } \lambda'_m = p \\ P & \text{otherwise} \end{cases},$$

with V_f^M defined as above. Note that for a single female, the expected value of being married is determined both by the labor market transitions of her potential husband, $\Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m)$, as well as her own labor market transitions, $\delta(x)$ and $\Upsilon_f^x(\varepsilon'_f | \varepsilon_f)$.

Finally, for a single female who is currently unemployed, the expected value of being married to a type- $(z, P, \lambda_m, \varepsilon_m)$ male with match qualities γ and ϕ is given by

$$\begin{aligned}
& EV_f^M(x, q, u, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\
= & \theta(x) \sum_{\varepsilon'_f} \sum_{\varepsilon'_m} \sum_{\lambda'_m} \tilde{\Upsilon}_f^x(\varepsilon'_f) \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_f^M(x, q, e, \varepsilon'_f; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi) \\
& (1 - \theta(x)) \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_f^M(x, q, u, 0; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi),
\end{aligned} \tag{4}$$

where

$$P' = \begin{cases} 1 & \text{if } \lambda'_m = p \\ P & \text{otherwise} \end{cases}.$$

4.5 Start-of-the-Period Value for a Single Male

For a single male it is easier to define the start-of-the-period value functions conditional on whether he is in prison or not.

4.5.1 If in prison

If a single male in prison, his current state is given by $P = 1$ (i.e. he has a criminal record), $\lambda = p$ and $\varepsilon = 0$ (i.e. he does not have any labor earnings). Next period, with probability π_{pu} he is released as an unemployed person and enjoys $V_m^S(z, 1, u, 0)$. He can also enter employment with probability π_{pe} . In that case, he starts working at the lowest wage

shock ε_1 . Finally, with the remaining probability he stays in the prison. If a male moves to unemployment or employment from prison, he remains single for one period, before he participates again in the marriage market. Then, his continuation value is given by

$$\tilde{V}_m^S(z, 1, p, 0) = \pi_{pu}V_m^S(z, 1, u, 0) + \pi_{pe}V_m^S(z, e, 1, \varepsilon_1) + (1 - \pi_{pu} - \pi_{pe})V_m^S(z, 1, u, 0). \quad (5)$$

4.5.2 Not in prison

If a single male is not in prison, then his start-of-the period value function is defined as

$$\begin{aligned} \tilde{V}_m^S(z, P, \lambda_m, \varepsilon_m) &= \varphi \sum_{q, \lambda_f, \varepsilon_f, \gamma, \phi} \max\{EV_m^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ &\quad I_f(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ &\quad EV_m^S(z, P, \lambda_m, \varepsilon_m)\} \Gamma(\gamma) \Theta(\phi) \Phi(x, q, \lambda_f, \varepsilon_f | x = z) \\ &+ (1 - \varphi) \sum_{q, \lambda_f, \varepsilon_f, \gamma, \phi} \max\{EV_m^M(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ &\quad I_f(x, q, \lambda_f, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ &\quad EV_m^S(z, P, \lambda_m, \varepsilon_m)\} \Gamma(\gamma) \Theta(\phi) \Phi(x, q, \lambda_f, \varepsilon_f), \end{aligned}$$

where, again $\Phi(x, q, \lambda_f, \varepsilon_f)$ is the *endogenous* distribution of single females. A single male meets a single female who has the same education level that he has with probability φ and meets someone randomly with the remaining probability. Upon a match the couple draws γ and ϕ , and then he decides, if the marriage is feasible, whether to get married or not. His decisions are based on expected values of being single and married.

The expected value of being single is given by

$$EV_m^S(z, P, \lambda_m, \varepsilon_m) = \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_m^s(z, \varepsilon'_m, \lambda'_m, P'), \quad (6)$$

with

$$P' = \begin{cases} 1 & \text{if } \lambda'_m = p \\ P & \text{otherwise} \end{cases}.$$

The expected value of being married with a female who is employed at the start of the period

is

$$\begin{aligned}
& EV_m^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\
= & \delta(x) \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_m^M(x, q, u, 0; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi) \\
& + (1 - \delta(x)) \sum_{\varepsilon'_f} \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Upsilon_f^x(\varepsilon'_f | \varepsilon_f) \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_m^M(x, q, e, \varepsilon'_f; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi),
\end{aligned} \tag{7}$$

with

$$P' = \begin{cases} 1 & \text{if } \lambda'_m = p \\ P & \text{otherwise} \end{cases}.$$

Finally, the expected value of being married with a female who is employed at the start of the period, $EV_m^M(x, q, u, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi)$, is defined as

$$\begin{aligned}
& EV_m^M(x, q, u, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\
= & \theta(x) \sum_{\varepsilon'_f} \sum_{\varepsilon'_m} \sum_{\lambda'_m} \tilde{\Upsilon}_f^x(\varepsilon'_f) \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_m^M(x, q, e, \varepsilon'_f; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi) \\
& (1 - \theta(x)) \sum_{\varepsilon'_m} \sum_{\lambda'_m} \Pi_m^z(\lambda'_m, \varepsilon'_m | \lambda_m, \varepsilon_m) V_m^M(x, q, u, 0; z, P', \lambda'_m, \varepsilon'_m; \gamma, \phi),
\end{aligned} \tag{8}$$

where again

$$P' = \begin{cases} 1 & \text{if } \lambda'_m = p \\ P & \text{otherwise} \end{cases}.$$

4.6 Indicators for Marriage

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

$$I_m(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) = \begin{cases} 1, & \text{if } EV_m^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \geq \\ & EV_m^S(z, P, \lambda_m, \varepsilon_m) \\ 0, & \text{otherwise.} \end{cases}$$

Similarly for females, we have

$$I_f(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) = \begin{cases} 1, & \text{if } EV_f^m(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \geq \\ & EV_f^s(x, q, e, \varepsilon_f) \\ 0, & \text{otherwise.} \end{cases}$$

