

# **Does Wealth Explain Black-White Differences in Early Employment Careers?**

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**Abstract.-** In this paper I inquire about the effects initial wealth has on black-white differences in early employment careers. I set up a dynamic model in which individuals simultaneously search for a job and accumulate wealth, and fit it to data from the National Longitudinal Survey (1979-cohort). Regime changes and decompositions of racial differences reveal that differences in the labor market environment and in preferences account fully for racial gaps in wealth and in wages persisting several years after High School graduation. Differences in initial wealth partially explain differences in early employment careers.

**Keywords:** Job search, wealth, racial differences, borrowing constraints, consumption, unemployment, estimation of dynamic structural models.

**JEL Classification:** C33, E21, E24, J64.

# 1 Introduction

The last decade has witnessed a growing interest in the black-white wealth gap. Whereas historically income disparity between blacks and whites has narrowed down (Smith and Welch 1989), wealth disparity remains large. Thus, while blacks earn between 50% and 64% of whites' income, blacks' wealth is only between 12% and 20% of whites' wealth (Blau and Graham 1990, Wolff 1994, Menchik and Jianakoplos 1997, Oliver and Shapiro 1997, Scholz and Levine 2003). Recent studies have focused on the role of differences in income, education, and patterns of marriage and fertility to explain racial gaps in wealth levels and growth rates (Gittleman and Wolff 2004, Altonji and Doraszelski 2005). I, on the other hand, examine whether causality may be also working in the opposite direction, that is, whether initial wealth disparity explains black-white differences in employed wages and employment rates for High School graduates. Therefore, throughout this paper I report differences in wages (the income of the employed) and in the unemployment rate rather than total differences in income, as in other studies. In order to abstract from wage differences caused by skill gaps (Neal and Johnson 1996, Neal 2005), I restrict the analysis to individuals with the same level of schooling. Subsequently, I estimate a dynamic model of wealth accumulation and job search and find that initial wealth has essentially no influence in explaining racial disparities several years after High School graduation in comparison with labor market variables. Initial wealth only accounts for the racial gap in wealth and wages at the *beginning* of employment careers. By contrast, differences in the labor market environment and in preferences are shown to account fully for both racial gaps, in wealth and in wages, persisting several years after High School graduation.

Imperfect capital markets allow wealth to affect job search outcomes: wealthier agents can search longer and obtain higher wages. This effect is formalized in a utility-maximizing job search model where agents' reservation wages depend positively on their wealth levels. Thus, wealth accumulation becomes part of the optimal job search strategy in which unemployed agents run down their wealth to maintain consumption

levels, and employed agents accumulate wealth to hedge against future unemployment spells, which also allows them to move to better paying jobs.

Utility-maximizing job search models are based on the seminal work of Danforth (1979), who analyzed in detail the role of wealth on an individual's optimal job search strategy. In his framework, only the unemployed look for a job and receive wage offers from a non-degenerate distribution; the employed do not search and do not become unemployed and there is no decision about search intensity. By recent years several empirical studies have attempted to test utility-maximizing search models inspired in Danforth's basic framework. In this paper I generalize Danforth's model to allow for on-the-job search, wage growth, variations of arrival and layoff rates as a function of age, retirement age, and a parametric limit on borrowing. In particular, I assume a parametric initial wealth distribution and unobserved heterogeneity with different types of individuals who differ in their labor market environments, initial wealth distributions, borrowing constraints, and preferences. These features allow my model to generate predicted life-cycle trajectories and distributions of employment status, wealth, and wages that match the observed ones.

The behavioral parameters of the model are recovered using the method surveyed by Rust (1988) and Eckstein and Wolpin (1989). I use the numerical solution to the joint job search and consumption problem to construct a distance function between the observed and the predicted paths of wealth, wages, and employment transitions, which is minimized over the behavioral parameters. This approach has been used by Wolpin (1992), Eckstein and Wolpin (1999), Keane and Wolpin (2000), and Bowlus and Eckstein (2002) to study black-white labor market differences and to conduct policy experiments. I study the effects on wealth accumulation and labor market outcomes of regime changes consisting of assigning blacks the labor market conditions, initial wealth distribution and access to credit, and preferences of whites. Furthermore, I use these counterfactual experiments to perform a decomposition of the total race differentials into these three components.

A regime change that gives blacks the labor market conditions of whites is able to generate full convergence in labor market outcomes both in the short and in the long run. If, additionally, there is a switch in taste parameters, this regime change can also eliminate long run wealth disparity, although not the initial wealth gap. On the contrary, a shift in initial wealth and access to credit fails to substantially narrow down the long run racial wealth and wage gaps, but it is the only regime change that accomplishes the elimination of racial gaps in wealth and wages at the beginning of employment careers.

The remainder of the paper is organized as follows. The next section explains the data source, the National Longitudinal Survey of Labor Market Experience - Youth Cohort (NLSY), the selection of the sample, and the descriptive statistics; Section 3 describes the theoretical model; Section 4 explains the simulated method of moments estimation procedure; Section 5 analyzes the estimation results; Section 6 assesses, both formally and graphically, the performance of the model in replicating the main trends of the data, and Section 7 presents regime changes and decomposition of race differences based on the estimated parameters of the model. The main conclusions of the paper are summarized in Section 7.

## 2 Data

The National Longitudinal Survey of Labor Market Experience - Youth Cohort (NLSY) contains data on household composition, military experience, school enrollment, and a week by week account of employment status, hourly wages, hours worked, and employers. An individual's complete weekly work history can be constructed from 1978 until 1993. Respondents whose employment histories started before 1978, i.e., those born before 1961, and for whom it is impossible to construct a complete employment history, are dropped from the sample. The final sample contains 158 black and 212 white High School male graduates born after December 31, 1960, who neither went

to college nor had any type of military experience. Black males were selected from the core and from the supplemental sample, whereas white males were taken from the core sample. Wolpin (1992) and Rendon (2006) also use this selection of individuals whose behavior is well described by a search-theoretic framework that excludes the decision to join the military.

Given that blacks exhibit higher High School dropout rates and whites are more likely to continue studying after High School, it is possible that this sample selection leads to an underestimation of the differences in labor market outcomes by race. As pointed out by Heckman, Lyons and Todd (2000) the definition of the sample is crucial in making inferences about black-white differentials. In this article, the lower tail of the income distribution of blacks and the upper tail of the income distribution of whites could be underrepresented. In spite of this, it will be shown that, under the assumption of exogeneity of educational attainment, wage and wealth differences by race remain important.

To make the estimation tractable I aggregate the data into quarters. Each individual's reported last week of school enrollment is assigned to its corresponding calendar quarter; employment history starts in the quarter thereafter. An individual is employed if he works twenty or more hours during the first week of the quarter; any other job held during the quarter is ignored. Otherwise, he is recorded as unemployed for that quarter. Reasons for leaving a given employer are classed as layoffs or quits. Individuals returning to work for their old employers are recorded as having new jobs. The quarterly wage is the wage of the first week of the quarter in 1985 dollars times 13. The Consumer Price Index is used to deflate nominal values into real amounts.

I evaluated the magnitude or potential for aggregation bias induced by the aggregation of data into quarters by comparing quarterly transitions computed using the observation of the first week with quarterly transitions implied by the weekly data for all black and white individuals in the survey. For both race groups aggregation

tend to overestimate the persistence of unemployment and underestimate job loss. For blacks there is a slight overestimation of persistence of work for the same employer, whereas for whites there is a slight underestimation of persistence of work for the same employer. This exercise reveals that the quarterly transitions are not that inaccurate, given the substantial omission of weekly observations. I report this exercise in Appendix A2, which, together with Appendices A3-A9, is contained in a separate document and is available from the author upon request.

Annual data on the market value of wealth are only available for years 1985 until 1993, with the exception of year 1991; this information is assigned to the calendar quarter in which the interview took place, leaving all other quarters blank.

Wealth consists of financial assets, vehicles and other assets (like jewelry or furniture), all net of debts and all computed at their “market value”, defined by the NLSY as the amount the respondent would reasonably expect someone to pay if the particular asset were sold in its current condition at any point in time. Other less liquid types of wealth, such as residential property and business assets, are excluded as I assume that agents will only use the most liquid wealth to finance their job search. Jianakoplos, Menchik and Irvine (1989), Blau and Graham (1990), and Smith (1995) show that, as individuals of both race groups become wealthier, they increase the proportion of their wealth in the form of residential property, business, farms or other property, and decrease the proportion of their wealth in the form of vehicles. Notably, at the same wealth level blacks systematically have a lower percentage of their wealth in business property than whites, denoting a relative absence of black-owned businesses (Fairlie 1999, Fairlie and Meyer 2000). Thus, racial inequality in terms of the most liquid wealth will be lower than racial inequality measured with total wealth. In Rendon (2006) I estimate a similar version of this model for one race group using *total* wealth; accordingly as we will see in Section 5, in that article borrowing constraints are estimated to be tighter and the coefficient of risk aversion higher than in the current article.

