

NBER WORKING PAPER SERIES

RACIAL DISCRIMINATION IN THE LABOR MARKET:  
THEORY AND EMPIRICS

Kevin Lang  
Jee-Yeon K. Lehmann

Working Paper 17450  
<http://www.nber.org/papers/w17450>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
September 2011

We are grateful to Dan Black, Kerwin Charles, David Dorn, Andrea Moro, Claudia Olivetti, Michael Manove, Lowell Taylor, Janet Currie, and Roger Gordon for helpful comments and suggestions. All remaining errors are our own. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2011 by Kevin Lang and Jee-Yeon K. Lehmann. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Racial Discrimination in the Labor Market: Theory and Empirics  
Kevin Lang and Jee-Yeon K. Lehmann  
NBER Working Paper No. 17450  
September 2011  
JEL No. J31,J64,J71

**ABSTRACT**

We review theories of race discrimination in the labor market. Taste-based models can generate wage and unemployment duration differentials when combined with either random or directed search even when strong prejudice is not widespread, but no existing model explains the unemployment rate differential. Models of statistical discrimination based on differential observability of productivity across races can explain the pattern and magnitudes of wage differentials but do not address employment and unemployment. At their current state of development, models of statistical discrimination based on rational stereotypes have little empirical content. It is plausible that models combining elements of the search models with statistical discrimination could fit the data. We suggest possible avenues to be pursued and comment briefly on the implication of existing theory for public policy.

Kevin Lang  
Department of Economics  
Boston University  
270 Bay State Road  
Boston, MA 02215  
and NBER  
lang@bu.edu

Jee-Yeon K. Lehmann  
Department of Economics  
University of Houston  
211B McElhinney Hall  
Houston, TX 77204  
jlehmann@uh.edu

# 1 Introduction

Labor market outcomes of black Americans, particularly of males, continue to be significantly worse than those of white Americans. In this paper, we first outline the broad differences in labor market outcomes that economic theory should explain. We then review the principal models of race discrimination in the labor market and discuss their ability to explain the broad empirical regularities with respect to wage and employment differentials. When possible, we also look for additional predictions derived from these theories and ask whether their predictions are consistent with the data.

In the past two decades, substantial progress has made in the development of theories that can explain various aspects of racial differentials in labor market outcomes. Although we find that no single existing theory is yet capable of simultaneously explaining key differences in both wage and employment patterns, a solid foundation has been laid in current literature for such a task. We offer suggestions as to how combining various elements of different theories might come close to this objective of explaining broad regularities in the racial wage and employment gap.

Following a brief discussion of terminology in the next section, we first establish the key regularities that we believe a theory should be capable of explaining. We divide the theoretical models into those based on tastes and those based on statistical discrimination reflecting imperfect information. Within taste-based models we briefly discuss the canonical Becker model with perfect labor markets before analyzing search models with a) random search and b) directed search. The imperfect information models are divided into those with a) differential observability of productivity and b) self-confirming stereotypes. We briefly relate controversies over audit studies to our discussion of theories before concluding.

## 2 Terminology

It will be helpful to begin by clarifying how we use certain terms. We distinguish between *prejudice* and *discrimination*. According to the *New Oxford American Dictionary*, prejudiced means “having or showing a *dislike* that is based on” a “preconceived opinion that is not based on reason or actual experience” (emphasis added). We therefore use prejudice to refer to an attitude or taste that we typically capture as an element of the utility function. Discrimination refers to the treatment of people and entails treating equals unequally. Profiling on the basis of race or ethnicity is discrimination regardless of whether it is based on reason, actual experience or prejudice. Similarly, a prejudiced firm may not act on its

prejudice because the cost of doing so is too high.

We will talk about outcomes as discriminatory if some equilibrium result leave blacks worse off (at least on average). Thus, in principle, although some employers may be prejudiced and refuse to hire blacks, if there are sufficient other jobs available, the labor market outcomes of blacks may be unaffected by the discriminatory behavior of the prejudiced firms. In this case, we will say that the labor market is not discriminatory or that the theoretical model does not produce discrimination.

Finally, we will not follow *Brown v Board of Education* in treating separate as inherently unequal. Segregation in our terminology is distinct from discrimination, although we will certainly discuss models in which both segregation and discrimination arise. But it is the wage or employment differentials that arise in such models, not the segregation *per se*, that correspond to our definition of discrimination.<sup>1</sup>

### 3 The Empirical Regularities

The goal of this section is to summarize some of the key differences in labor market outcomes of blacks and whites in the United States. At this point, we do not address whether such differences can be explained by labor market discrimination except to ask whether they are readily explained by characteristics other than race.

We focus almost exclusively on the differential labor market experiences of black and white men. This is not because we think the experiences of women are unimportant but because differences in the patterns of participation between black and white women make analysis difficult. For the most part, non-participation among prime-age males is concentrated among low-skill workers regardless of race. As we discuss briefly below, this is not true for women. Our decision to focus the discussion of empirical regularities on men is reinforced by the complex interaction between the marriage and the labor markets for women. While marriage rates are lower among both black men and women than among their white counterparts, this gap is markedly higher among women. It is difficult to determine to what extent differential labor market outcomes for women reflect this difference in the marriage market (or vice versa).

---

<sup>1</sup>For an extended discussion of the definition of discrimination, see Kevin Lang (2007, chapter 10).

### 3.1 Wage Differentials

The literature on black-white wage differentials is extensive, particularly for men. We do not attempt to review it thoroughly but rather seek to bring out what we view as key elements on which we think there is a consensus.

To start, there is a large raw wage differential between black and white men. At least among young men, much of this differential can be explained by differences in the skills they bring to the labor market (June O’Neill, 1990). Derek Neal and William Johnson (1996) find that after controlling for age and performance on the Armed Forces Qualifying Test (AFQT),<sup>2</sup> the black-white wage differential among young men was modest (about seven percent) and statistically insignificant. The paper has sometimes been interpreted as showing that the entire differential is due to premarket factors although the paper, itself, does not make that claim.

The Neal/Johnson result has been tempered by some additional considerations. In particular, controlling for additional predictors of wages can increase the estimated wage differential.<sup>3</sup> Rodgers and Spriggs (1996) and Pedro Carneiro, James Heckman, and Dimitry Masterov (2005) find that adjustments for years of schooling at the time the respondents took the AFQT lead to the reemergence of a substantial wage differential. Similarly, Kevin Lang and Michael Manove (2011) show that controlling for final educational attainment increases the estimated differential. This is because conditional on AFQT, blacks get more education than whites do. This is true even if we limit the sample to those who would not have completed school at the time they took the AFQT and if we control for their educational attainment at the time they took the test. One obvious objection to the Lang/Manove result is that blacks, on average, attend lower quality schools. They show conceptually that this can bias the estimated differential up or down and find that controlling for a broad variety of school quality measures has no effect on the results. Other controls may also be important. Dan Black, Natalia Kolesnikova, Seth Sanders and Lowell J. Taylor (2010) find that controlling for location increases the estimated gap.