4.7 Start-of-the-Period Value for a Married Female

Now consider the value of being married at the start of a period for a married female. Given her state $(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi)$, a female has to decide whether to continue her

marriage or divorce. She will do this before she observes her and her partner's new labor market status. Her problem is then given by

$$\begin{aligned} \tilde{V}_f^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) &= \max\{EV_f^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ &\quad I_m^d(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ &\quad EV_f^S(x, q, e, \varepsilon_f) - \eta\}, \end{aligned}$$

where $EV_f^S(\cdot)$, the expected value of being single, is defined above by equations (1) and (2), and her expected value of continuing with the current marriage, $EV_f^M(\cdot)$, is defined by equations (3) and (4). Note that $I_m^d(\cdot)$ indicates whether her husband wants to continue with the current marriage or not. If she decides to have a divorce, then she suffers the utility cost η .

4.8 Start-of-the-Period Value for a Married Male

Similarly, given his state $(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi)$, a married male has to decide whether to continue his marriage or divorce. He makes this decision based on the following comparison

$$\begin{aligned} \tilde{V}_m^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) &= \max\{EV_m^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ &\quad I_f^d(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi), \\ &\quad EV_m^S(z, P, \lambda_m, \varepsilon_m) - \eta\}, \end{aligned}$$

where $EV_m^S(\cdot)$ is defined by equations (5) and (6), and $EV_m^M(\cdot)$ is defined by equations (7) and (8).

Note that $I_f^d(\cdot)$ indicates whether his wife wants to continue with the current marriage or not. A married male who is in prison can decide whether to continue his marriage or not as long as his wife agrees. If he or his wife decide to have a divorce, then he is a single man next period. He can be a single man in prison or can be released and enter into the labor market.

4.9 Indicators for Divorce

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

$$I_m^d(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) = \begin{cases} 1, & \text{if } EV_m^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ & \geq EV_m^S(z, P, \lambda_m, \varepsilon_m) - \eta \\ 0, & \text{otherwise.} \end{cases}$$

Similarly for females, we have

$$I_f^d(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) = \begin{cases} 1 & \text{if } EV_f^M(x, q, e, \varepsilon_f; z, P, \lambda_m, \varepsilon_m; \gamma, \phi) \\ & \geq EV_f^M(x, q, e, \varepsilon_f; z) - \eta \\ 0, & \text{otherwise.} \end{cases}$$

Note that these are identical to singles' indicators, except for the fact that divorce involves a one-time utility cost η .

5 Quantitative Analysis

We know fit the model economy to the US data for 2006. We assume that the length of a period is one year. Let β (the subjective discount factor) be 0.96, a standard value in macroeconomic studies, such as in Prescott (1986). All the targets for the estimation are calculated for individuals between ages 25 and 54, which corresponds to an operational lifespan of 30 years. Hence, we set $(1 - \delta) = 1/30 = 0.033$, so that individuals in the model also live 30 years on average.

The quantitative analysis focuses on black and white non-hispanics and non-immigrants who are between 25 and 54 years old. We assume that there are four types (education groups): less than high school (< HS), high school (HS), some college (SC), and college and above (C). Table 3 shows how the population is distributed across gender, and education within each race based on the 2006 US American Community Survey (ACS) from the Integrated Public Use Microdata Series (King 2010). The fractions for each race sum to one in Table 3.¹³ Whites on average are more educated than blacks, and females are more educated than males. The college-education gap between black females and males is particularly striking. About 10% of the black population consist of college-educated females while only 6.5% are college-educated males. This gap is smaller for whites (17% versus 15.5%).

Table 3: Distribution of Population

		Black		White		
		Female	Male	Female	Male	
< HS		5.64	6.57	< HS	2.53	3.38
HS		22.67	22.84	HS	17.76	19.72
SC		14.95	10.54	SC	12.96	11.35
C		10.26	6.52	C	16.82	15.48

¹³In the benchmark economy, 88% of the population is white and the rest are black.

Wages Table 4 shows hourly wages in the data, which map directly to $\omega_f^r(x)$ and $\omega_m^r(z)$ 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, whites have greater average hourly wages than blacks. Males have higher wages than females, but the gender wage gap is much smaller for blacks than it is for whites.¹⁴ Finally, based on Western (2006), the earnings penalty after prison is set to $\psi(P) = .642$ for whites, and $\psi(P) = .631$ for blacks.

Table 4: Hourly Wages
(normalized by mean wages)

	Blacks		Whites	
	Female	Male	Female	Male
<HS	0.496	0.561	0.510	0.682
HS	0.624	0.757	0.654	0.900
SC	0.710	0.846	0.796	0.993
C	1.062	1.183	1.200	1.679

Hours Worked Table 5 shows hours worked per week from the ACS 2006 (conditional on working) by gender and marital status where hours worked are normalized by 100 available hours per week. Conditional on working, single males and females work quite similar hours, while there is about 9 percentage point difference between hours worked by married males and females.

Table 5: Hours Worked

All		
	Female	Male
Unmarried	0.396	0.424
Married	0.369	0.457

5.1 Incarceration

Despite the large number of prisoners, data on prison stocks and flows are rather scarce.¹⁵ The available data does not allow us to directly identify transitions by race and education for the entire prison population. The most detailed and reliable survey is the Survey of Inmates

¹⁴See Neal (2004) for an analysis of black-white wage gap.

¹⁵The available data allows us to consider state and federal prison but not to include transitions in and out of jail.

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.