[Table 1 here]

Table 1 shows the evolution of employment rates and transitions, wealth and wages three, six, and nine years after High School graduation. From year 3 to year 9, the fraction of blacks who are unemployed decreases from 34% to 20%, while the corresponding percentage for whites decreases from 18% to 9%. In the same period, blacks increase their wealth from \$1,393 to \$3,702, whereas whites increase their wealth from \$4,921 to \$8,780, that is, the black-white ratio of average wealth increases from 28% to 42%. The percentage of individuals with more than \$10,000 increases from 1% to 11% for blacks, and from 15% to 29% for whites. Average wage, income of the employed, for blacks increases from \$3,104 to \$3,739 and from \$3,363 to \$4,552 for whites, meaning that the black-white ratio of average wage decreases from 92% to 82%. It is clear that wealth accumulation does accompany the increase in employment rates and wages that occurs after graduation from High School, and that a reduction in the racial wealth gap is associated with a widening of the racial wage gap.

[Table 2 here]

Table 2 reports average wealth by wage level, number of years since graduation and race group. Wages measure the quarterly income of the employed only; the unemployed are not included in this table. It is shown that agents with higher wages tend to have a higher level of wealth. No more than 6 years after graduation, blacks with wages below \$2,000 have an average wealth of \$724, whereas blacks with wages above \$6,000 have an average wealth of \$5,634. The corresponding wealth of whites for the same wage brackets is, respectively, \$1,396 and \$8,511. These descriptive statistics show the existence of a link between labor market progress and wealth accumulation for both race groups.



[Table 3 here]

Table 3 relates saving behavior to employment transitions between two periods for which wealth data are available. As the interviews were conducted in different quarters for different individuals, this time interval does not necessarily correspond to four quarters. For both race groups becoming or staying unemployed is associated with wealth decumulation, while becoming employed or changing employer is associated with increases in wealth. Staying with the same employer is associated with wealth accumulation for whites, and with wealth decumulation for blacks. Black individuals who are unemployed and become employed save on average \$1,740 between two quarters; the corresponding amount for whites is \$365. White individuals who are employed and become unemployed decrease their wealth in \$1,515; the corresponding amount for blacks is \$953. Explaining these related trends requires a theoretical model that will account jointly for wealth accumulation and employment transitions.

### 3 Model

In this section I describe a model of wealth accumulation and job search under borrowing constraints. It is an extension of Danforth's (1979) model to allow for on-the-job search, wage growth, variations in arrival and layoff rates as a function of age, retirement age, and a parametric borrowing limit.

An individual maximizes expected utility of consumption over his life,  $T_F$  (=262) quarters. He can be employed or unemployed during his active life,  $T$  (= 162) quarters, after which he retires and lives off his savings. Each period he faces a utility function  $U(\cdot)$  over consumption and, when employed, he suffers a constant utility loss captured by  $\psi \geq 0$ , which represents the disutility of working.

While unemployed at period  $t$  he receives, with probability  $\lambda_t$ , one wage offer  $x$  drawn from the known base wage offer distribution  $F(\cdot)$ ,  $x \in (\underline{w}, \bar{w})$ ,  $0 < \underline{w} < \bar{w} < \infty$ . An unemployed individual becomes employed if he receives and accepts a wage offer;

otherwise he remains unemployed. Transitions from unemployment are illustrated in the following scheme:

[Figure 1 here]

While employed at period  $t$ , an individual can be laid off with probability  $\theta_t$  and receive a new wage offer with probability  $\pi_t$ , drawn from the same base distribution  $F(\cdot)$ . If he is not laid off and receives a job offer, he can accept it and switch to a new job, reject it and stay in the current job, or reject it and quit to unemployment. If he is not laid off and does not receive a job offer, he has to decide between staying in his current job or quitting to unemployment. If he is laid off, he can still receive a job offer; accepting it means switching to a new job; rejecting it means becoming unemployed. If a person is laid off and does not receive an offer, his only option is to become unemployed. The possible transitions from being employed are shown below.

[Figure 2 here]

When unemployed, the agent receives transfers  $b$ , which are non-labor income such as family transfers and unemployment compensation net of search costs. When employed, the agent experiences wage growth as a function of age, that is, his current wage  $w_t$  depends on the initial wage draw  $\omega$  and age  $t$ . Similarly, both the probability of receiving an offer while unemployed and while employed,  $\lambda_t$  and  $\pi_t$  respectively, as well as the layoff rate  $\theta_t$ , depend on the agent's age  $t$ . Modelling wage and arrival rates as functions of experience would have been preferable, but would also increase drastically the computation burden to solve and estimate this model.

At each period  $t$ , given his employment state and his wealth  $A_t$ , the agent determines his consumption  $C_t^u$  and  $C_t^e$ , and thereby his wealth for the next period  $A_{t+1}^u$  and  $A_{t+1}^e$ . Initial wealth is inherited and final wealth is zero. The rate of return  $r$

is constant; the subjective discount factor is  $\beta \in (0, 1)$ . Agents can save freely, but borrowing is restricted so that current wealth cannot be lower than an age-dependent level  $B_t$ . In a free capital market with fully risk-averse lenders individuals can borrow up to the level they can pay back with certainty, that is, the ‘natural borrowing limit’ (Ljungqvist and Sargent 2000), which is the present discounted value of the lowest possible income level  $b$ :  $\tilde{B}_t = -\sum_{\tau=t}^T b/(1+r)^{T-\tau}$ . Wealth levels below this limit imply non-positive consumption,  $C = \tilde{B}_t + b - \tilde{B}_{t+1}/(1+r) = 0$ , which is not admissible for utility functions that satisfy the Inada condition  $\lim_{C \rightarrow 0} U(C) = \infty$ . Hence, the only non-redundant constraint is  $B_t > \tilde{B}_t$ , which allows us to express and parameterize the borrowing constraint as a fraction of the natural constraint. Let  $s$  measure the tightness of the borrowing constraint as a fraction of  $\tilde{B}_t$ , then the lower bound on wealth is  $B_t = s\tilde{B}_t$ ,  $s \in [0, 1]$ .

The expected lifetime utility of a retired agent of age  $t$ ,  $V_t^R$ , depends on wealth  $A_t$ :

$$V_t^R(A_t) = \max_{\{A\}_{\tau=t+1}^{T_F}} \sum_{\tau=t}^{T_F} \beta^{\tau-t} U\left(A_\tau - \frac{A_{\tau+1}}{1+r}\right),$$

where  $A_{T_F+1} = 0$ . This agent saves voluntarily for retirement with full control over his pension funds, so that the dynamic problem becomes ‘a cake-eating problem.’ A possible extension of this model is to allow for a pension system with realistic contribution schemes during the working lifetime and pensions during retirement with an increasing mortality. However, since the estimation will only contain a young labor force, this extension should not affect the main results substantially. Accordingly, it is left for future research.

When unemployed, expected lifetime utility at age  $t$ ,  $V_t^u$ , depends on wealth  $A_t$ :

$$V_t^u(A_t) = \max_{A_{t+1}^u \geq B_{t+1}} \left\{ U\left(A_t + b - \frac{A_{t+1}^u}{1+r}\right) + \beta \left[ \lambda_{t+1} \int \max [V_{t+1}^e(A_{t+1}^u, x), V_{t+1}^u(A_{t+1}^u)] dF(x) + (1 - \lambda_{t+1}) V_{t+1}^u(A_{t+1}^u) \right] \right\}.$$

When employed, expected lifetime utility at age  $t$ ,  $V_t^e$ , depends on wealth  $A_t$  and wage  $w$ :

$$\begin{aligned}
V_t^e(A_t, \omega) = & \max_{A^e \geq B_{t+1}} \left\{ U \left( A_t + w_t(\omega) - \frac{A_{t+1}^e}{1+r} \right) - \psi \right. \\
& + \beta \left[ (1 - \theta_{t+1}) \left( \pi_{t+1} \int \max [V_{t+1}^e(A_{t+1}^e, x), V_{t+1}^e(A_{t+1}^e, \omega), V_{t+1}^u(A_{t+1}^e)] dF(x) \right. \right. \\
& \quad \left. \left. + (1 - \pi_{t+1}) \max [V_{t+1}^e(A_{t+1}^e, \omega), V_{t+1}^u(A_{t+1}^e)] \right) \right. \\
& \left. \left. + \theta_{t+1} \left( \pi_{t+1} \int \max [V_{t+1}^e(A_{t+1}^e, x), V_{t+1}^u(A_{t+1}^e)] dF(x) + (1 - \pi_{t+1}) V_{t+1}^u(A_{t+1}^e) \right) \right] \right\}.
\end{aligned}$$

This dynamic programming (DP) problem has a finite horizon  $T$  and a ‘salvage value’ which is the present discounted utility at retirement age, that is, at  $t = T + 1$ :  $V_t^u(A_t) = V_t^R(A_t)$ , and  $V_t^e(A_t, \omega) = V_t^R(A_t)$ . The solution to this problem includes two policy rules for wealth accumulation,  $A_{t+1}^u(A_t)$  and  $A_{t+1}^e(A_t, \omega)$ , and a reservation base wage  $\omega_t^*(A_t) = \{\omega \mid V_t^u(A_t) = V_t^e(A_t, \omega)\}$ . In this model, under certain conditions nobody will work for a wage below  $b$ , that is:

**Proposition 1** *If  $\lambda_{t+1} \geq \pi_{t+1}$  and  $\psi \geq 0$ , then  $w_t(\omega_t^*(A_t)) \geq b$ ,  $t = 1, \dots, T$ .*

**Proof:** *In Appendix A1.*

Notice that requiring the arrival rate while unemployed to be higher than while employed is a sufficient but not necessary condition for reservation wages to be greater or equal than unemployment transfers. Even if this condition is not fulfilled, high disutility levels associated to working can generate reservation wages that exceed unemployment transfers.