Moreover, the wage differential has increased over time for the group studied by Neal and Johnson. Donald Tomaskovic-Devey, Melvin Thomas, and Kecia Johnson (2005) find that, while wages measured in early adulthood show little evidence of racial inequality (in part because there is little wage dispersion to begin with), the racial wage gap then grows

---

<sup>2</sup>The sample used by Neal and Johnson and others took the test as part of a national survey and was not selected on the basis of interest in the armed forces.

<sup>3</sup>See also William Darity and Patrick Mason (1998) and the reply by James Heckman (1998) and William M. Rodgers III and William E. Spriggs (2002).

across the life course, reaching 14 percent by the time these men reach forty (controlling for AFQT and other person-specific characteristics). For a single sample, we cannot determine directly whether the gap has been growing with age or with time although the latter seems more likely. Yariv Fadlon (2009) replicates part of the Neal/Johnson analysis using the National Longitudinal Survey of Youth, 1997. For 2007, when the men were twenty-two to twenty-eight years old, he finds that, controlling for AFQT, the wage gap is about 12 percent. Differences between the measures and issues with the AFQT data from the 1997 survey, however, force us to be careful in making this comparison.<sup>4</sup>

While for some purposes it is useful to summarize wage differentials between blacks and whites using a single number, doing so obscures important differences even when we limit the analysis to men. The original Neal/Johnson paper provided suggestive evidence that the black-white wage gap decreases with skill level and that wages converge at high levels of education for those with similar AFQTs. Lang and Manove also find that black and white men with high levels of education and high AFQT have similar earnings. Black et al (2006) examine a sample of college educated men and find no race difference in wages once they control for other factors. Similarly, David Bjerck (2007) finds that the entire black-white wage differential in the white-collar sector can be explained by observable measures of skill, but that a significant unexplained differential remains in blue-collar jobs. In addition, Lang and Manove find convergence for very low levels of education and AFQT, an interaction not permitted by Neal and Johnson. However, it is likely that the differential among low-skill workers is understated because such comparisons are conditioned on observing a wage, and low-skill black men are more likely to be unemployed or in prison (Amitabh Chandra, 2000).

Thus, while one challenge is to explain earnings differentials between black and white men, there is an even greater challenge, which is to explain the simultaneous existence of wage differentials among relatively low-skill male workers and their possible absence among high-skill male workers.

We know considerably less about wage differentials between black and white women. Raw wage differentials between black and white women have historically been considerably lower than between black and white men (Lang, 2007, p 284) and have at times been reversed so that mean earnings of black women were higher than those of white women. However, as Neal (2004) demonstrates, this surprising finding reflects, at least partially, the differential selection of black and white women into the labor force. White women with wages are noticeably less positively selected than are black women, which results in a significant un-

---

<sup>4</sup>For a fuller discussion see Joseph Altonji, Prashant Bharadwaj and Fabian Lange (2008).

derestimate of the black-white wage gap among women. His estimates suggest that the wage gap is only somewhat smaller among women than among men and that the gap probably declines with education among women as it does among men.

While our focus is on labor market discrimination, the importance of differences in the skills blacks and whites bring to the labor market requires some comment.<sup>5</sup> Almost all of the models we will discuss assume that in the absence of *labor market* discrimination, blacks and whites would be equally skilled. Glenn Loury and Kenneth Arrow, among others, have noted the shortcomings of current state of discrimination theories and called for more realistic and nuanced analysis that takes into account factors “beyond market interactions” (Loury, 1998) and those that are “unmediated by prices and markets” (Arrow, 1998).

By adolescence, on tests of cognitive ability, the differential between blacks and whites is typically reported as being on the order of one standard deviation although this is somewhat sensitive to the choice of test and scaling. There has been a fairly clear decline in this differential in recent years so that in 2002 it probably stood at around .8 standard deviations. Nevertheless, at current rates of convergence, it will take sixty years to eliminate the gap.<sup>6</sup> While we cannot rule out the possibility that both the level and the trend in the differential reflect differences in the expectations blacks and whites have about the value of cognitive skills, we find it unlikely that none of the difference is explained by other factors.

While housing segregation has declined over the last thirty years, it remains high (Douglas Massey and Nancy Denton, 1993; Edward Glaeser and Jacob Vigdor, 2001) with the consequence that blacks live in poorer and more black areas than whites do. Such segregation may lead to social isolation and formation of negative social identities associated with lower educational outcomes and a variety of negative behaviors that can adversely affect labor market outcomes (Jomills Braddock, 1980; Braddock and James McPartland, 1987; Harry Holzer, 1987). The strand of research examining the relation between the pressure not to “act white” (David Austen-Smith and Roland Fryer 2005, Fryer and Paul Torelli 2010<sup>7</sup>) and lower achievement of black students has further emphasized the importance of social identity, status, and conformity in determining individual’s educational attainment and other critical choices that can determine labor market outcomes (George Akerlof 1997).<sup>8</sup>

---

<sup>5</sup>We thank our referees for emphasizing this point.

<sup>6</sup>The evidence on levels and convergence comes from William Dickens and James Flinn (2006).

<sup>7</sup>Fryer and Torelli, however, find that the “acting white” effect is actually more pronounced in schools with greater interracial contact.

<sup>8</sup>One potentially important area we do not explore is the possible relation between housing segregation and the labor market, either through spacial mismatch or social interactions. While it is notoriously difficult to establish causality in models of social interaction, residential segregation may impact job matching,

Moreover, blacks, on average, attend lower quality schools, live in neighborhoods where the average level of cognitive skills is lower and are born to parents who suffered similar, if not greater, disadvantages. William Dickens and James Flynn (2001) show how small differences in environmental conditions can be greatly magnified by differential association. In a theoretical framework, Audra Bowles, Glenn Loury, and Rajiv Sethi (2010) show that social segregation is critical in generating and sustaining differences in large economic outcomes across generations. In their model, each individual's investment costs depend both on an individual's ability and on the level of human capital in one's social network, with the higher costs associated with higher individual and group ability. In this setup, small inequalities between groups at the start can be amplified by the investment decisions of group members, with the initially disadvantaged group investing in human capital at lower rates than the advantaged group. Thus while many models are designed to explain discrimination in settings with minimal or no average differences between blacks and whites, it is not obvious to us that such models should be preferred to ones in which the existence of mean differences contributes to the differential treatment of blacks and whites.

## Time Trends

Figure 3.1 shows the smoothed<sup>9</sup> ratio of black to white median annual earnings among all men age 20 and over and those working year-round/full-time, defined by the Census as those working at least 35 hours per week and at least 50 weeks per year. Although the magnitudes differ, the broad patterns are similar for the two series: the relative earnings of black men rose sharply from the late 1960s until the mid-to-late 1970s and then fell somewhat until the mid 1980s, after which they rose again until roughly 2000, since which they have remained flat.