Following an approach similar to Pettit and Western (2004), we approximate transitions in and out of prison for males in three steps. 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. We don't know, however, whether an agent entered into prison from employment or unemployment. As a result, we assume that these probabilities are equal. Second, we multiply these shares by the total number of admissions to state and federal prisons in 2004, which we can be obtained from the Bureau of Justice Statistics (BJS). This approach assumes the SISCF is representative of total admissions in 2004. Third, using the Current Population Survey (CPS) and the number of people for each race and level of education obtained in the second step, we compute the fraction of the total population of a given race and level of education who were admitted to prison in 2004.

Table 6: Probability of Going to Prison
(yearly)

Education	Black	White
< HS	.085	.015
HS	.030	.007
SC	.010	.002
C	.005	.001

The results are reported in Table 6, and are used to calibrate $\pi_{up} = \pi_{ep}$ for each race and education level. Blacks are about five times more likely to transition into prison within each education category .

Next we calibrate π_{pp} . Using the SISCF, we find that the average sentence length of blacks and whites between ages 25 and 54 who were admitted to prison in 2004 is around 6 years. Most sentences, however, are not fully completed. According to the National Corrections Reporting Program from the BJS, the average share of sentences in terms of time served was 49% in 2004 for males, which suggests that the average time spent in prison is 3 years.¹⁶ Given that one model period is one year, the average prison stay is three model periods. Therefore, for both whites and blacks we set $\frac{1}{1-\pi_{pp}} = 3$ or $\pi_{pp} = 0.67$. We also assume that π_{pp} is independent of an agents education.

¹⁶See <http://www.bjs.gov/index.cfm?ty=pbdetailid=2056>.

Finally, using the survey on Religiousness and Post-Release Community Adjustment in the United States 1990-1998 (Sumter 2005), we compute the probabilities by race of moving to employment or non-employment upon release from prison. In the data, white males are slightly more likely to transit directly into employment. In particular, conditional on being released, a white inmate has a 43.6% chance of moving to employment and a 56.4% chance of moving to unemployment. For a black inmate, the probabilities are 37.5% and 62.5%, respectively. As a result, since a white inmate has $1 - \pi_{pp} = 1 - 0.67$ probability of being released, his chances of moving from prison to employment and unemployment are given by $(1 - 0.67) \times (0.436) = 0.144$ and $(1 - 0.67) \times (1 - 0.436) = 0.186$, respectively. For a black inmate, the chances are $(1 - 0.67) \times 0.375 = 0.124$ and $(1 - 0.67) \times (1 - 0.375) = 0.206$, respectively. Again these probabilities are assumed to be independent of a male's education.

5.2 Labor Market Transitions, Males

We compute the transition matrix $\Lambda(\lambda'|\lambda)$ based on data on labor market transitions by exploiting the Merged Outgoing Rotation Group (MORG) of the Current Population Survey. We consider two states, employment ($\lambda = e$) and non-employment ($\lambda = u$). The latter comprises unemployment as well as being out of the labor force. The resulting yearly transition matrices are shown in Table 7 for 2000-2006 period.

Table 7: Employment Transitions, 2000-2006
(yearly)

		Black				White			
		Female		Male		Female		Male	
		e	u	e	u	e	u	e	u
< HS	e	.812	.188	.850	.150	.847	.153	.911	.089
	u	.154	.846	.157	.843	.151	.849	.195	.805
HS	e	.882	.118	.897	.103	.914	.086	.947	.053
	u	.249	.751	.244	.756	.219	.781	.309	.691
SC	e	.900	.100	.918	.082	.923	.077	.954	.046
	u	.304	.696	.328	.672	.251	.749	.368	.632
C	e	.950	.050	.950	.050	.952	.048	.975	.025
	u	.403	.597	.354	.646	.280	.720	.478	.522

For males, we then 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 ($\lambda = p$). Consider, for example, black male high school drop-outs (top right quadrant of Table 7). According to Table 6, the probability of going to prison for this group is 0.085. As we mentioned above, we assume this is the same whether you are employed or unemployed as we do not have information to separate the two, i.e. $\pi_{ep} = \pi_{up} = 0.085$. We also know that the chances for blacks of moving to non-employment is about 0.625 and to employment is 0.375. Furthermore, for all blacks $\pi_{pe} = 0.124$ and $\pi_{pu} = 0.206$. Putting all these pieces together, and noting that the transition matrix for u and e contains the non-prison population and therefore needs to be multiplied by the size of the civilian population, 0.915 in the CPS sample, we get

$$\Lambda_m^{b,<HS}(\lambda'|\lambda) = \begin{array}{c} p \quad u \quad e \\ \begin{array}{l} p \\ u \\ e \end{array} \left[\begin{array}{ccc} .670 & .206 & .124 \\ .085 & .771 & .144 \\ .085 & .137 & .778 \end{array} \right]. \end{array}$$

We repeat this procedure for other education types as well as for whites.

5.3 Wage Shocks

We construct the transition matrix $\Upsilon_g(\varepsilon'|\varepsilon)$ in the following way. We interpret ε as deviations from the mean, i.e. when $\varepsilon = 1$, the individual has mean earnings. 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 and level of education to construct transition matrices $\Upsilon_g(\varepsilon'|\varepsilon)$ for those who were employed. We also construct a productivity distribution for those agents who move from unemployment to employment and use this to calibrate $\tilde{\Upsilon}_g(e)$.

We assume that ε takes five values. These five levels represent wage changes, relative to the 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 $\varepsilon_1 = 0.75, \varepsilon_2 = 0.9, \varepsilon_3 = 0, \varepsilon_4 = 1.10, \varepsilon_5 = 1.25$. Given that for some segmentations 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.