In the absence of analytical solutions for this problem, and in order to solve it numerically one needs to assume specific functional forms:

- a constant relative risk aversion (CRRA) utility function  $U(C) = \frac{C^{1-\gamma}-1}{1-\gamma}$ , where  $\gamma > 0$  is the coefficient of risk-aversion that satisfies the Inada conditions;
- a truncated log-normal wage offer distribution  $\ln \omega \sim N(\mu, \sigma^2 \mid \ln \underline{\omega}, \ln \bar{\omega})$ ;

- a wage growth function  $w_t(\omega) = \omega \exp(\alpha_1 t + \alpha_2 t^2)$ ; and
- age-dependent arrival and layoff rates given by the logistic function

$$q_t = \frac{q_0 \exp(\alpha_q t)}{1 + q_0 [\exp(\alpha_q t) - 1]}, \text{ where } q = \{\lambda, \pi, \theta\}.$$

and  $q_0$  are the initial arrival and layoff rates. This expression comes from  $q_t = \exp(\alpha_q^0 + \alpha_q t) / [1 + \exp(\alpha_q^0 + \alpha_q t)]$  and letting  $\alpha_q^0 = \ln(q_0 / [1 - q_0])$ .

Then the model is solved recursively on a discretized state space. Using longer period lengths for the more distant future value functions in the DP problem makes the estimation more tractable (Wolpin 1992). Appendix A3 describes in detail the discretization and the numerical solution technique.

As shown in Rendon (2006), this model produces policy rules with the following features:

- The unemployed decumulate wealth. That is, they maintain their consumption while searching for a job by decreasing their wealth monotonically until reaching the borrowing limit.
- The employed can accumulate or decumulate wealth, depending on their wages and current wealth, so that wealth converges to some age-dependent desired level. They keep this wealth as a precaution to cushion future unemployment spells that may follow, if the layoff rate is not zero. As retirement age approaches they increase their wealth accumulation.
- The reservation wage is increasing in wealth. This means that wealthier agents are more selective and end up with higher accepted wages.

These policy rules imply a close interaction between labor market turnover and saving decisions. During unemployment spells, longer for wealthier people, reservation wages decline and hazard rates increase. In contrast, during employment spells, and

for some combinations of current wealth and wages, wealth and reservation wage increase. It may occur that the reservation wage exceeds the current wage, in which case the current job is no longer preferable to unemployment. Barring a better wage offer from a new employer, the agent will quit his current job to search for a better one while unemployed with higher arrival rates. Thus, wealth accumulation underlies quits to unemployment, which reflect the agent's permanent desire to move to better paying jobs.

As explained in Rendon (2006), quits to unemployment can only happen in this framework if arrival rates are higher while unemployed than while employed. Although this difference is not assumed in the model and is not a restriction imposed in the estimation, observed quits will yield estimated parameters that satisfy this difference. Notice that the incentive to quit is there in spite of age wage growth.

With these features the policy rules will be able to generate realistic employment transitions and trajectories and distributions of wealth and wages over the life cycle.

## 4 Estimation

The estimation strategy is designed to recover the behavioral parameters of the theoretical model. I assume that individuals start off their careers with a wealth level drawn from a parametric initial wealth distribution and, for each parameter set, I compute the policy rules that solve the DP problem and use them to generate simulated careers paths. Then, at each iteration of the parameters I construct a measure of distance between the observed and the simulated moments, namely the distributions of employment status and transitions, wages, and assets. The estimation is thus a simulated method of moments (SMM) procedure in which the parameter estimates of the theoretical model are the minimizers of this function.

All individuals start off their careers being unemployed, with a wealth level  $A_0$  drawn from a displaced lognormal distribution,  $\ln(A_0 - B_0) \sim N(\mu_0, \sigma_0^2)$ . I add the

lowest admissible wealth level  $B_0$  to each unobservable initial value of wealth to make the term inside the logarithm positive. The identification of the parameters of this function is not only given by wealth data, which are scarce for the first quarters after graduation, but also, in the presence of persistence in observed wealth values over time, by employment transitions and wages over time. The parameters to estimate are then the following:

1. Labor Market Parameters:  $\Theta^1 = \{\lambda_0, \pi_0, \theta_0, \mu, \sigma, \alpha_1, \alpha_2, \alpha_\lambda, \alpha_\pi, \alpha_\theta\}$ .
2. Wealth Parameters:  $\Theta^2 = \{s, \mu_0, \sigma_0\}$ .
3. Taste Parameters:  $\Theta^3 = \{b, \gamma, \psi\}$ .

The parameters of the standard search model,  $b, \lambda_0, \pi_0, \theta_0, \mu,$  and  $\sigma$ , extended by  $\alpha_1, \alpha_2, \alpha_\lambda, \alpha_\pi, \alpha_\theta,$  and  $\psi$  are identified from the reservation wage rule by the observed transitions, accepted wages, and wealth level at each quarter after graduation. The interest rate  $r$  and the discount factor  $\beta$  are not identified separately from the arrival rates, so they are fixed at 0.015 and 0.98, respectively. The other parameters, namely  $\gamma$  and  $s$  are specific of a utility-maximizing job search model, which generates rules for wealth accumulation, and are pinned down by the observed evolution of wealth by employment status and wages.

Individuals do not only differ in their initial wealth, but also in other characteristics that have permanent effects on their work history. Assuming there is only one type of agent would, therefore, lead to making wrong inferences, in particular with regards to the estimation of wage offer distributions and arrival rates (Lazear 1979, Orazem 1987). To prevent this I introduce unobserved heterogeneity in the estimation and assume eight types of agents within each race group, which requires solving the DP problem eight times, one for each type of agent.

I assume two types for each of the three subsets of parameters, indexed by 1 and 2. Therefore, there are  $8 = 2^3$  types of individuals characterized by each possible combination of the three subsets:  $\Theta_{ijk} = \{\Theta_i^1, \Theta_j^2, \Theta_k^3\}, i, j, k = 1, 2$ . The probabilities

of being type 1 for each of the three subset of parameters are denoted as  $p_1 = \Pr(\Theta_1^1)$ ,  $p_2 = \Pr(\Theta_1^2)$ , and  $p_3 = \Pr(\Theta_1^3)$ , so that the proportion for each type combination in the subsample is  $p_{ijk}, i, j, k = 1, 2$ , obtained as the product of the probabilities of each type for each subset of parameters:

$$\begin{aligned} p_{111} &= p_1 p_2 p_3, & p_{112} &= p_1 p_2 (1 - p_3), \\ p_{121} &= p_1 (1 - p_2) p_3, & p_{122} &= p_1 (1 - p_2) (1 - p_3), \\ p_{211} &= (1 - p_1) p_2 p_3, & p_{212} &= (1 - p_1) p_2 (1 - p_3), \\ p_{221} &= (1 - p_1) (1 - p_2) p_3, & p_{222} &= (1 - p_1) (1 - p_2) (1 - p_3). \end{aligned}$$

Accordingly, the vector for all parameters of the model is defined as  $\Theta = \{\Theta_1^1, \Theta_1^2, \Theta_1^3, \Theta_2^1, \Theta_2^2, \Theta_2^3, p_1, p_2, p_3\}$  and contains the two types of the three subsets of parameters and three type probabilities.

I generate simulated career paths for 8000 individuals, that is, 1000 draws for each type of agent in each subsample. The moments used in this estimation are the cell-by-cell probability masses for the following distributions:

1. wealth distribution (10 years  $\times$  5 moments),
2. wage distribution (10 years  $\times$  4 moments),
3. employment status (10 years  $\times$  2 moments),
4. employment transitions from unemployment (10 years  $\times$  2 moments),
5. employment transitions from employment (10 years  $\times$  3 moments),
6. layoffs from employment to unemployment (10 years  $\times$  2 moments), and
7. layoffs when changing employer (10 years  $\times$  2 moments).