---

employment, and wage outcomes by limiting the quantity and quality of personal networks that can assist in job searches. Bruce Weinberg, Patricia Reagan, and Jeffrey Yankow (2004) find that living in a disadvantaged neighborhood reduces hours worked, with the greatest impact found in the worst neighborhoods and among less educated workers. Patrick Bayer, Stephen Ross, and Giorgio Topa (2008) find that greater availability of (potential) labor market referrals at the neighborhood block level is associated with significant increase in labor force participation, hours, and earnings. But note that if people segregate by race even within neighborhoods, blacks who live in primarily white neighborhoods may also be disadvantaged (Kerwin Charles and Patrick Kline, 2006).

<sup>9</sup>Using the Stata `lowess` command with a bandwidth of .15. Data are derived from the Annual Demographic Supplement (March Current Population Survey) and can be found at United States Census Bureau, *Historical Income Statistics*, Table P41 <http://www.census.gov/hhes/www/income/data/historical/people/index.html>

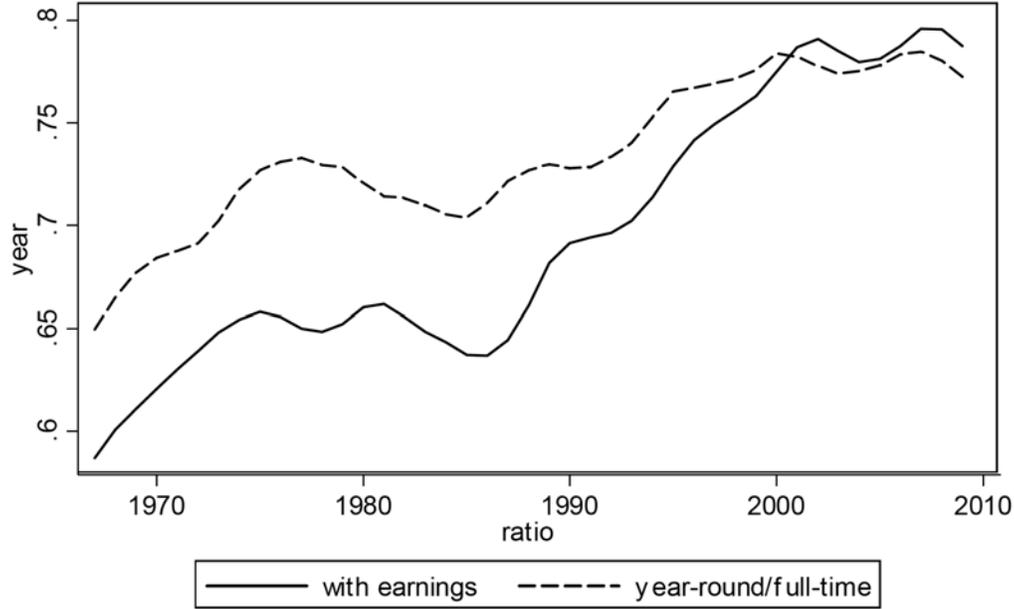


Figure 1: Ratio of Median Earnings: Black Men/White Men, 1967-2009

These patterns should *not* be ascribed solely to changes in labor market discrimination. Much of the improvement in the early period is undoubtedly due to the declining labor force participation of black men (Charles Brown, 1984; Chandra, 2000; Chinhui Juhn, 2003). In addition, early improvements can also be credited to both the rise in the relative level of educational attainment (Smith and Welch, 1989) and the relative quality of the schools attended by blacks (David Card and Alan Krueger, 1992). Nevertheless, it is difficult to come up with plausible estimates of the effects of human capital that would fully explain the wage convergence in the 1960s and early 1970s. On the other hand, they make the absence of further convergence in the late 1970s and much of the 1980s even more surprising.

The very large gains made by black men after the mid-to-late 1980s cannot be accounted for by nonearners in the Current Population Survey since there was little change during this period. While the the proportion of black men age 22-64 who were in prison or jail (and thus not in the CPS sample) grew (Bruce Western 2006, table 1.1; Bruce Western and Becky Petit, 2005), the increase in incarceration rates cannot explain the large convergence from a black-white earnings ratio of .62 in 1987 to .77 in 2000. Moreover, Neal (2006) shows that skill convergence between young black and white men stopped and may even have reversed itself among those born after 1960. Thus overall skill convergence should have slowed after 1990, making it difficult to explain why earnings convergence reasserted itself.

## 3.2 Employment Differentials

Much less attention has been paid to racial employment and unemployment differentials than to wage differentials although the former are in many ways more dramatic. In 2008, the labor force participation rate of black men age 25-54 was 83.7% compared with 91.5% among white men. The unemployment rate was 9.1% compared with 4.5%. These two differences combined imply that white men in this age group are fifteen percent more likely to be employed than are black men. It should be recalled that these figures refer to the civilian non-institutionalized labor force. While adding the military would somewhat reduce the racial discrepancy, including the incarcerated population would worsen it noticeably (Chandra, 2000; Western and Pettit, 2005).

Leslie Stratton (1993) finds that very little of the unemployment differential can be accounted for by education or other characteristics captured in the Census. More strikingly, in contrast with Neal and Johnson's results for wages, Johnson and Neal (1998) find a large unexplained annual earnings differential between black and white men even after controlling for AFQT. Holding age and AFQT constant, black men earn about 27% less than white men, and, since the wage differential is small, most of this difference in earnings reflects a disparity in hours worked. Like the wage differential, the employment differential declines with education. Johnson and Neal report that black male high school dropouts work only 80% of their white counterparts' work weeks, while weeks worked among male college graduates are essentially independent of race. When they estimate separate earnings equations for blacks and whites, their standard errors are somewhat large, but the point estimates suggest the existence of an earnings differential at almost all levels of education and AFQT.<sup>10</sup> Joseph Ritter and Lowell Taylor (2010) examine unemployment and nonemployment using additional waves of the NLSY. They find that controls, including AFQT, can explain at most about one half of the unemployment and nonemployment differentials.

Part of the employment differential is due to differences in nonparticipation. As already noted, black men are more likely than are white men to be incarcerated and more likely to be out of the labor force even when not incarcerated. However, blacks also experience longer unemployment durations. From 2003 and 2008, the ratio of mean incomplete unemployment duration of black men sixteen and older relative to white men sixteen and older ranged from 1.28 to 1.33. While projecting from incomplete to completed unemployment durations

---

<sup>10</sup>Black and white high school graduates with AFQT two standard deviations above the mean have the same earnings. Because the point estimates actually suggest higher earnings for black high school graduates than for black college graduates, there is no realistic level of AFQT at which the earnings of black and white college graduates are equal.

requires some strong stationarity assumptions, given the consistency of this ratio, it is reasonable to estimate that the unemployment duration of black men is roughly thirty percent longer than that of white men. This is consistent with the difference that Audra J. Bowlus and Zvi Eckstein (2002) calculate for high school graduates in the National Longitudinal Survey of Youth 1979. Similarly, Stefano DellaVigna and Daniele Paserman (2005) estimate that the exit rate from unemployment is about 20% lower for blacks than for whites even controlling for AFQT.