The transition matrix for black high school dropout males, for example, takes the following form

$$\Upsilon_m^{b,<HS}(\varepsilon'|\varepsilon) = \begin{bmatrix} .365 & .282 & .200 & .094 & .059 \\ .104 & .377 & .251 & .126 & .142 \\ .042 & .170 & .420 & .231 & .137 \\ .052 & .117 & .240 & .403 & .188 \\ .043 & .148 & .174 & .113 & .522 \end{bmatrix}.$$

For a high school dropout black male, if $\varepsilon = \varepsilon_1$, i.e. he earns about 25% less than the mean for his type. In this case there is a 37% chance that he will again face the same shock next period, while there is a 6% chance that next period his wage will be 25% above the mean wage for his type. Using a similar procedure, we compute matrices for each gender, race, and level of education. Tables A1 and A2 in the Appendix show the resulting transitions for all cases.

5.4 Government

We use the 2004 wave of the Survey of Income and Program Participation (SIPP) to approximate a welfare schedule as a function of labor earnings for different household types, $T_f^s(I)$, $T_m^s(I)$, and $T^m(I)$. The SIPP is a panel surveying households every three months retrospectively for each of the past three months.¹⁷ We compute the average amount of welfare, unemployment benefits, and monthly labor earnings corrected for inflation for each household. The welfare payments include all the main means-tested programs, namely Supplemental Social Security Income (SSSI), Temporary Assistance for Needy Families (TANF formerly AFDC), social security income, Supplemental Nutrition Assistance Program (SNAP formerly food stamps), Supplemental Nutrition Program for Women, Infants, and Children (WIC), Housing Assistance, and Medicaid.¹⁸

Using the monthly household average as the unit of observation, we first compute the average amount of the sum of welfare and unemployment benefits received by households with zero labor earnings. This allows us to pin down b_0 . Then via ordinary least square

¹⁷The sample of black and white household heads aged 25-54 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 per household.

¹⁸The SIPP only provides the information of whether households received Housing Assistance and Medicaid but no information about value or amounts. We use the methodology of Scholz, Moffitt and Cowan (2009) to value Medicaid and Housing Assistance reception. For all other transfer programs the SIPP provides information on the actual amount received.

estimation, we estimate the slope and intercept of the sum of welfare and unemployment benefits as a function of positive labor earnings by household type and determine b_1 and b_2 . Table 8 reports the resulting estimates. A single female that is not working, for example, receives benefits that are about 16% of mean earnings, which is more than married or single male households receive.¹⁹ In Figure 4 presents the welfare schedule graphically where both household income and benefits are reported as a fraction of mean household earnings in the economy.

Table 8: Welfare Functions

Parameter	Description	Married	Single male	Single female
b_0	Benefit when not working	0.11	0.11	0.16
b_1	Intercept when working	0.09	0.07	0.14
b_2	Slope when working	-0.07	-0.07	-0.14

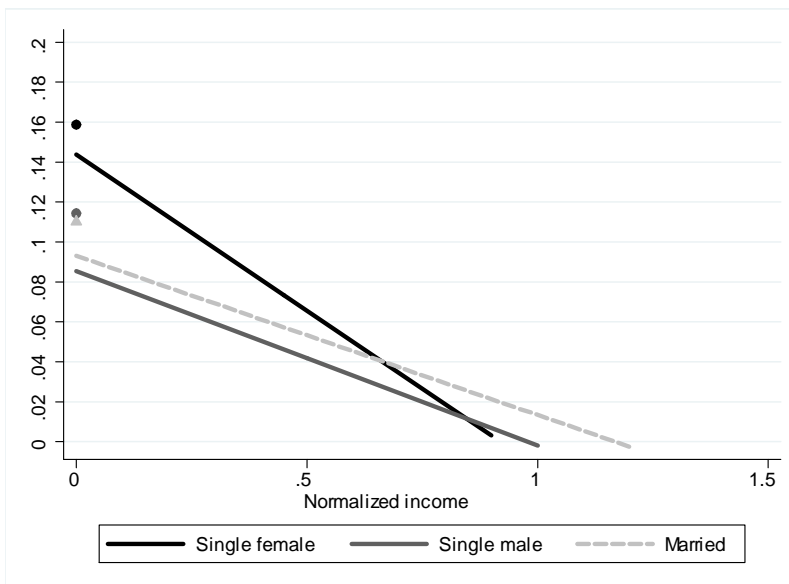


Figure 5: Welfare Functions

6 Benchmark Economy

The parameters that can be set based on a priori information or available evidence are listed in Table 9.

¹⁹Using data from the ACS 2006 we compute mean per capita earnings to be \$37,632.

Table 9: Parameter Values
(a priori information)

Parameter	Description	Value
σ	curvature	2 (standard)
β	discount factor	0.96 (standard)
κ	economies of scale	0.7 (OECD scale)
μ	weight on female	0.5
δ	survival	$1/(1 - \delta) = 30$
$\psi(P)$	wage penalty for prison	0.642 (white), 0.631 (black)

We assume that the values of q are drawn from a flexible Gamma distribution with parameters α_1 and α_2 .²⁰ Finally, 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 $(\mu_\gamma, \sigma_\gamma)$ and (μ_ϕ, σ_ϕ) . As a result, we have 27 parameters to be determined:

$$\underbrace{\eta, \underline{c}, \zeta, \varphi^w, \varphi^b}_{\text{marriage}}, \underbrace{\theta^w(x), \delta^w(x), \theta^b(x), \delta^b(x)}_{\text{labor markets}}, \underbrace{\alpha_1, \alpha_2, \mu_\gamma, \sigma_\gamma, \mu_\phi, \sigma_\phi}_{\text{heterogeneity-shocks}}$$

These parameters are chosen to match:

1. Marital status of population by race, gender, and education level (Table 12, 16 moments).
2. Fraction of women married by ages 20, 25, 30, 35, and 40, by race (top panel of Table 13, 10 moments).
3. Fraction of marriages that last 1, 3, 5, and 10 years by race (bottom panel of Table 13, 8 moments).
4. The degree of marital sorting among whites and blacks (Table 14, 2 moments).
5. Labor market and prison status of population by race, gender, education level and marital status (Table 15, 48 moments).