Thus, there are 200 moments to estimate 32 parameters, 16 for each type of agent plus 3 proportions of types for each race group. These simulated moments are computed for each year and without excluding actually missing observations (these moments barely change when they are computed excluding simulated individual and



quarterly observations when the observed counterpart is missing). The SMM procedure relates a parameter set to a weighted measure of distance between sample and simulated moments:

$$S(\Theta) = \Delta m'W^{-1}\Delta m,$$

where  $\Delta m$  is the distance between each sample and simulated moment and  $W$  is a weighting matrix. As shown in Appendix A4, the matrix  $W$  can be chosen so that this weighted distance equals the sum of the  $\chi^2$ -statistics of the selected distributions. In that case, minimizing this function is equivalent to minimizing a goodness of fit measure:  $\Delta m'W^{-1}\Delta m = \chi_{130}^2$ . Hence, fit measured by this criterion is the best that can be attained. The estimated behavioral parameters are thus  $\Theta^* = \arg \min S(\Theta)$ .

The function is minimized using Powell's method (Press, Teutolsky, Vetterling and Flannery 1992), which requires only function evaluations, not derivatives. This algorithm first calculates function values for the whole parameter space and then searches for the optimal parameter direction in the next iteration for function minimization. Underlying the computation of this optimal direction there is an implicit model of the derivative structure of the objective function. Once a new set of parameters is obtained, the algorithm goes back to calculate a new function value  $f_t$ , and the process is repeated until a convergence criterion is satisfied, namely that the percentage variation of this value falls below a certain value:  $2|f_t - f_{t-1}| / (|f_t| + |f_{t-1}|) \leq 10^{-10}$ . Asymptotic standard errors are calculated using the outer-product gradient estimator; their computation is explained in greater detail in Appendix A5.

## 5 Estimation Results

In this section, I discuss the parameter estimates for the two race groups and compare graphically and numerically actual and fitted moments: hazard rates at the first unemployment spell, trajectories for all observed variables and wealth variations by

employment transitions.

The parameter estimates by race and type and their corresponding asymptotic standard errors are reported in Table 4.

[Table 4 here]

The first set of parameters, which characterize the labor market environment, is reported in the upper part of the table. The probabilities of receiving an offer while unemployed are initially lower but grow faster for blacks than for whites. In the first period out of school these are 69% for Type 1 and 30% for Type 2 of blacks. However, forty quarters after graduation they have grown substantially to 83% and 98% respectively. For whites these probabilities are initially 84% for Type 1 and 58% for Type 2; forty quarters later they have not grown much: 99% and 68%, respectively.

On the other hand, the probability of receiving an offer while employed is higher for blacks than for whites: it is initially 17% for Type 1 and 81% for Type 2 of blacks and 10% for Type 1 and 53% for Type 2 of whites. For both race groups these probabilities do not grow much with age: forty quarters after graduation they become 19% and 82% for blacks and 28% and 55% for whites. The relatively slow growth of offer rates while employed in contrast to the fast growth of offer rates while unemployed, captures the observed trend of decreasing job-to-job transitions over time that is simultaneous to exit rates from unemployment remaining pretty constant. To match increasing reservation wages, a result of wealth accumulation, arrival rates while unemployed have to go up so that exit rates remain more or less constant. Thus, if agents are becoming more selective in their job acceptance decisions and are moving up to better paying jobs, because of changing employers and of age wage growth, matching observed decreasing job-to-job transitions requires offer rates while employed not to grow too fast.

Finally, the layoff rate is initially higher but decreases faster for blacks. While it is 22% for Type 1 and 17% for Type 2 of blacks, it is 7% for Type 1 and 13% for Type 2

of whites. Forty quarters after graduation these parameters become, respectively, 3% and 9% for blacks and 5% and 3% for whites, which means that there is relatively fast convergence in layoff rates. Only for blacks of Type 2 these arrival and layoff rates, both the initial values and the associated variation parameters, exhibit large standard errors; for all other groups they are estimated precisely.

Blacks exhibit lower means but higher standard deviations of the log-wage offer distributions than whites'. These parameters imply an estimated initial mean quarterly wage offer for Type 1 and Type 2 of \$1,999 and \$1,590 for blacks and \$1,575 and \$2,511 for whites, respectively. Wages grow at a declining rate for both races, but they grow higher for whites, who also reach a maximum level later in their working life: at 266 and 30 quarters for Type 1 and Type 2, respectively, of whites. The equivalent for blacks is 108 and 19 quarters. The highest attainable mean wage offers are \$3,173 for Type 1 and \$1,609 for Type 2 of blacks, and \$5,235 for Type 1 and \$3,115 for Type 2 of whites. Thus, although wages of Type 1 are initially the lowest of whites, because of their higher growth, they end up overtaking wages of Type 2. Asymptotic standard errors for these parameters are in general small, with the exception of the quadratic term of wage growth for Type 2 of blacks, which is found to be non-significant.

While these implications are useful in providing a first glance on the evolution of wage offers, they do not consider wealth-dependent labor turnover (agents switching jobs and employment states depending on their wealth position) and therefore do not imply that wages for a given individual wages will peak at the above age. Simulations of the model over the individuals' life cycle yield quarterly wages that peak at \$7,540 for blacks and \$10,118 for whites. The interested reader will find further insights on the maximum attainable wages over an individual's life cycle in Appendix A6.

These parameters are characteristic of the standard search model and represent a labor market environment that is more favorable for whites than for blacks. As in Wolpin (1992), whites have a better wage offer distribution and more wage growth.

However, here the differences in arrival rates are much larger for both race groups: arrival rates while unemployed are higher, arrival rates while employed are lower, and layoff rates are higher. Accounting for the evolution of wealth and the reason for leaving the current employer, particularly voluntary quits from employment to unemployment, require larger differences between arrival rates by employment status and larger layoff rates.

The second set of parameters are specific of a utility-maximizing search model: the tightness of the borrowing constraint and the parameters characterizing the initial wealth distribution. Borrowing constraints are tight for both race groups, especially for both types of blacks. The parameter  $s$  capturing the tightness of the borrowing constraints is 0.4% and 2.3% for Type 1 and Type 2 of blacks and somehow looser for the two types of whites: 4.9% and 4.7%. Their standard errors are small, except for Type 2 of whites.

The means and standard deviations of the displaced log-wealth distribution are higher for whites than for blacks. However, standard deviations exhibit high asymptotic standard errors, which reveals that they are not precisely estimated. Notice that this distribution is identified mainly from initial wealth observations that start only in 1985. A larger number of early observations would certainly yield a more precise estimation of these parameter.

Whereas initial average wealth of blacks is between -\$549 and \$0 for Type 1 and between \$18,518 and \$19,337 for Type 2, for whites it is \$8,829 for Type 1 and \$17,148 for Type 2. There is no unique initial average wealth level, because the support of the initial wealth distribution depends also on the amount of transfers while unemployed.

The third set of parameters reveals that blacks tend to have more transfers while unemployed, less risk-aversion, and more disutility of working than whites. Transfers while unemployed for Type 1 and Type 2 are respectively \$1,049 and \$312 for blacks and \$515 and \$326 for whites. The estimated coefficient of risk-aversion  $\gamma$  is 1.08 and 0.3 for Type 1 and Type 2 of blacks, respectively, and accounts for lower saving

rates. It is 1.07 and 1.31 for Type 1 and 2 of whites. The disutility of working is 0.20 and 0.99 for blacks and 0.11 and 0.20 for whites. Together with transfers while unemployed, this parameter is pinned down by the higher unemployment rates and lower exit rates from unemployment of blacks. All these parameters exhibit small standard errors, with the exception of the disutility of working of Type 2 of blacks and transfers of Type 2 of whites.

These parameter estimates are similar to those of Rendon (2006) despite the differences in the model specification and the estimation method. In that article wage growth depends on specific human capital accumulation, not on age, arrival and layoff rates are constant over time, there is no disutility of working, the initial wealth distribution is non parametric, the sample only contains white individuals, there is no unobserved heterogeneity, and the estimation method of choice is maximum likelihood. These differences are so substantial that it is difficult to make a one-to-one comparison between the parameter estimates in the two articles. For example, wage growth in the current article is found to be lower than in that article, but we would be comparing age wage growth with tenure wage growth; certainly the former will be estimated to be slower than the latter. Similarly, arrival rates in that article, which do not grow over time, are greater than initial arrival rates, but not than longer term arrival rates in the current paper. The most notable comparable differences in parameter estimates are for borrowing constraints and the coefficient of risk aversion, respectively tighter and higher in that article, which may stem from using liquid wealth rather than total wealth in the current article.