Casey Dawkins, Qing Shen and Thomas Sanchez (2005) find, in a sample of job losers, that with no controls black workers are unemployed for approximately twenty percent longer than white workers. Controlling for worker and household characteristics has only a very modest effect on this differential. However, controls for job accessibility and residential location reduce it to seven percent and render it statistically insignificant. We note that these results need to be treated with some caution. As Kim Clark and Lawrence Summers (1979) emphasize, there is considerable movement between unemployment and out of the labor force, and it is likely that some spells of unemployment that are interrupted by a period of nonparticipation should be viewed conceptually as continuous unemployment.<sup>11</sup>

Regardless of whether locational factors account for most of the unemployment duration differential, it is important to note that unemployment duration does not explain most of the unemployment rate differential. Some fraction of this difference may be accounted for by movements in and out of nonemployment, but there is clearly an important difference in rates of entry into unemployment from employment.

As an approximation, if workers live forever and do not move in and out of the labor force, then in steady-state the unemployment rate is given by

$$u = \frac{d^u}{d^u + d^e} \quad (1)$$

where  $d$  is the duration of a spell of unemployment ( $u$ ) or employment ( $e$ ). In practice, this formula will be a little off because new entrants typically begin their labor market experience with a spell of unemployment. Nevertheless, it is approximately correct. If we set  $d_b^u = 1.4 d_w^u$ , then  $u_b/u_w$  cannot exceed 1.4 unless average employment duration also differs between blacks and whites. Yet the unemployment rate ratio of black men relative to white men is typically around two. A little algebra establishes that therefore the mean employment duration of black men must be strictly less than 70% of the mean of white men based on

---

<sup>11</sup>This is separate from the issue of whether recorded labor force status has predictive power for reemployment, which it clearly does (Christopher Flinn and James Heckman, 1983).



Figure 2: Adjusted Employment/Population and Unemployment Gap: Black v White Men, 1968-2008

the unemployment rates in 2008.

### Time Trends

Using annual data from 1968 through 2008,<sup>12</sup> we find that the relative unemployment rate of black and white men is well approximated by a constant ratio. If we regress the unemployment rate of black men on a quadratic in the unemployment rate of white men, the squared term is small and statistically insignificant. Using only the linear term, the constant term is also insignificant, and the coefficient on the white male unemployment rate is 2.27. The solid line in figure 3.2 shows the residual from the linear regression.<sup>13</sup>

We perform a similar exercise using employment-to-population ratios. In this case we use the residuals from a regression of the black-male employment-to-population ratio on a

<sup>12</sup>Data are for white men and black and black and other or African American men age twenty and over and are from Table B-41 (employment-to-population ratio) and Table B-43 (unemployment rate) of the *Economic Report of the President: 2010*. If we include 2009, because of the very high unemployment rate and low employment-to-population ratio, it has an undue influence on the regressions. We have therefore excluded it.

<sup>13</sup>The equation is  $black\ unemployment\ rate = -0.19 + 2.27 * white\ unemployment\ rate$ . The coefficient standard errors are .49 and .11, respectively.

quadratic in the white-male ratio. The dashed line in figure 3.2 shows the result of this exercise.<sup>14</sup>

There are at least a couple of points to be drawn from figure 3.2. First, the pattern of improvement in the wage ratio shown in figure 3.1 is by no means mirrored in figure 3.2. The late 1960s and early 1970s which appear to be a period of earnings convergence are also a period when the unemployment rate of blacks was relatively low and the employment-to-population ratio relatively high. But, between the late 1980s and 2000 when there was strong wage convergence, the unemployment rate ratio fluctuated around its mean. The black employment-to-population ratio was somewhat higher than would be expected over this period, but since the relative incarceration rate of blacks rose rapidly over the same period, this may be an artifact of using the Current Population Surveys.

Perhaps most importantly, in 1982 and 2007 (admittedly a trough and a peak), the employment-to-population ratio of white men was 73.0% and 73.5%. For black men, it was 61.4% and 65.5% and thus even adjusting for incarceration rates did not drop noticeably. Even allowing for the increased incarceration of black men over this period and the lesser increase among white men, there was no strong change in the employment-to-population rate of men of either race. Yet, over the same period, there was strong wage convergence. This suggests to us that there is real wage convergence to be explained and that it is not just a result of changes in who is employed.

Of course, without looking more carefully at who is employed (which would vastly increase the scope of this article), we cannot rule out the possibility that wage convergence reflects changes in the *distribution* of who is employed within each racial group. If low-skill blacks left the labor force (in part because of increased incarceration) but low-skill whites did not (or did so to a much lesser degree), we could get convergence in earnings. Since empirically, unemployment and skill are negatively correlated, given the disappearance of large numbers of low-skill black men from the labor force, we would have expected the relative unemployment rate of black men to fall instead of remaining constant over the full period of our interest. Similarly, any explanation that relied solely on convergence in human capital would have to simultaneously explain why the earnings of black and white men converged while their unemployment rates have not.

---

<sup>14</sup>The estimated equation is  $black\ emp./pop. = 543.77 - 14.02 * white\ emp./pop. + 0.10 * (whiteemp./pop.)^2$ . The coefficient standard errors are 155.52, 4.07 and 0.03, respectively.

### 3.3 Racial Attitudes

Many intellectuals in the post-Civil Rights era have suggested a “declining significance of race” (William J. Wilson, 1978) in American society, pointing to a dramatic reduction in prejudice against blacks. Figure 3.3 documents the decline in prejudice as measured by national polls and surveys. The data show large declines since the 1950s and 60s in whites’ expression of prejudiced views on school segregation, social interaction, and blacks in politics. While we cannot completely discount the possibility that whites are merely becoming more cautious in expressing what are now socially unacceptable views, there is behavioral evidence to support the change. In the late 1950s over half of whites said they would not vote for a black president. The evidence of the 2008 election suggests that this proportion has declined significantly.

In 1958, 94% of Americans disapproved of marriage between a white and a black. By 2007, this figure was 17%.<sup>15</sup> Consistent with this attitudinal change, the frequency of black/white marriages has increased eight-fold since 1960 albeit it from a very low level (Michael J. Rosenfeld, 2007). Thus, the survey results suggest that strong prejudice is an increasingly peripheral explanation for racial inequalities in the labor market.<sup>16</sup>

However, results from Implicit Association Tests (IAT) (Andrew Greenwald, Debbie McGhee and Jordan Schwartz, 1998) suggest the presence of a more subtle or subconscious form of discrimination. In the race IAT test, the test-taker must quickly categorize pictures of faces appearing at the center of a computer screen as “African-American” or “European White” and/or sort words as “Good” or “Bad” by hitting a computer key corresponding to the correct side of the grouping.<sup>17</sup> In the first version of the test, the two paired categories are meant to be “incompatible” to the social stereotype (i.e. “African American” and “Good”). In the second version, the two categories on one side are meant to be “compatible” to the social stereotype (i.e. “European White” and “Good”). If there exists an implicit bias against African-Americans, the IAT predicts that people will be able to categorize compatible pairings more quickly than incompatible pairings. On average, the results show that this is indeed the case (Greenwald et al., 2002). While the sample of people taking the test is not random, it is very large, and we expect that it is skewed to more educated and more

---

<sup>15</sup><http://www.gallup.com/poll/28417/most-americans-approve-interracial-marriages.aspx>, downloaded January 5, 2010.