Let \mathbf{M} represent the vector of these 84 moments. A vector of the analogous 84 moments can be obtained from the steady state of the model. The moments for the model are a

²⁰Hence, $q \sim Q(q) \equiv q^{\alpha_1 - 1} \frac{\exp(-q/\alpha_2)}{\text{Gamma}(\alpha_1)\alpha_2^{\alpha_1}}$, where $\text{Gamma}(\alpha_1)$ represents the gamma function.

function of the parameters to be estimated. Let $\mathcal{M}(\boldsymbol{\theta})$ represent this vector of moments, where $\boldsymbol{\theta}$ denotes the vector of 15 parameters to be estimated. Define the vector of deviations between the data and the model by $\mathbf{G}(\boldsymbol{\theta}) \equiv \mathbf{M} - \mathcal{M}(\boldsymbol{\theta})$. Minimum distance estimation picks the parameter vector, $\boldsymbol{\theta}$, to minimize a weighted sum of the squared deviations between the data and the model, i.e.,

$$\hat{\boldsymbol{\theta}} = \arg \min \mathbf{G}(\boldsymbol{\theta})' \mathbf{W} \mathbf{G}(\boldsymbol{\theta}),$$

where \mathbf{W} is the inverse of the variance of the data moments. We discuss the data targets in detail below.

6.1 Targets

Marital status We compute marital status by gender, race, and level of education using the ACS 2006. As can be seen in Table 12, white males and females of all levels of education are more likely to be married than their black counterparts. The relative differences in marriage rates by race help us to pin down the consumption cost of a married household, \underline{c} , and the utility cost of having a husband in jail, ζ , while the general levels of married couples help determine the match quality shock parameters.

Marriage Transitions The probability of first marriage for women comes from data from the 2006-2010 National Survey of Family Growth (NSFG), as reported in Copen et al (2012), and is presented by race in Table 13. White women are more likely to marry for the first time at younger ages than black women. The entry into marriage moments determine the parameters of the initial permanent match quality distribution, μ_γ and σ_γ .

The probability of the first marriage remaining intact also comes from data from the 2002 NSFG, as reported in Goodwin, Moshe and Chandra (2010). Even though black females tend to marry later, in Table 13 we see that their marriages on average dissolve at a faster rate. These targets help us to select the divorce cost parameter, η , and the parameters of the transitory match quality distribution, μ_ϕ and σ_ϕ .

Marital Sorting We compute a measure for assortative mating in terms of education for blacks and whites aged 25-54 using the 2006 ACS. We find that the Spearman rank correlation for whites is .54, whereas for blacks it is .48. Hence, whites are slightly more

likely than blacks to marry alike in terms of education. These targets directly affect the probability that an individual matches with his/her own education type, φ^r .

Labor Market and Prison Status We target labor market status by education, marital status, and race for women. For men, we also include prison status along with employed and unemployed. These moments help to pin down the parameters of the utility cost of work, α_1 and α_2 , as well as the probability of finding and losing a job for females, $\theta^r(x)$ and $\delta^r(x)$. To compute labor market status and prison status we use the ACS 2006. Once again we restrict the sample to non-hispanic, non-immigrant, black and white individuals aged 25-54. These data moments are contained in Table 15.

6.2 Calibrated Parameters and Fit

Table 10 and 11 contain the calibrated parameters.

Table 10: Calibrated Parameters
(preferences and match quality shocks)

Parameter	Description	Value
τ	tax rate	0.0377
η	divorce cost	27.019
\underline{c}	cost of a married household	0.025
α_1	scale parameter of the gamma dist. for q	1
α_2	shape parameter of the gamma dist. for q	5.737
μ_γ	mean of γ draw	-9.452
σ_γ	s.d. of γ draw	18.32
μ_ϕ	mean of ϕ draw	0
σ_ϕ	s.d. of ϕ draw	17.11
ζ	utility cost when husband is in prison	121.78
φ^b	Probability of meeting own type (black)	0.353
φ^w	Probability of meeting own type (white)	0.504

Table 11: Calibrated Parameters
(labor market transitions, females)

	Job arrival θ		Job destruction δ	
	Black	White	Black	White
< HS	.16	.15	.20	.15
HS	.24	.24	.12	.08
SC	.32	.30	.10	.07
C	.51	.48	.04	.04

Table 12 shows the measure of the population that is not married by gender, race, and education in the model and in the data. The model does a good job matching marital status of the population. The match for whites is better than for blacks, while for both races the marriage probabilities for individuals with less than high school education is quite less likely than they are in the data.

Table 12: Fraction Not-Married
model (data)

	Education	Not Married	
		Black	White
Female	< HS	.86 (.79)	.61 (.47)
	HS	.66 (.69)	.44 (.35)
	SC	.56 (.65)	.36 (.35)
	C	.42 (.58)	.30 (.32)
Male	< HS	.97 (.75)	.63 (.52)
	HS	.66 (.62)	.46 (.42)
	SC	.49 (.53)	.36 (.38)
	C	.35 (.47)	.30 (.31)

The top panel of Table 13 shows the probability of marriage for black and white woman by a given age in the model and in the data. In our model, we simply compute how long it takes for women in a new birth cohort (education and employment shocks match the steady state values by gender and race) to marry. The model does well matching these statistics, although it slightly underpredicts the speed of entry into marriage for white women, while the opposite occurs for black women.