Race groups are split by their labor market conditions into two types: 57% and 43, for blacks, and 56% and 44%, for whites. For both race groups one type faces a labor market environment that is comparable to previous estimates (see Wolpin 1992 and Rendon 2006), with higher arrival rates while unemployed, and relatively low layoff rates. These parameters generate reservation wages that are increasing in wealth. Notice, however, that for blacks the type with the best arrival rates faces

also a better wage offer distribution, whereas for whites the type with the best arrival rates has the worse wage offer distribution. For the second subset of parameters, which account for initial wealth and borrowing constraints, the partition into types is also very similar for the two race groups: for blacks one of the types amounts to 80% of their group, while for whites one of the types represents 86% of their sample. For both race groups, one type is initially wealthier, but only for blacks the wealthy type faces tighter borrowing constraints; for whites, borrowing constraints are very similar across the two types. Finally, type composition for taste parameters differs substantially across race groups: 64% of blacks and 91% of whites belong to one of the types. One type is characterized by larger transfers while unemployed and a lower disutility of working for both race groups but by higher risk aversion for blacks and lower risk aversion for whites.

These probabilities for each subset of parameters produce eight combinations within each race group. However, four of these combinations alone cover 80% of blacks, while only two combinations represent altogether 78% of whites. For a better understanding of these combinations I also report unemployment rates, average quarterly wages, and wealth by race group and type combination for years 3 and 9 in Table 5.

[Table 5 here]

For blacks type combination  $p_{111}$  equals 29% and is the largest of this race group. It combines initially high job turnover, a relatively high wage offer distribution and high wage growth with low wealth, tight borrowing constraints, high transfers while unemployed, high risk aversion, and low disutility of working. This subset of the black population has high wages, which increase substantially over time, combined with the highest wealth levels and faster wealth accumulation of blacks. It also has relatively high unemployment levels, caused by the high reservation wages.

Type combination  $p_{211}$  of blacks represent 22% of its group, the second largest. It exhibits the same features of the previous combination, except for the labor market environment, which produces lower mean accepted wages. Accordingly, unemployment rates are higher, and wages and wealth levels over time are lower. Type  $p_{112}$ , representing 16% of blacks, exhibits similar features as type combination  $p_{111}$ , except for taste parameters: lower transfers while unemployed, lower risk aversion and more disutility of working. Hence, this subset is more likely to work at lower wages and accumulate less, and thus exhibits lower unemployment rates, lower wages and lower wealth levels. Finally, Type  $p_{212}$  is the poorest segment of the blacks subsample and covers 12% of blacks. It is characterized by low transfers while unemployment, low wages and a labor market environment in which it is hard to receive a job offer when unemployed, and easy to receive a job offer and get fired while employed. Accordingly, and despite the relatively high disutility of working, reservation wages are relatively low, and therefore, unemployment rates, wages, and wealth levels are relatively low. However, in spite of having the lowest wage levels among blacks, they exhibit a clear trend to accumulate wealth over the life cycle. This may be explained by the relatively low parameter for risk-aversion and the tight borrowing constraint combined by the modest increases in wages over time.

In turn, there are two main type combinations among whites,  $p_{211}$  with 44% and  $p_{111}$  with 34% of individuals, which share the same wealth and taste parameters. However, combination  $p_{211}$  enjoys in the long run a relatively more favorable labor market environment with relatively low unemployment rates, and higher wages and wealth levels than combination  $p_{111}$ . This last segment of the white sample faces a labor environment which is characterized by a reservation wage that is increasing in the agent's wealth position, but with relatively low wage offers. This type combination faces a depressed labor market, characterized by an unemployment rate which is lower than the average, but also with lower wages. This type combination is also characterized by low initial wealth, the lowest of whites, low disutility of working and

low risk-aversion. However, because of the poor labor market, it exhibits low savings and decreasing wealth trajectories.

Comparing specific type combinations across race groups reveals that they depict similar patterns in unemployment rates, wages and wealth, just at different levels. For instance, the main single combination of each race group,  $p_{111}$  of blacks and  $p_{211}$  of whites, shows a similar pattern of low unemployment with important wage gains and wealth accumulation over time, more than the average in their respective race groups. The next important segment inside each race group shares wealth and taste parameters with these two main type combinations but have different labor market parameters associated with lower wages and lower wealth levels. Consequently, the most important source of heterogeneity for both race groups lies in the labor market rather than in wealth or taste parameters.

## 6 Model Fit

To assess how well these parameter estimates mimic the data, I compare the observed and the predicted choice distributions of employment status, employment transitions, wealth, and wages.

[Figure 3 and Figure 4 here]

Figure 3 and Figure 4 show the actual and the predicted hazard rates for the first unemployment spell. For both groups, the model is able to replicate the data closely, especially for whites for whom the predicted hazard rate mimics closely the actual hazard rate and its negative duration dependence. However, for blacks the predicted hazard rate does not exhibit the pronounced negative duration dependence of its observed counterpart. This may be related to the increase in the observed hazard rate of blacks from quarter 11 until 13. A similar increase, though less abrupt, is also



present in the hazard rate of whites from quarter 8 until 13. Since the initial wealth distribution and heterogeneity play a crucial role for reproducing this pattern, the few early wealth observations used in the estimation may be the reason the model does not reproduce closely the negative duration dependence of blacks. Conditional on initial wealth level and type, hazard rates are increasing over time: individuals reduce their wealth position while unemployed, so that reservation wages decline and hazard rates increase. However, because poorer individuals exhibit high hazard rates and are first to exit unemployment, the predicted average hazard rate tends to go down over time. Considering also that the observed hazard rates were not used in the estimation, this comparison can be considered a cross validation, an out-of-sample assessment of the model's success in fitting the data.

[Figure 5 here]

[Table 6 here]

Figure 5 offers a graphical comparison of all actual and predicted variables by quarter since graduation for both race groups. Additionally, Table 6 presents a summary  $\chi_t^2$ -statistics of the distributions of employment status and transitions, wages and wealth for years 3, 6, and 9 after graduation for both race groups. Goodness of fit tests allow us to evaluate whether the theoretical model at the estimated parameters can mimic the cell-by-cell distribution of the data. The test statistic across choices  $j$  at time  $t$  is defined as  $\chi_t^2 = \sum_{j=1}^J (n_{jt} - \hat{n}_{jt})^2 / \hat{n}_{jt}$ , where  $n_{jt}$  is the actual number of observations of choice  $j$  at time  $t$ ,  $\hat{n}_{jt}$  is the model predicted counterpart,  $J$  is the total number of possible choices and  $T$  is the number of years. This statistic has an asymptotic  $\chi^2$  distribution with  $J - 1$  degrees of freedom. This table also contains the predicted average wages and wealth levels and their associated black-white ratios.

In the graphical comparison, the evolution of predicted employment status and employment transitions replicate the actual paths for both race groups very accurately: unemployment rates in Figures 5a and 5b, transitions from unemployment to

employment shown in Figures 5c and 5d, job separations reported in Figures 5e and 5f, and job-to-job transitions, in Figures 5g and 5h. Observed exits from unemployment and job-to-job transitions are particularly noisy. The  $\chi^2$  statistics corroborate this graphical evidence and show that prediction is accurate for both race groups: all of these variables pass the  $\chi^2$  tests.

As illustrated by Figures 5i-5l the model overpredicts slightly the percentage of layoffs in job separations, but predicts very accurately the percentage of layoffs in job-to-job transitions. Yet, at the formal level, the choice distributions of these transitions pass the  $\chi^2$  tests.

The corresponding evolution of wealth is illustrated graphically in Figures 5m and 5n. In spite of the noise in the wealth data, the model mimics well the observed pattern of wealth accumulation. As implied by the initially decreasing hazard rate seen above, just after graduation whites decumulate wealth in order to finance their first unemployment spell, but then they accumulate wealth as a result of making progress in their employment careers. Blacks also show initial wealth decumulation, but it is not as pronounced as for whites. The model passes the  $\chi^2$  tests for both race groups at all years. Recall from Table 1 that the actual wealth of whites is more noisy than that of blacks. Nevertheless, the model reproduces relatively well the racial wealth ratio at the average, particularly at years 6 and 9, and its decreasing trend from year 6 to year 9.

As explained above, for most individuals in the sample initial wealth is not observed, as it is only observed from 1985 onwards. This implies that conditioning on initial wealth in simulating the data for the goodness of fit tests is not feasible. Had such data been available, I could certainly have shown a better model fit.

Figures 5o and 5p show that wages are especially well replicated on average, with some overprediction for blacks and some underprediction for whites in later periods. The model also mimics well the observed wage distribution: it passes the  $\chi^2$  tests for both race groups in all years, with the exception of whites in year 9. The racial

wage ratio is relatively well replicated, although its declining trend is only partially captured by the model, at year 3 and year 6.