<sup>16</sup>The only question that receives large numbers of prejudiced responses is on the question of whether “blacks should not push in where they are not wanted.” We include this question because it has been used elsewhere as a measure of prejudice. However, we confess uncertainty as to what it means and whether respondents would give substantially different answers if the question were about whites.

<sup>17</sup>Readers may want to take the sample test at <http://implicit.harvard.edu>.

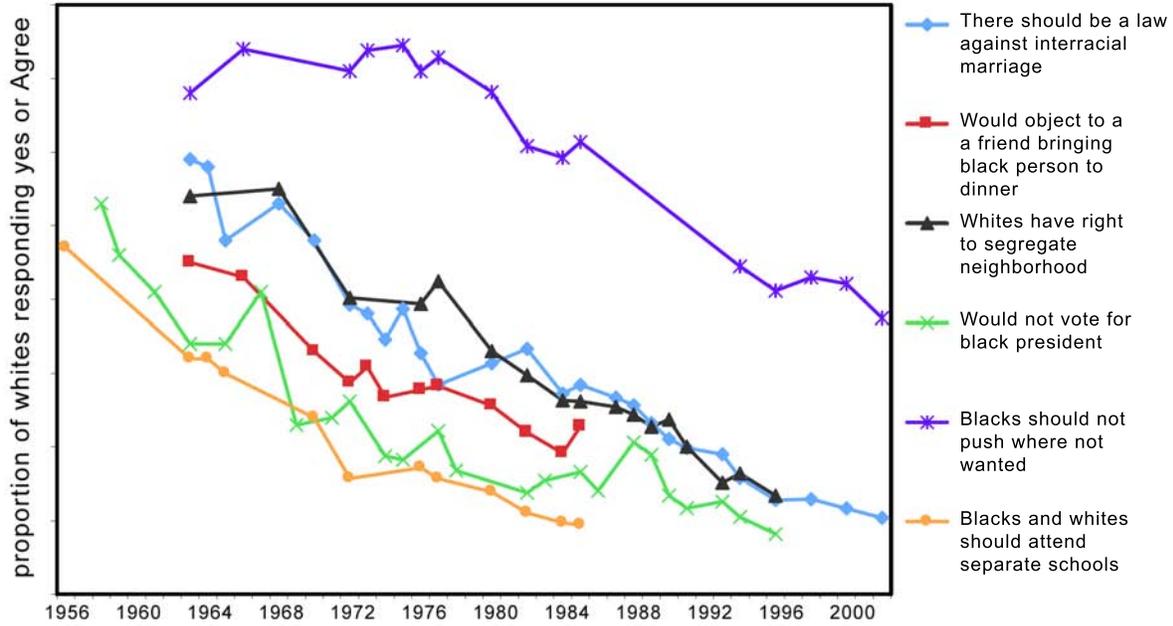


Figure 3: Trends in Prejudice Measures, 1956-2003

liberal individuals with an interest in discrimination.

Several studies have tried to distinguish between the roles of explicit and implicit forms of discrimination in the labor market by comparing the relation between responses to direct survey questions addressing personal bias and racial hiring differences with the relation between respondents' IAT results and their hiring behaviors (Jonathan Ziegert and Paul Hanges, 2005; Marianne Bertrand, Dolly Chugh, and Sendhil Mullainathan, 2005; Dan-Olof Rooth, 2007). In all three studies, the researchers find that implicit racist attitudes show a greater correlation with actual discriminatory behavior than do explicit expressions of prejudice. Whether people are consciously aware of their own biases or not, the implicit association tests demonstrate that it is at least plausible that discrimination is driven by prejudice. But it is also important to note that in these studies, subjects were choosing among candidates who were often quite similar and about whom they had a relatively modest amount of information. For example, in Ziegert and Hanges, subjects were asked to recommend the hiring of one of eight candidates, six of whom were highly qualified and had been found to be unranked in the absence of information on race. Furthermore, a recent essay evaluating the application of the IAT results to law and policy (Gregory Mitchell and Philip Tetlock, 2006) has criticized Ziegert and Hanges for relying on extreme anti-black outliers to drive their results.

We take the evidence from the surveys and the IAT as suggesting that credible models of discrimination based on prejudice may rely on the presence of strong prejudice among a relatively small portion of the population and/or weak prejudice among a significant fraction of the population, but not on widespread strong prejudice. It does not seem likely that a large proportion of employers, for example, are willing to forego significant profits in order to avoid hiring blacks. The reader should note our careful wording. We do not conclude that the IAT convincingly establishes that there is widespread weak prejudice, only that the evidence suggests that this assumption should not be ruled out as implausible.

### 3.4 Summary

In summary, we would like a theory of discrimination to explain the following regularities while relying on either strong prejudice in only a small portion of the population or widespread mild prejudice:

1. There is a notable wage gap between blacks and whites. This gap is smaller or nonexistent for very high-skill workers and possibly for very low-skill workers. If we ignore this heterogeneity, a plausible number for the (male) wage differential after controlling for other factors is around 10 percent.
2. There is a notable employment gap between blacks and whites that is somewhat smaller among high-skill than among low-skill workers. Blacks have both longer unemployment duration and a higher rate of entry into unemployment. The difference in duration after controlling for personal characteristics including AFQT is on the order of 25 percent.
3. The black-white earnings gap has fallen, albeit sporadically, over the last forty-five years but the unemployment gap has remained constant and may even have risen after adjusting for the increased human capital of black men in the labor force.

We will see that statistical discrimination models generally do not address employment while taste-based search models typically do not permit within-race heterogeneity and therefore cannot address wage differentials at different skill levels. Therefore, no existing model can fully explain these regularities. However, some come closer, and it is possible that, by combining elements of existing models, we could explain these major regularities simultaneously. Finally, existing models of discrimination generally cannot explain the evolution of wage and employment disparities over time either because they predict a constant level of discrimination regardless of the extent of prejudice or because we would expect a steady

decline in wage and employment disparities as discrimination declines. We focus the bulk of our discussion on whether existing theories can explain the first two points and offer a much more limited evaluation of theories in explaining patterns of changes in the black and white wage/employment gaps over time.

Finally, we note that wage and employment discrimination on the basis of race are both illegal in the United States. Almost all of the models discussed below implicitly assume that firms are nevertheless able to engage in such illegal practices. For the most part, we do not address whether firms would be able to violate the law or how models would have to be adjusted if some types of discrimination (e.g. wage) were easier to detect than others (e.g. hiring). We have not explored how this would affect market equilibrium since it would presumably be very model specific.

## 4 Taste-Based Discrimination in Perfect Labor Markets

Our discussion of taste-based models begins with the Gary S. Becker (1971) model even though it relies on strong discriminatory tastes in assuming that employers or other economic agents are willing to pay to avoid contact with blacks. We then move on to taste-based models in which either agents have only very weakly prejudicial preferences or only some agents hold strongly prejudicial preferences.

### 4.1 The Becker Model

In Becker's classic model, white employers, workers or consumers dislike employing, working with, or purchasing from blacks. Although the Becker model is well known, it is worth reviewing briefly since it is the starting point for more recent papers.