Table 13: Marriage Dynamics for Women
model (data)

<i>Probability of Marriage by Different Ages</i>					
By age	20	25	30	35	40
Black	.06 (.05)	.32 (.24)	.50 (.47)	.63 (.58)	.72 (.64)
White	.09 (.14)	.42 (.48)	.63 (.74)	.76 (.84)	.84 (.89)

<i>Fraction of Intact Marriages by Duration</i>				
Duration	1 year	3 years	5 years	10 years
Black	.89 (.92)	.73 (.81)	.63 (.73)	.47 (.51)
White	.95 (.95)	.86 (.86)	.81 (.78)	.72 (.64)

The bottom panel of Table 13 contains the probability that a marriage remains intact after so many years for black and white couples. In the model, with no memory beyond the last period, there is no distinction between first and subsequent marriages. Therefore, we compute this moment for all marriages. In the model, black marriages are less likely to survive over time than we observe in the data. For white marriages the probability of survival is matched for the first three years, but becomes slightly higher than it is in the data afterwards.

Table 14 shows the degree of assortative mating in the model and the data. Both in data and model whites are more likely to marry assortatively than blacks, although the model underestimates the degree of assortative mating for both races.

Table 14: Assortative Mating	
Spearman rank correlation	
Black	.40 (.48)
White	.49 (.54)

Finally, Table 15 contains the data and model moments on employment status for women and employment, unemployment, and prison status for men by race, marital status, and education. Since there is not a labor supply decision for men in our model and the transition matrix between employment states is exogenously given, the only decision that affects these moments for men is their marriage decision. Therefore, the model is expected to, and does do well in matching these statistics for men. There is, however, an extensive labor supply

decision for single and married women.

The model does quite well at matching the employment status of women, both black and white. First, there is a significant fraction of black men with less than high school education who are in prison. About 21% and 28% of single black men with less than high school education are in prison in the model and the data, respectively. Not all black men who are in prison are, however, single. About 9% and 14% of married black men with less than high school education are married in the model and the data, respectively. For each education category, white men, married or single, are much less likely to be in prison than black men, and for both races the fraction of men who are in prison declines rapidly by education. Second, black males who are in prison, are much more likely to be unemployed than white man and the gap persists even for those with college education. About 12% of single black men with a college degree are unemployed, while the same number for whites is only 6%. A similar gap, 12% versus 5%, exists for married men with a college degree. Finally, while educated (those with some college or above) black women are more likely to be employed than their white counterparts, the opposite is true for less educated black women. The model captures these qualitative differences very well.

Table 15: Labor Market and Marital Status
model (data)

Race	Educ	Marital St.	Females		Males	
			E	E	U	P
Black	< HS	Single	.43 (.39)	.37 (.29)	.42 (.43)	.21 (.28)
		Married	.51 (.47)	.66 (.57)	.25 (.29)	.09 (.14)
	HS	Single	.64 (.63)	.56 (.56)	.33 (.32)	.11 (.12)
		Married	.72 (.69)	.74 (.78)	.23 (.18)	.03 (.04)
	SC	Single	.74 (.77)	.72 (.71)	.24 (.22)	.04 (.07)
		Married	.79 (.78)	.82 (.85)	.17 (.13)	.01 (.02)
	C	Single	.92 (.86)	.83 (.82)	.15 (.16)	.02 (.02)
		Married	.89 (.86)	.87 (.92)	.12 (.07)	.01 (0.1)
White	< HS	Single	.47 (.45)	.58 (.54)	.36 (.38)	.06 (.08)
		Married	.52 (.43)	.75 (.75)	.23 (.23)	.02 (.02)
	HS	Single	.71 (.72)	.78 (.74)	.18 (.22)	.04 (.04)
		Married	.74 (.69)	.87 (.90)	.12 (.10)	.01 (0)
	SC	Single	.79 (.81)	.87 (.82)	.12 (.17)	.01 (.01)
		Married	.77 (.74)	.89 (.92)	.11 (.07)	0 (.01)
	C	Single	.91 (.89)	.94 (.89)	.06 (.11)	0 (0)
		Married	.56 (.77)	.95 (.96)	.05 (.04)	0 (0)

6.3 Benchmark Economy in Historical Perspective

What is the elasticity of entry into marriage with respect to the incarceration rate implied by the model economy? To find this elasticity, we conduct the following experiment. We decrease the probabilities of going to prison for black and white males, i.e. we reduce the parameters $\pi_{ep}^r = \pi_{up}^r$, by small percentage increments, and for each new value of $\pi_{ep}^r = \pi_{up}^r$, 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 marriages. We then compare the relation between incarceration and marriage implied by our model with the same relation implied by the US historical experience. For the data we take the difference in differences between blacks and whites in 1980 and 2006 across US states, whereas for the model we take the difference in differences between blacks and whites in the benchmark model versus the outcomes that result from the incremental reductions in $\pi_{ep}^r = \pi_{up}^r$.

In particular, we change the probabilities of going to prison such that it produces a range of increases in the share of incarcerated blacks relative to incarcerated whites that is

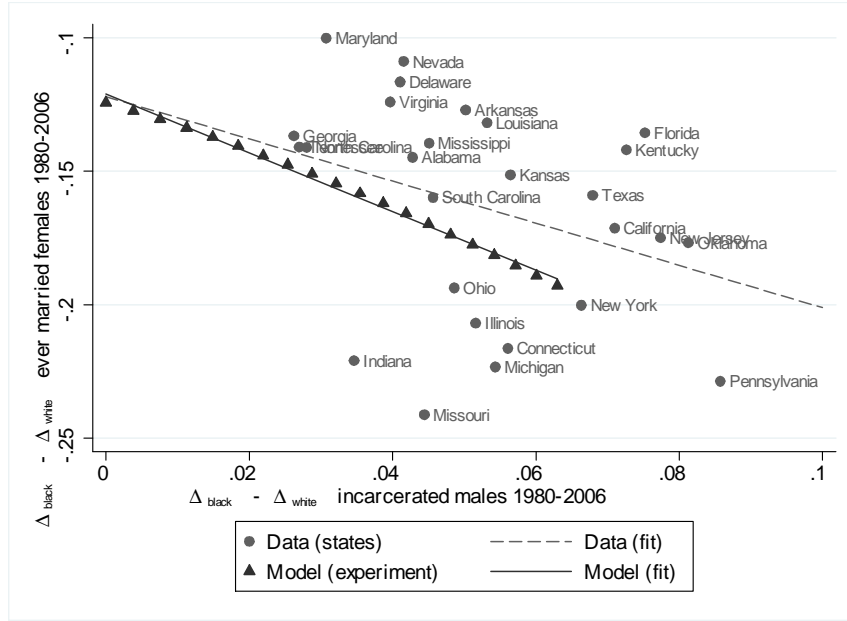


Figure 6: Black-White Differences in Changes in Incarceration versus Marriage, Model and Data