[Table 7 here]

Table 7 shows the actual and predicted first unemployment spell duration and first accepted wage. It is shown that the model is able to replicate these two variables pretty well, though with some underprediction of the unemployment duration of blacks and some overprediction of the first accepted wage of whites. This table also provides a comparison between observed and predicted savings by employment transitions as reported previously in Table 3. Comparing these predicted moments with their observed counterparts, as the hazard rates, is informative about the ability of the model to replicate observables that have not been used in the estimation. This table reveals a relatively good prediction of savings during job separations for both race groups, exits from unemployment and employment retention for whites, and job-to-job transitions for blacks. Other wealth variations by employment transitions are under- or overestimated. By contrast, the employment transitions themselves are very accurately predicted by the model.

In short, both graphically and formally the model is fairly successful in replicating the main features of the data.

## 7 Regime Changes and Decomposition of Race Gaps

After recovering the underlying behavioral parameters, I explore black-white variations of short-and long-term outcomes resulting from differences in the economic environment and in preferences as captured by the three subsets of parameters: first, assigning blacks the labor market conditions of whites, second, the initial wealth distribution and access to credit of whites, and, third, the taste parameters of whites. I

also evaluate the outcomes of performing two of these changes at a time. Education is assumed to be invariant to the regime changes considered here. In Appendix A8 I explain in greater detail how these experiments are performed.

The effects of these experiments are reported in Table 8, where the first and last columns show selected predicted variables for the black and white subsample, respectively. Once again, average wages only contain the income of the employed.

[Table 8 here]

The first experiment, reported in column 2, addresses the importance of labor market conditions, that is, of the first subset of parameters in blacks' outcomes. In this experiment, blacks face the same labor market conditions as whites. In the short-term, the fourth quarter after High School graduation, this experiment narrows down the racial wealth gap very slightly: the black-white wealth ratio goes down from 46% to 41%. On the other hand, this experiment practically eliminates the initial racial wage gap: in the fourth quarter the black-white wage ratio increases from 90% to 102%. Wealth does not initially converge substantially, because agents rely more on good labor market conditions and can afford to initially decumulate their initial wealth to finance their job search. These conditions also imply employment transitions and, therefore, unemployment rates that are very similar to those of whites. In the long run, forty quarters after graduation, the better labor market conditions prevail and wealth increases following wage increases, so that the racial wage ratio increases from 92% to 103%, and the racial wealth ratio from 27% to 54%. Although this last gap has importantly narrowed down, it remains relatively wide due to remaining differences in preferences.

As shown in column 3, having whites' initial wealth distribution and access to credit increases blacks' average wealth and wages in the fourth quarter after graduation, smoothing out racial differences almost completely: the racial wealth and wage

ratio increase to 135% and 102%, respectively. It increases blacks' consumption substantially in the fourth quarters after graduation. On the other hand, more initial wealth leads to a longer initial unemployment spell and higher rates of unemployment at the start of employment careers, deteriorating blacks' employment situation. In the long-run, racial disparities do not diminish in wealth: forty quarters after graduation the racial wealth ratio falls from 27% to 23%. Broader access to credit, unlike the displacement of initial wealth, is a permanent change and undermines the need for holding wealth. However, increased wages persist and become 99% of whites'. Thus, this experiment shows that increases in initial wealth do have a long-lasting effect in labor market outcomes.

The outcomes for blacks when they are assigned the taste parameters of whites are presented in column 4. With more risk-aversion, less disutility of working, and less transfers while unemployed blacks become less selective in their job search and suffer an initial decline in the unemployment rate, from 39% to 36%, but an increase in accepted wages, from 90% to 100% of whites' wages and in wealth 46% to 100% of whites'. Despite this initial elimination of racial disparities in wealth and wages, consumption diminishes from \$1,975 to \$1,532, the lowest attained by any experiment. Forty quarters after graduation, little is left from this full initial convergence in black-white ratios in wealth and in wages: the black-white wealth ratio becomes 65% and the black-white wage ratio becomes 87%. The unemployment rate raises to 27%, when in the baseline case is only 17%.

The second set of experiments starts in column 5, combining two changes at a time. This column illustrates the results of extending the first experiment by also assigning blacks the initial wealth distribution and borrowing possibilities of whites. This variation increases blacks' consumption, plus having the initial effect of diminishing both the wealth and the wage gap: in the fourth quarter after graduation relative wealth of blacks increases from 46% to 65% of whites' and relative wages go up from 89% to 109%. However, the improved labor market conditions combined with looser

borrowing constraints, both permanent changes, undermine the need of precautionary savings, so that forty quarters after graduation wealth does not accumulate that fast and the racial wealth ratio increases from 27% to only 61%. At the same time, the wage gap disappears fully. Hence, this experiment is successful in achieving convergence in wages, but not in wealth, with an important increase in consumption: forty quarters after graduation blacks' average consumption has increased from \$3,406 to \$3,808, overtaking whites' consumption of \$3,518.

Had blacks the labor and taste parameters of whites, as reported in column 6, they would experience an important increase in their initial wealth: the racial wealth ratio rises from 46% to 168%. In this scenario, blacks' first unemployment spell is shorter, their exit rates from unemployment higher, their unemployment rate lower, and their wages higher, even higher by 11% than whites. In the fortieth quarter after graduation this experiment has created full long run racial convergence in wealth and wages: all wage and wealth gaps have disappeared. Given that borrowing constraints are the only remaining permanent difference with whites and that these are relatively tight and quite similar across race groups, this combined change is the most successful in eliminating wealth and wage racial differences in the long run, so that the consumption level of blacks overtakes the consumption level of whites. Additionally, this experiment generates both faster wealth accumulation while employed and faster wealth decumulation while unemployed.

The combination of better initial wealth distributions, looser borrowing constraints, and the taste parameters of whites, reported in column 7, almost eliminates initial wealth racial differences. This convergence, however, does not prevail forty quarters after graduation, as the wealth black-white ratio becomes 59%. However, this experiment has the effect of reducing the relative wage of blacks, initially from 90% to 85% and in the long run from 92% to 86% of whites' wages. Unlike the second experiment, in which only initial wealth distributions and access to credit are increased, the current experiment also reduces the disutility of working and trans-

fers while unemployed, which results in lower reservation wages and, therefore, lower accepted wages. The increase in risk-aversion, which has the effect of increasing reservation wages, does not seem enough to counteract this trend. Consequently, blacks do not only have lower wages, but also, and similarly to whites, lower unemployment rates and employment transitions.

Another variable of interest in these experiments is the saving rate. Compared to blacks, whites save more when employed and dissave more when unemployed. Blacks' savings rates in the long run converge to those of whites only when blacks are assigned the taste parameters of whites.

Summarizing, improving labor market conditions of blacks accomplishes initial and long run convergence of labor market outcomes, that is, of wages, unemployment rates and employment transitions. If this improvement is combined with a switch in preferences, it also eliminates initial and long run wealth disparity. On the other hand, improving the initial wealth distribution and access to credit of blacks and changing their taste parameters are both regime changes that eliminate both racial wealth and wage gaps at the beginning of employment careers. However, none of these changes alone does diminish substantially the long run racial wealth gap. Interestingly, increasing initial wealth does have a permanent effect in wages, it does reduce the racial wage gap, and accounts partially for the observed racial wealth disparity.

One can further use this set of experiments to decompose the total racial differences into the three parts considered here: labor market conditions, wealth, and preferences. The resulting partitions are reported in Table 9. Appendix A9 details how these decompositions are performed

[Table 9 here]

Table 9 shows that labor market conditions are the most important component underlying the racial differences in almost all variables. Initial wealth is important in

accounting for racial wage differentials in the first unemployment spell. However, it has a persistent effect in accounting for job separations, job-to-job flows, wealth and consumption. Preferences play a crucial role in explaining differences in exit from unemployment, job-to-job flows, wealth levels, and saving rates both while employed and while unemployed. Actually, the wealth gap is mostly determined by differences in preferences, followed in the short-term by initial wealth, and by labor market conditions in the long-term. These decompositions reinforce the message obtained previously that labor market conditions are the leading force underlying the observed racial differences. Differences in initial wealth and preferences are, however, crucial in explaining differences in some important variables that the labor market does not account for.

## 8 Conclusions

The main purpose of this paper has been to determine the extent to which initial wealth disparity is responsible for the observed differences in early employment careers of black and white individuals. I generalize Danforth's (1979) utility-maximizing search model to allow for on-the-job search, wage growth, arrival and layoff rate variations, retirement, and a parametric borrowing limit, and estimate it by a simulated method of moments using data from the NLSY. At the recovered behavioral parameters, the model mimics well the main observables, namely, the hazard rate during the first unemployment spell, first accepted wages, savings by employment transitions, and the cross-sectional distributions of wealth, wages, and employment transitions over time.