Employers maximize utility which depends positively on the profit they make and negatively on the number of blacks they employ:

$$u_e = u_e(\pi, L_b) \tag{2}$$

where the subscript  $e$  denotes the employer and  $b$  denotes blacks.

Black and white workers are equally productive and perfect substitutes so that

$$\pi = f(L_w + L_b) - w_w L_w - w_b L_b \tag{3}$$

and

$$u_e = u_e(f(L_w + L_b) - w_w L_w - w_b L_b, L_b). \quad (4)$$

The first order conditions for utility maximization are given by

$$\frac{\partial u_e}{\partial \pi} f' \leq w_w \quad (5)$$

$$\frac{\partial u_e}{\partial \pi} f' \leq w_b - \frac{\partial u_e}{\partial L_b}. \quad (6)$$

Equation (5) holds with equality whenever the firm hires whites and (6) whenever it hires blacks. If a firm hires both blacks and whites, then

$$w_w - w_b = -\frac{\partial u_e}{\partial L_b}. \quad (7)$$

Since Arrow (1972), it is common in the literature to simplify the utility function so that it is given by

$$u_e = f(L_w + L_b) - w_w L_w - w_b L_b - d_e L_b \quad (8)$$

in which case (7) reduces to

$$w_w - w_b = d_e. \quad (9)$$

Note that whenever the wage gap exceeds  $d_e$ , the employer will strictly prefer to hire blacks and whenever it is less than  $d_e$ , he strictly prefers to hire whites. If, as seems reasonable, the distribution of  $d_e$  has no mass points, then, assuming the labor market is otherwise perfect, (9) implies that either there is no discriminatory wage differential or (almost) all firms are completely segregated. Since not all firms are completely segregated, this version of the Becker model cannot account for wage differentials between blacks and whites.

However, if we use the more general version of the Becker model, given by (2) and (6), then, in general, firms will not be fully segregated. However, as noted by Becker and emphasized by Kenneth J. Arrow (1972), employers with weaker prejudicial tastes will make more profit and will expand. Demand for black workers will grow, and in the long run, if there are sufficient employers with no aversion to hiring blacks, the wage differential will fall to zero. Those employers who are averse to hiring blacks and who survive in the labor market will hire only whites. In short, employment will be partially segregated, but there

will be no wage discrimination.<sup>18</sup>

More generally, if some employers, workers or consumers have prejudicial tastes, the market should organize itself so that employers with such tastes hire only white workers; the workers they hire should include all those with prejudicial tastes, or, if there are insufficient employers with prejudicial tastes, some unprejudiced employers should nevertheless hire an all-white workforce consisting of prejudiced workers; and these all-white firms should serve prejudiced customers. More realistically, prejudiced customers probably do not care about workers with whom they do not interact. So blacks will be employed disproportionately in jobs with no direct customer contact.

If the Becker model is correct, the market should relentlessly eliminate discrimination except where it cannot provide sufficient segregation. This is most likely to occur for workers in specialized occupations requiring customer awareness of the race of the worker, where firm entry is limited, where the proportion of blacks in the labor force is large, and where prejudice is widespread.

## 4.2 Testing the Becker Model

In addition to recognizing the historical importance of Becker's work, it is important to assess its empirical validity. If the Becker model were satisfactory in explaining all the empirical regularities, there would be little need to assess models based on informational differences.

As discussed above, wage discrimination will be smaller if the market is able to segregate blacks and white racists to a greater degree. When there are few blacks in the labor market and many unprejudiced white employers, workers and consumers, in most cases it should be possible to achieve something approximating full segregation. Blacks will work for unprejudiced employers and alongside other blacks and unprejudiced whites. Racist consumers will patronize restaurants with white waiters, but there will be ample job opportunities for black waiters serving non-racists. When the black population is large and white racism widespread, such segregation will be difficult to achieve, and wage differentials will persist.

Kerwin Charles and Jonathan Guryan (2008) attempt to test this prediction directly. They point out that for a fixed distribution of prejudice among whites, segregation should be more difficult to achieve when the fraction of blacks in a state is higher. More notably, since in any state, blacks are at most a modest proportion of the population, black workers

---

<sup>18</sup>If individuals who fail to discriminate or fail to sanction those who violate social norms become, themselves, the subjects of discrimination, discrimination may persist even when it would otherwise be profitable to deviate and not discriminate. And often, historically in the United States, social enforcement did not take a subtle form but rather was effected through violence.

will be matched with whites in the lower tail of the prejudice distribution, that is those who are relatively unprejudiced. They use data from the General Social Survey, similar to those in figure 1, to construct a measure of prejudice among non-whites and regress the adjusted black/non-black wage differential in a state on the 10th, 50th and 90th percentiles of the prejudice distribution and on the proportion black in the state. They find that the wage differential is increasing in the proportion blacks and the prejudice measure at the 10th percentile. In contrast, the median and 90th percentile of the distribution have no relation to the differential.

The model implies that the critical percentile of the prejudice distribution should be increasing in the proportion black in the state. If we assume that all firms are the same size, that black and white workers are perfectly segregated, that there is no consumer prejudice (or at least that the market can avoid it), that the distribution of prejudice is the same among employers as among the population as a whole and that the labor force participation rates of black and white workers are the same, then the critical percentile of the prejudice distribution is the proportion black in the state. As the authors understand, these are unreasonably strong assumptions (and undoubtedly false). Nevertheless, these assumptions justify a parsimonious specification that relies on the level of prejudice of the “marginal employer.” The parsimonious specification fits the data well although probably not quite as well as a specification with both the 10th percentile prejudice and the proportion black.

Despite its predictive power across states, the Charles/Guryan approach is unlikely to match the time-series. Figure 1 shows a fairly steady decline in measures of prejudice, yet this is not matched by a steady decline in the black-white wage differential. As Charles and Guryan (2011) point out, their prediction is about the relation between the wage gap and the prejudice of the marginal, not the average, employer. Since the prejudice scale is fundamentally ordinal, it is essentially impossible to determine whether the prejudice of the marginal employer declined at varying rates over this period. The scale chosen by Charles and Guryan does show a steady decline of prejudice at the 10th percentile except in the late 1980s and is thus not consistent with the time-series, but it is possible that other scales would show a somewhat different pattern.

## 5 Taste Discrimination in Search Models

In models of discrimination based on a neoclassical framework, two related forces – segregation and firm entry – render wage differentials between blacks and whites an unstable

phenomenon in the long-run. Subsequent models have incorporated Becker’s taste-based discrimination in a search theoretic framework to explain the persistence of wage differentials in the labor market. In our discussion, we focus on search models with employer-taste discrimination rather than consumer (George J. Borjas and Stephen G. Bronars, 1989) and coworker (Masaru Sasaki, 1999) discrimination. The presence of prejudiced employers can lead to differential impact of search frictions across race groups, providing an explanation for the black-white differences in equilibrium employment and unemployment.