consistent with the US data in the left panel of Figure 3. Figure 3 reported the relation between difference-in-difference between black and white incarceration and marriage rates between 1980 and 2006 and shows that increases in incarceration rates were associated with lower marriage rates. The question is whether the model is able to generate a similar decline in the ever married black females. Figure 5 shows the results of this experiment. The dashed line is a similar regression line as in Figure 5. The solid line is the model-implied relation. The model does remarkably well as the model-implied relation between incarceration and marriage behavior is in line with what we observe in the data.

7 Understanding Black-White Marriage Gap

In the model economy, the white and black population differ by their wages, their education distribution, and the rates at which they transition between prison, unemployment, and various employment shocks. In this section we investigate the importance of each source of heterogeneity for the black-white marriage gap. First, we distribute black males and females across education levels as whites are distributed, i.e. we impose the educational attainment of whites in Table 3 on blacks. The results in the second column of Table 17 show that within

each level of education, the fraction of singles don't change much. However, since in this counterfactual economy more blacks have higher levels of education, and people with higher levels of education are more likely to marry in general, the size of black single population declines by about 5 percentage points. This is reported in row labelled as "Change". This represents about 20% of the observed marriage gap between blacks and whites.²¹ Table 17 reports, in columns 1 and 8, the fraction of single blacks and whites in the benchmark economy.

We next replace the wages and wage transitions of the black population with those of the white population to see how much that heterogeneity matters for the difference in the share of single individuals. To this end, we impose wage distributions of whites in Table 4 on blacks and use the wage shock transitions of whites from Tables A1 and A2 for both whites and blacks. The results in the third column of Table 17 suggest that wages play a relatively small role in marriage differences accounting for only 6% of the overall gap.

Next, we impose the transitions between employment and non-employment of whites on blacks. Employment transitions are important and close about one-fourth of the marriage gap between whites and blacks. Then, we impose the prison transitions of whites on blacks, i.e. we reduce the probability of entering into prison for blacks in Table 6 to the levels that we observe for whites. This has a larger impact accounting for 39% of the aggregate gap in singles.

The next columns highlight interaction affects. When we impose both prison and wage transitions of whites on blacks, marriage rates of blacks increase significantly closing 45% of the black-white gap, and imposing both employment and prison transitions accounts for about 76% of the marriage gap between whites and blacks. For combined experiments, we find that the combined effect is larger than the sum of the two separate experiments.

²¹If blacks were to marry with the counterfactual probabilities within each level of education, but remained distributed across levels of education as in the benchmark, then the gap would only shrink by 17%.

Table 17: Accounting for the Black-White Marriage Gap
Fraction Single

		Blacks	Educ.	Wage	Emp.	Prison	Prison &Wage	Prison &Emp.	Whites
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Females	< HS	.86	.76	.85	.77	.78	.76	.63	.61
	HS	.66	.62	.65	.58	.58	.57	.47	.44
	SC	.56	.50	.53	.49	.46	.43	.39	.36
	C	.42	.35	.42	.41	.33	.34	.32	.30
Males	< HS	.97	.98	.96	.91	.80	.77	.66	.63
	HS	.66	.67	.65	.59	.57	.56	.48	.46
	SC	.49	.50	.46	.41	.43	.40	.36	.36
	C	.35	.38	.35	.31	.34	.34	.30	.30
Change									
Gap accounted (%)									
			-0.05	-.01	-.07	-.09	-.10	-.17	
			20	6	29	39	45	76	

7.1 Counterfactual Criminal Justice Policies

In order to understand the effect of harsher sentencing and the War on Drugs on the formation of black families, we conduct two experiments. First, we reduce the average prison term from three to two years and then to one year by reducing the probability of remaining in prison from 0.67 to 0.50 and 0, respectively. Second, we simulate the economy whilst correcting transitions into prison for drug offenses in the SISCF. Given the limitations of the prison data we experiment with two scenarios. In the first scenario (which we label low), we try to identify those prisoners convicted for drug offenses only, whereas in the second experiment (high) we consider individuals with a drug offense but who might have committed multiple offenses. Then we remove these inmates in our calculations of Table 6 transitions. The resulting transitions are shown in Table A3.

The results of these experiments are presented in Table 18. We find that reducing the average time in prison has a substantial effect on marriage. If males spend two years on average or only one year with certainty, the marriage gap is closed by 13 or 41%, respectively. The reduction in the marriage gap is 13% and 20% for the low and high War on Drug experiments, respectively.

We also consider eliminating the utility cost of having a spouse in prison and the wage penalty a male suffers after having been to prison. Eliminating the utility cost of having a

spouse in prison reduces the marriage gap by 42%, while eliminating the wage penalty after having been to prison accounts for 7% of the gap.