Counterfactual experiments and decompositions of the racial differentials into labor market, wealth and taste components reveal that most of the differences in labor market performance between blacks and whites several years after High School graduation are accounted for by differences in their wage offer distributions and arrival



and layoff rates, both in levels and growth, as well as preferences, in particular, the disutility of working. Differences in initial wealth do account for the racial gap both in wealth and wages at the beginning of employment careers, and several years after High School graduation only for the racial wage gap, however not for the racial wealth gap. Thus, initial wealth does partially explain differences in early employment careers.

These results are revealing about racial differences in labor market outcomes stemming from initial wealth, the labor market environment, and preferences. Throughout this paper, I have abstracted from racial differences arising from schooling choices, which also provide insurance for labor risk (Whalley 2005), and general equilibrium effects, that is, regime changes can also affect wage offer distributions and arrival rates. The utility-maximizing job search model proposed here can be extended in these two directions, which may alter the effects of regime changes implemented in this paper. Recent papers by Lee (2005) and Lee and Wolpin (2006) account for schooling decisions in a general equilibrium setting and are thus encouraging about the feasibility of these extensions in future research.

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## Appendix: Proof of Proposition 1

I proceed inductively, showing  $w_{t+1}(\omega) \geq b$  implies  $w_t(\omega) \geq b$ , for  $t < T$ . Suppose that  $w_{t+1}(\omega) \geq b$  and  $w_t(\omega) = b$ , for  $t < T$ , then the value functions become:

$$\begin{aligned}
 V_t^e(A_t, b) &= \max_{A^e \geq B_{t+1}} \left\{ U \left( A_t + b - \frac{A_{t+1}^e}{1+r} \right) - \psi \right. \\
 &\quad \left. + \beta \left[ \pi_{t+1} \int \max [V_{t+1}^e(A_{t+1}^e, x), V_{t+1}^u(A_{t+1}^e)] dF(x) + (1 - \pi_{t+1}) V_{t+1}^u(A_{t+1}^e) \right] \right\}, \\
 V_t^u(A_t) &= \max_{A^u \geq B_{t+1}} \left\{ U \left( A_t + b - \frac{A_{t+1}^u}{1+r} \right) \right. \\
 &\quad \left. + \beta \left[ \lambda_{t+1} \int \max [V_{t+1}^e(A_{t+1}^u, x), V_{t+1}^u(A_{t+1}^u)] dF(x) + (1 - \lambda_{t+1}) V_{t+1}^u(A_{t+1}^u) \right] \right\}.
 \end{aligned}$$

Thus,  $V_t^u(A_t) \geq V_t^e(A_t, b)$ , if  $\lambda_{t+1} \geq \pi_{t+1}$  and  $\psi \geq 0$ , so that  $V_T^e(A_T, \omega) = V_T^u(A_T)$  only when  $w_T(\omega) \geq b$ .

Now suppose that at period  $T$ ,  $w_T(\omega) = b$ , then if  $\psi \geq 0$ :

$$\begin{aligned}
 V_T^e(A_T, b) &= \max_{A_{T+1}^e \geq B_{T+1}} \left\{ U \left( A_T + b - \frac{A_{T+1}^e}{1+r} \right) - \psi + \beta V_T^R(A_{T+1}^e) \right\} \\
 V_T^u(A_T) &= \max_{A_{T+1}^u \geq B_{T+1}} \left\{ U \left( A_T + b - \frac{A_{T+1}^u}{1+r} \right) + \beta V_T^R(A_{T+1}^u) \right\},
 \end{aligned}$$

Thus,  $V_T^u(A_T) \geq V_T^e(A_T, b)$ , if  $\psi \geq 0$ , so that  $V_T^e(A_T, \omega) = V_T^u(A_T)$  only when  $w_T(\omega) \geq b$ . ■

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Table 1: Unemployment, Wealth and Wages by Number of Years since Graduation.  
Black and White Male High School Graduates (amounts in 1985 dollars)

In small fonts: Number of observations						
Variable	Blacks			Whites		
	Year 3	Year 6	Year 9	Year 3	Year 6	Year 9
<b>Employment status and transitions</b>						
% Unemployed	34.2	19.3	19.7	18.3	10.9	8.8
Observations	622	592	569	845	832	804
% Unemployed becoming Employed	24.9	22.8	33.0	37.4	45.1	47.9
% Employed becoming Unemployed	12.2	5.9	8.3	8.4	6.5	5.6
changing Employer	9.5	8.2	7.4	11.4	8.5	5.2
% Quits in flows from Employment to Unemployment	31.1	53.9	47.2	30.6	43.2	37.9
Observations	45	26	36	49	37	29
to another Employer	47.2	72.2	58.6	65.7	80.0	66.7
Observations	36	36	29	67	55	33
<b>Wealth</b>						
Average	1393	3381	3702	4921	5664	8780
Black-White Ratio (%)				28	60	42
% with						
$A \leq 0$	2.8	5.7	6.2	7.8	13.8	10.7
$0 < A \leq 10,000$	95.8	86.8	83.2	76.6	68.8	60.0
$10,000 < A \leq 20,000$	0.0	4.7	6.2	10.9	10.9	12.1
$20,000 < A \leq 30,000$	1.4	0.9	2.7	3.1	2.2	10.7
$A > 30,000$	0.0	1.9	1.8	1.6	4.4	6.4
Observations	71	106	113	64	138	140
<b>Wages</b>						
Average Quarterly Wage	3104	3473	3739	3363	4114	4552
Black-White Ratio (%)				92	84	82
% with						
$w \leq 2,000$	20.2	12.7	10.9	16.7	8.5	4.6
$2,000 < w \leq 4,000$	61.3	60.7	56.1	58.2	50.7	38.2
$4,000 < w \leq 6,000$	16.2	19.1	21.6	18.6	27.7	40.7
$w > 6,000$	2.3	7.5	11.4	6.5	13.2	16.5
Observations	346	440	412	598	651	668

Note: Wages are only the labor income of the employed and do not include any income of the unemployed.

Table 2: Average Wealth by Wages and Years after Graduation (in 1985 dollars)  
 In small fonts: Number of observations

Wages	Blacks		Whites	
	Years $\leq 6$	Years $> 6$	Years $\leq 6$	Years $> 6$
$w \leq 2,000$	724	1674	1396	2338
	38	38	48	27
$2,000 < w \leq 4,000$	1762	2361	4056	6049
	177	202	193	208
$4,000 < w \leq 6,000$	4528	6108	6227	8747
	53	76	94	168
$w > 6,000$	5634	9377	8511	11283
	7	30	34	52

Note: This table only contains observations for employed individuals. Wages are only labor income.

Table 3: Average Quarterly Savings by Employment Transitions:  
 Blacks' savings/Whites' savings. In small fonts: No. of blacks / No. of whites

Employment Status $t$	$t + \Delta$			Total
	Un- employment	Same Employment	New Employment	
Unemployment	-101/-2918 123/41		1720/365 109/81	766/-738 568/122
Employment	-953/-1514 98/68	-73/545 483/698	243/129 150/194	-141/329 731/960
Total	-484/-2043 221/109	-95/561 483/698	870/206 259/275	77/209 963/1082

Note: Wealth is only observed annually, at quarter  $t$  and quarter  $t + \Delta$ . Employment transitions and savings are, respectively, the employment and the average quarterly wealth variation between these two quarters.

Table 4: Parameter Estimates and Asymptotic Standard Errors (in small fonts)  
 ( $r = 0.015, \beta = 0.98$ )