We divide search models into two classes based on how agents meet. In the first, firms and job applicants meet randomly. Within this class, wages may be set by firms who make take-it-or-leave-it offers or may be negotiated. In the second class of models, workers decide where to apply in response to announced wages.

Before doing so, we want to recognize that prejudicial tastes are likely to be more complex than in the models we describe. Prejudiced employers are modeled as requiring compensation in order to employ black workers. But the owners and managers of southern manufacturing plants that would not hire blacks were not necessarily averse to hiring black maids. And it is not necessarily the case that prejudiced employers would only be willing to hire blacks into low pay and low skill jobs. Recent work on identity (George A. Akerlof and Rachel E. Kranton, 2000) may explain why, for example, a male school custodian might object to working with a female custodian but not with a better paid female teacher.

## 5.1 Discrimination with Random Search

The basic intuition behind the persistence of wage and employment inequalities generated in random search models is as follows. In search models in which workers sequentially search for a job, the worker will accept a job or wage offer if the expected value of that offer is greater than or equal to the expected value of an additional search. Consequently, the equilibrium wage and employment are determined by the worker’s *reservation wage or match quality*, defined as the wage/match quality level that makes the worker just indifferent between accepting the offer or continuing to search. The presence of prejudiced employers in the market generates differential outcomes across worker groups by lowering the equilibrium reservation wage or match quality of workers facing employer prejudice. More specifically, because some firms either refuse to hire certain groups of workers or are only willing to hire them at a reduced wage, workers who are prejudiced against face lower probabilities of finding a position that will dominate their current offer. Therefore, because search is costly and time-consuming, these workers facing prejudice are willing to accept a job offer with

a lower wage and/or match quality which provides all employers (not just the prejudiced ones) with the incentive to offer lower wages to members of the group subject to employer prejudice.

We begin with a simple search model of employer taste-based discrimination based on Dan Black (1995) in which employers and workers meet randomly, workers possess some private information about the quality of the match, and firms make take-it-or-leave-it wage offers upon meeting the worker.

Assume that there are two types of firms. A fraction  $\theta$  of the firms are prejudiced and are only willing to hire white workers. The remaining  $(1 - \theta)$  firms are willing to hire both whites and blacks. All workers produce  $P$  in the market and nothing in home production. Workers do not search for a job while employed and unemployed workers search sequentially for a job. The cost of job search each period is denoted by  $\kappa$ . Workers and firms live forever, and there is no discounting.

When workers arrive at a potential job, they are told the wage offer (set in advance by the firm) for their type,  $w^i$ , and learn the value of parameter  $\alpha$ , which can be interpreted as how much they like the job. The utility associated with the job is  $u = w + \alpha$ . Therefore, workers with low realizations of  $\alpha$  will not take the job. The distribution function of  $\alpha$  is denoted  $F(\alpha)$ , and the associated density function  $f(\alpha)$ . We impose the common restriction that  $F(\alpha)$  is strictly log-concave which implies that the inverse hazard function or Mills ratio  $m(\alpha) \equiv [1 - F(\alpha)]/f(\alpha)$  is strictly decreasing.

### 5.1.1 Worker's Strategy

We can fully describe the worker's equilibrium strategy by specifying a reservation utility level at which the worker is just indifferent between accepting the job and continuing to search. In other words, the worker's reservation utility is exactly equal to his/her expected value of search  $V$ . For white workers, the expected value of search can be defined as

$$V^W = E\max\{w^W + \alpha, V^W\} - \kappa, \quad (10)$$

and similarly for black workers except that they receive an offer only with probability  $1 - \theta$ ,

$$V^B = \theta V^B + (1 - \theta) \times E\max\{w^B + \alpha, V^B\} - \kappa. \quad (11)$$

Using the distribution of  $\alpha$ , we can rearrange (10) and (11) to get

$$\kappa = \int_{V^W - w^W}^{\infty} (w^W + \alpha - V^W) f(\alpha) d\alpha \quad (12)$$

and

$$\frac{\kappa}{(1 - \theta)} = \int_{V^B - w^B}^{\infty} (w^B + \alpha - V^B) f(\alpha) d\alpha, \quad (13)$$

respectively, which define the optimal reservation utility for white and for black workers. The left-hand sides of (12) and (13) reflect the expected cost of generating an additional offer for each type of worker while the right-hand sides show the expected gains from an offer. From here, it is easy to see that the existence of prejudiced firms ( $\theta > 0$ ) raises the expected cost of generating an additional offer for black workers. This, in turn, implies that for a given wage offer, they will accept jobs with a lower level of satisfaction, have a higher acceptance rate, and  $V^B < V^W$ .

### 5.1.2 Firm's Strategy

Now consider the firm's behavior. The assumption that the workers possess some private information about their match quality implies that each firm is a monopsonistic competitor, facing an upward-sloping labor supply function. Therefore, each firm chooses a wage to maximize its profits. Since white workers do not care whether they work for a prejudiced or unprejudiced firm, their labor supply function will be independent of firm type. Given the constant returns to scale production function, it is therefore evident (and easy to prove) that prejudiced and unprejudiced firms will both choose the same wage offer for whites.

Prejudiced firms refuse to hire black workers at any positive wage. However, we can readily show that the presence of prejudiced firms increases the monopsonistic power of unprejudiced firms toward black workers, and the wages offered by *unprejudiced* firms will be lower for blacks than for whites. To see this, consider the profit-maximization problem. Unprejudiced firms want to maximize the probability of an acceptance multiplied by the profit conditional on acceptance or

$$\max_{w^i} \pi^i = [1 - F(V^i - w^i)][P - w^i] \quad (14)$$

which gives the necessary condition

$$P - w^i - m(V^i - w^i) = 0 \tag{15}$$

for  $i \in \{W, B\}$ .<sup>19</sup>

From (15), it is easy to see that the monopsony wage will be lower for blacks than for whites. Intuitively, at the equilibrium wage for whites, the benefit to the firm from lowering that wage will be greater when faced with a black worker, because his probability of acceptance will be higher due to his higher search costs. Somewhat more formally, since  $m$  is strictly decreasing,  $m(V^B - w^W) > m(V^W - w^W)$  since  $V^B < V^W$ . This implies that the left-hand side of (15) is negative at  $V^B$  and  $w^W$ , and the second order conditions ensure that equality is reached by lowering the wage.

In summary, the existence of prejudiced firms bolsters the monopsonistic powers of the unprejudiced firms with respect to black workers. Even though all workers are equally productive, unprejudiced firms exploit this power by offering lower wages to black workers despite having no distaste for hiring blacks.<sup>20</sup>

It is important to note that we have thus far assumed that the proportion of prejudiced firms in the market is equal to an exogenously determined proportion  $\theta$ . Yet given a fixed cost of operation, the profitability of prejudiced firms is always lower than that of unprejudiced firms since prejudiced firms are unwilling to hire blacks even at a lower wage. Consequently, as in neoclassical models of taste discrimination, long-run wage inequalities cannot persist in our current setup as long as there are enough unprejudiced potential entrants to drive out prejudiced firms.<sup>21</sup>

### 5.1.3 Calibration

It is perhaps somewhat unfair to ask whether such a stylized model can fit the broad empirical regularities regarding black/white wage and unemployment differences without relying on

---

<sup>19</sup>The sufficient conditions are guaranteed by the log-concavity of  $F(\alpha)$ .