Table 18: Criminal Justice Policies and the Black-White Marriage Gap
(fraction not-married)

		Blacks	Average term		War on drugs		Utility	Wage	White
			2 years	1 year	(low)	(high)	cost	penalty	
Females	< HS	.86	.85	.81	.84	.82	.79	.85	.61
	HS	.66	.64	.57	.63	.62	.58	.65	.44
	SC	.56	.52	.46	.52	.50	.46	.53	.36
	C	.42	.37	.32	.39	.37	.31	.42	.30
Males	< HS	.97	.96	.87	.93	.90	.74	.95	.63
	HS	.66	.62	.54	.63	.61	.56	.65	.46
	SC	.49	.45	.42	.46	.45	.45	.45	.36
	C	.35	.34	.34	.35	.34	.35	.34	.30
Change			-.03	-.09	-.03	-.05	-.09	-.02	
Gap accounted (%)			13	41	13	20	42	07	

8 Concluding Remarks

We have studied the drivers of the racial marriage gap, which has widened substantially over the past decades. Changes in the US labor markets in recent decades left many low-skilled workers without jobs. Coincidentally, the number of people behind bars has increased so much that the US now holds 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 males. We ask whether the bleak labor market prospects of black males and the considerable risk of being locked up might be able to explain why so many black females are choosing not to marry. Using an equilibrium model of marriage, divorce and labor supply that takes into account the transitions between employment, unemployment, and prison, we are able to disentangle and quantify the key contributors to the racial marriage gap.

We proceed by generating an economy resembling the US in 2006 in terms of labor market and marriage statistics. We conduct a range of counterfactual experiments in which we assign labor market and prison characteristics of white males to black males. We find that the higher likelihood that black males face in terms of incarceration can account for

nearly half of the racial marriage gap. Adding differences in employment transitions narrows the aggregate gap by more than three-fourths.

Finally, we find that changes in incarceration policies, such as decreased term lengths, could lead to increases in marriages among blacks. Of course none of our experiments are meant to be interpreted as normative judgements as we neither model crime as a decision nor does crime exhibit any negative externalities in the model. Nonetheless, we think it is important to understand how labor market characteristics and incarceration policies are affecting marriage formation. There are several ways to extend the model developed here. In particular, questions about how incarceration is affecting fertility and children are left for future research.

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9 Appendix

9.1 Wage Transitions

Table A1: Wage Transitions, Males

		Black					White				
		1	2	3	4	5	1	2	3	4	5
< HS	1	.209	.313	.239	.164	.075	.361	.234	.197	.102	.107
	2	.076	.418	.271	.138	.098	.094	.484	.206	.123	.093
	3	.057	.208	.371	.201	.163	.051	.178	.445	.224	.101
	4	.038	.173	.269	.375	.144	.025	.101	.198	.501	.175
	5	.008	.093	.217	.217	.465	.033	.071	.133	.179	.584
HS	1	.385	.294	.161	.095	.065	.464	.251	.134	.085	.067
	2	.128	.418	.229	.145	.081	.123	.481	.216	.11	.071
	3	.072	.183	.389	.217	.139	.058	.162	.482	.204	.094
	4	.063	.123	.212	.389	.213	.041	.099	.187	.51	.162
	5	.048	.13	.131	.224	.467	.038	.088	.119	.191	.564
SC	1	.392	.267	.122	.136	.083	.459	.268	.127	.084	.062
	2	.134	.39	.192	.159	.126	.108	.509	.216	.103	.064
	3	.088	.174	.419	.204	.115	.066	.167	.471	.214	.082
	4	.067	.15	.19	.388	.205	.046	.097	.169	.516	.171
	5	.06	.129	.131	.225	.454	.047	.077	.094	.172	.609
C	1	.403	.266	.162	.097	.071	.518	.239	.113	.085	.046
	2	.176	.403	.195	.131	.096	.136	.49	.211	.109	.055
	3	.105	.197	.352	.223	.123	.073	.166	.452	.228	.081
	4	.062	.121	.179	.429	.208	.052	.091	.167	.522	.168
	5	.057	.082	.13	.209	.522	.043	.069	.102	.209	.577

Table A2: Wage Transitions, Females

		Black					White				
		1	2	3	4	5	1	2	3	4	5
< HS	1	.365	.282	.200	.094	.059	.392	.265	.114	.136	.093
	2	.104	.377	.251	.126	.142	.120	.427	.201	.160	.091
	3	.042	.170	.420	.231	.137	.075	.175	.410	.253	.087
	4	.052	.117	.240	.403	.188	.044	.118	.169	.504	.165
	5	.043	.148	.174	.113	.522	.054	.099	.127	.203	.517
HS	1	.310	.268	.149	.134	.139	.456	.241	.138	.108	.057
	2	.110	.400	.205	.161	.124	.117	.456	.230	.135	.061
	3	.068	.234	.353	.213	.132	.060	.135	.480	.219	.076
	4	.049	.157	.207	.394	.193	.051	.105	.190	.501	.153
	5	.070	.169	.140	.191	.429	.044	.099	.126	.238	.493
SC	1	.346	.210	.198	.156	.091	.450	.246	.146	.104	.055
	2	.175	.392	.186	.166	.082	.121	.457	.230	.132	.059
	3	.080	.250	.362	.225	.083	.072	.174	.462	.218	.074
	4	.043	.153	.185	.403	.216	.048	.102	.191	.504	.155
	5	.068	.114	.117	.203	.498	.036	.078	.108	.223	.555
C	1	.377	.266	.178	.103	.075	.483	.264	.124	.085	.045
	2	.175	.385	.246	.124	.069	.141	.478	.223	.104	.053
	3	.113	.194	.329	.232	.132	.075	.177	.464	.206	.077
	4	.071	.133	.210	.409	.177	.048	.095	.183	.496	.179
	5	.054	.099	.150	.165	.533	.043	.070	.095	.225	.566

Table A3: Initial Wage Shocks

		Black					White				
	Educ.	1	2	3	4	5	1	2	3	4	5
Females	< 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
Males	< 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

9.2 Counterfactual Prison Transitions

Table A4: Probability of Going to Prison
(yearly)

Education	High Scenario	Low Scenario
< HS	.0516	.0632
HS	.0177	.0215
SC	.0057	.0066
C	.0031	.0041