Parameter	$\Theta$	Blacks				Whites			
		Type 1		Type 2		Type 1		Type 2	
		Est.	ASE	Est.	ASE	Est.	ASE	Est.	ASE
$\Theta_1$									
Base unemp. arrival rate %:	$\lambda_0$	69.30	4.65	29.47	55.30	83.62	21.45	57.56	3.81
Base emp. arrival rate %:	$\pi_0$	16.53	0.73	81.24	28.21	9.90	6.18	53.42	11.61
Base layoff rate %:	$\theta_0$	22.31	3.13	16.83	14.02	7.22	0.79	13.25	2.11
Mean base log-wage dbn :	$\mu$	7.19	0.07	6.58	0.11	6.91	0.02	7.71	0.02
St. dev. base log-wage dbn:	$\sigma$	0.60	0.05	0.63	0.05	0.50	0.01	0.45	0.03
Unemp. arrival rate growth $\times 10^2$ :	$\alpha_\lambda$	1.93	0.50	11.84	42.04	7.58	2.33	1.09	0.43
Emp. arrival rate growth $\times 10^2$ :	$\alpha_\pi$	0.40	0.25	0.17	0.36	3.20	2.00	0.16	0.16
Layoff rate growth $\times 10^2$ :	$\alpha_\theta$	-6.01	0.62	-1.72	2.53	-1.06	0.41	-3.65	0.63
Wage growth (linear) $\times 10^3$ :	$\alpha_1$	8.60	1.79	1.27	0.64	9.04	0.12	14.42	1.62
Wage growth (quadratic) $\times 10^5$ :	$\alpha_2$	-4.00	0.78	-3.41	2.67	-1.70	0.32	-24.15	2.20
Proportion of Type 1:	$p_1$	57.41	4.46			43.67	5.15		
$\Theta_2$									
Borrowing Tightness %:	$s$	0.43	0.04	2.27	0.27	4.85	0.42	4.66	2.31
Mean of log-wealth dbn :	$\mu_0$	6.17	0.00	10.46	0.00	8.77	2.53	10.59	2.04
St. dev. of log-wealth dbn :	$\sigma_0$	0.05	0.33	1.52	0.41	1.73	1.09	1.86	0.98
Proportion of Type 1:	$p_2$	79.76	7.54			86.45	1.92		
$\Theta_3$									
Unemployment Transfers:	$b$	1049	73	312	237	515	41	326	209
Risk aversion	$\gamma$	1.08	0.00	0.30	0.19	1.07	0.03	1.31	0.09
Disutility of working:	$\psi$	0.20	0.06	0.99	6.21	0.11	0.03	0.20	0.07
Proportion of Type 1:	$p_3$	63.66	2.86			90.65	0.93		
Criterion value:	$\chi^2$			283.20				343.11	



Table 5: Decomposition by Types of Selected Predicted Variables  
Unemployment Rate, Wages and Wealth by Race, Year and Type Combination

Variable	Blacks							Whites						
	Unemp. %		Wage		Wealth			Unemp. %		Wage		Wealth		
	Type	Year	Year		Year		Type	Year	Year		Year			
Types	%	3	9	3	9	3	9	%	3	9	3	9	3	9
$p_{111}$	29.1	37.8	23.4	3367	4903	3749	6184	34.2	15.5	8.1	2343	3061	4309	2572
$p_{112}$	16.6	28.4	16.8	3124	4596	1903	380	3.5	63.4	69.5	2948	3557	8082	10157
$p_{121}$	7.4	43.9	23.4	3683	4925	8515	5727	5.4	17.1	8.3	2430	3077	7481	2876
$p_{122}$	4.2	30.2	16.7	3192	4602	3601	-167	0.6	70.8	69.7	3062	3590	11373	10084
$p_{211}$	21.6	36.6	25.5	2494	2857	962	4725	44.1	8.1	3.7	3990	5265	4467	17565
$p_{212}$	12.3	6.2	2.3	2212	2490	247	305	4.6	61.4	33.1	4838	5523	8635	16959
$p_{221}$	5.5	56.9	26.1	2703	2860	7423	4626	6.9	9.2	3.7	4030	5270	8084	18652
$p_{222}$	3.1	6.2	2.3	2212	2490	2147	-235	0.7	70.8	32.7	5030	5515	12035	16948
All	100	32.2	19.4	2888	3874	2905	3588	100	16.4	9.6	3343	4365	5234	11385

Table 6: Summary. Blacks and Whites: Actual and Predicted Choice Distribution.  
Employment Status and Transitions, Wealth and Wages for three selected Years  
after Graduation (in %)

$\chi^2$ Year	Years after Graduation					
	Blacks			Whites		
	3	6	9	3	6	9
Unemployment Rate	1.1	12.6	0.0	2.4	3.9	0.6
Transitions form Unemployment	1.1	1.7	2.1	0.6	2.2	0.3
Transitions form Employment	0.1	5.1	4.6	1.3	0.1	5.3
Quit-Layoff rate in job loss	2.7	8.4	4.4	0.2	4.5	1.8
Quit-Layoff rate in job-to-job flow	3.2	0.4	1.8	1.8	0.0	4.3
Wealth Distribution:	4.7	3.3	1.4	3.8	7.0	14.2
Predicted Average Wealth	2905	3064	3588	5234	6014	11385
Predicted Black-White ratio	56	51	32			
Wage Distribution:	7.4	3.5	0.5	2.1	8.5	22.4
Predicted Average Wage	2888	3415	3874	3343	3948	4365
Predicted Black-White ratio	86	86	89			

Crit. values at .5% signif.:  $\chi^2_{(1)} = 7.9$ ,  $\chi^2_{(2)} = 10.6$ ,  $\chi^2_{(3)} = 12.8$ ,  $\chi^2_{(4)} = 14.9$ .

Table 7: Actual and Predicted First Unemployment Duration, First Accepted Wage, and Savings and Frequencies in Employment Transitions

Variables	Blacks		Whites	
	Act.	Pred.	Act.	Pred.
First Unemployment Spell Duration	4.2	3.4	2.5	2.6
First Accepted Wage	2236	2246	2291	2466
Savings and frequencies (below) in transitions from				
Unemployment to unemployment	-101	-614	-2918	-1499
	73.1	72.1	58.1	58.5
Unemployment to employment	1720	572	365	416
	26.9	27.9	41.9	41.5
Employment to unemployment	-953	-998	-1514	-1481
	9.4	9.4	6.3	6.3
Employment to same employment	-73	277	545	512
	81.7	82.0	85.2	84.7
Employment to new employment	243	206	139	486
	8.8	8.6	8.5	9.0

Table 8: Regime Changes: Blacks with Whites' Parameters

Variables at First Unemp Spell 4th and 40th Quarter after Grad.	Counterfactuals: Blacks with whites'							
	Blacks	Parameters						Whites
	Pred.	Labor	Wealth	Taste	Labor	Labor	Wealth	Pred.
	( 1 )	( 2 )	( 3 )	( 4 )	( 5 )	( 6 )	( 7 )	( 8 )
	First unemployment spell							
Duration	3.4	2.2	4.5	2.9	3.5	3.0	3.1	2.6
Wages	2246	2431	2776	2047	2838	2784	2199	2466
	92	99	126	83	115	129	89	100
	4th Quarter after Graduation							
Unemployment Rate %	39.0	22.3	43.3	36.4	31.3	23.6	30.1	21.2
Exit from Unemp. %	28.6	37.2	23.5	36.4	27.2	33.3	34.4	39.3
Job Separations %	15.9	8.7	13.9	20.2	7.9	7.6	12.4	8.7
Job-to-job flow %	13.0	12.5	12.7	15.9	10.3	13.0	18.3	13.0
Wealth	3127	2764	9113	6734	4401	11294	7083	6734
	46	41	135	100	65	168	105	100
Wages	2591	2952	2940	2888	3160	3200	2440	2888
	90	102	102	100	109	111	85	100
Consumption	1975	2599	3182	1532	3061	3618	2256	2833
	40th Quarter after Graduation							
Unemployment Rate %	16.5	7.3	15.0	27.2	8.9	7.9	13.1	8.0
Exit from Unemp. %	24.9	42.9	27.1	22.6	37.5	42.7	36.1	42.1
Job Separations %	4.5	3.0	4.55	7.1	3.2	3.2	4.4	3.3
Job-to-job flow %	6.0	6.1	6.7	7.7	5.6	7.0	8.5	6.9
Wealth	4218	8362	3563	10051	9481	17064	9174	15626
	27	54	23	65	61	109	59	100
Wages	4100	4591	4411	3877	4633	4863	3815	4470
	92	103	99	87	104	109	86	100
Consumption	3406	3765	3671	2781	3808	3886	3039	3518
Savings rates								
Employed	8	14	13	18	16	17	15	18
Unemployed	-42	-48	-45	-207	-120	-410	-406	-391

Table 9: Decomposition of observed racial gaps  
by differences in labor market, wealth and tastes

Predicted Variables	% of racial gap due to			Racial Gap
	Labor	Wealth	Taste	
First unemployment spell				
Duration	89.6	-60.4	70.8	-0.8
Wages	129.0	74.5	-103.5	220
4th Quarter after Graduation				
Unemployment Rate	71.2	-6.1	34.9	-17.8
Exit from Unemployment	43.0	-15.9	72.9	10.7
Job Separations	93.5	24.1	-17.6	-7.2
Job-to-job flows				0
Wealth	-7.3	22.4	84.9	3607
Wages	120.7	-9.3	-11.3	297
Consumption	84.8	39.4	-24.3	858
40th Quarter after Graduation				
Unemployment Rate	105.9	30.0	-35.9	-8.5
Exit from Unemployment	76.1	10.9	13.0	17.2
Job Separations	145.1	30.6	-75.7	-1.2
Job-to-job flow	-88.9	27.8	161.1	0.9
Wealth	49.9	-5.8	55.9	11408
Wages	157.7	-8.3	-49.4	370
Consumption	434.2	14.1	-348.4	112
Saving rates				
Employed	33.3	18.3	48.3	10
Unemployed	12.4	11.4	76.2	-349