<sup>20</sup>The reader will note that conditioning wage offers on race is a violation of the law in the United States. We have not tried to revise Black's model to account for this. It appears to us that firms hiring both whites and blacks would offer a wage between the white and black monopsony wages so that the model would continue to generate an average wage differential. However, the unemployment analysis would be more complex because, given the possibility of a higher wage offer from a prejudiced firm, whites would be more likely than blacks to turn down offers from unprejudiced firms.

<sup>21</sup>Search frictions may make social enforcement easier than in Becker's model. If firms hire more than one worker and those that hire a black worker have more difficulty hiring white workers, nondiscriminating firms may not find it profitable to enter the market. See Akerlof (1985) for a related model.

an unduly large proportion of prejudiced employers. Nevertheless, we undertake this exercise.

We add the following conditions to the model:

$$\begin{aligned} w^B &= .9w^W \\ 1.4w^W &= P \end{aligned}$$

The first condition sets the black-white wage differential at ten percent. The second ensures that approximately seventy percent of value-added goes to workers.

It is relatively straightforward to choose parameter values such that a 10% black-white wage differential arises with a modest proportion of prejudiced firms. For example, if we want only 10% of firms to be unwilling to hire blacks, then we can set  $\kappa$  equal to 1.23 in which case the equilibrium wages of whites and blacks turn out to be 11.0 and 9.9.

On the other hand, it is much more difficult to explain the difference in unemployment durations with this type of model unless prejudice is widespread. It is somewhat easier to make this point in continuous time. Assume that the arrival of an acceptable job offer (based on the wage and personal satisfaction value) is a Poisson process.

Then the probability of a white worker still being unemployed at time  $t$  is  $\exp(-\lambda_w t)$  where  $\lambda_w$  is the arrival rate of an acceptable offer and equals  $\delta p_w$  where  $\delta$  is the arrival rate of offers and  $p_w$  is the probability that an offer is acceptable to the white worker. We can then write the probability of a black worker being unemployed after  $t$  as

$$\exp(-\delta(1-\theta)p_b t) < \exp(-\delta(1-\theta)p_w t) \tag{16}$$

since whites are choosier about jobs than blacks are. Let  $t_b$  and  $t_w$  represent the mean (or median) unemployment duration of blacks and whites, respectively. A little manipulation of (16) establishes that

$$\theta > 1 - t_w/t_b. \tag{17}$$

Bowlus and Eckstein (2002) report that the median unemployment durations are 22.15 and 29.05 weeks for black and white high school graduates. According to (17) these figures imply a lower bound of about one-quarter of jobs being offered by firms that are unwilling to black worker for that job. If one uses mean or median incomplete unemployment durations for black men and white men in 2008, the lower bounds for the proportion of prejudiced

firms are 24% and 29%.<sup>22</sup> It should be stressed that these estimates are *lower* bounds. If the arrival rate of offers were indeed 25 percent lower for blacks than for whites, the theory predicts that blacks should be much less picky about their jobs. So to generate these differences in unemployment durations, Black's model probably requires that the proportion of jobs offered by very prejudiced employers be substantially greater than 25 to 30 percent.

Although Black's model gives us a simple, intuitive understanding of how the presence of prejudiced employers can lead to inequalities in wages and unemployment between blacks and whites, it requires (in all likelihood) an unrealistically high proportion of strongly prejudiced firms to match the broad empirical regularities in the labor market. Furthermore, the simplifying assumptions of the model precludes us from explaining several important black/white differences. First, although high levels of prejudiced firms are sufficient to generate the differences in unemployment rates that we observe between black and white men, we must also explain higher rates of separations into unemployment for black workers hired by unprejudiced firms. This issue cannot be addressed with the Black model, since there is no post-employment separation.

#### 5.1.4 Estimation of Wage and Unemployment Differences

Bowlus and Eckstein (2002) develop a closely related model that they estimate using the National Longitudinal Survey of Youth 1979. From their estimates, we can confirm our calibration that models of this style require large numbers of highly prejudiced firms.

Like Black, they assume that firms can condition the wage offer on worker type but not on his employment situation or current wage. However, they depart from the Black model in important ways.

1. The distaste for hiring blacks among prejudiced employers is finite so that there is some wage at which such firms will hire blacks. However, they assume that all prejudiced firms share the same taste parameter.
2. Workers search while on-the-job. This generates a distribution of wage offers,<sup>23</sup> which substitutes for the role of match-specific utility in Black by leading workers to reject some offers.

---

<sup>22</sup><http://www.bls.gov/cps/cpsaat31.pdf> (downloaded November 9, 2009).

<sup>23</sup>Although there are exceptions, models in which workers can hold two offers simultaneously generally produce a continuum of wages with no mass points. If there were a gap between wages  $w_1$  and  $w_0 < w_1$ , a firm offering  $w_1$  could lower its wage towards  $w_0$ , be just as likely to have their offer accepted but make more profit conditional on having a worker. If there were a mass of offers at  $w_0$ , a firm offering  $w_0$  could raise its wage infinitesimally and increase its probability of having its offer accepted by a finite amount.

3. The productivity of black and white workers may differ.
4. Matches break up randomly at a race-specific rate.
5. The rate at which firms meet black workers depends on whether the firm is racist.

Identification of the model is complex and depends heavily on the fact that the shape of the wage distribution depends in different ways on worker productivity, the arrival rate of matches, the proportion of prejudiced firms and the degree of their prejudice. This is somewhat of a concern since the model implies that the density of the wage distribution is strictly increasing over the range of observed wages, a prediction that is empirically false.

Bowlus and Eckstein conclude that the productivity of blacks is only about three percent below that of whites and that most of the wage differential reflects the presence of a large fraction of very prejudiced firms. They estimate that over half of the firms are prejudiced with a disutility of hiring blacks equal to about 31% of the white productivity level. To capture the divergence in unemployment duration, the model requires prejudiced firms to search for black workers with about 60% of the intensity with which they search for whites. Between their low offers and search intensity, such firms employ only about 14% of the black workers. Black workers also face an exogenous job destruction rate that is about twice the rate faced by whites. Thus, their results confirm our earlier conclusion that this class of models requires implausibly large proportions of highly prejudiced firms.

### **5.1.5 Private Information about Match Quality and Longer Unemployment Duration for Blacks**

Asa Rosén (1997) develops a model that can generate different unemployment durations for blacks and whites in equilibrium even when no firm is prejudiced. She assumes that workers have private information about their match-specific productivity. The unique stable equilibrium is strongly discriminatory, with lower wages and longer unemployment spells for blacks. The driving force behind the model is that firms make more profit by hiring workers with greater match-specific productivity, but if blacks have greater difficulty finding jobs, then, relative to whites, they will apply for jobs to which they are not particularly well-matched. Therefore, even unprejudiced firms will prefer to hire whites. Blacks will take longer to form matches and will receive lower wages because, on average, they are less well matched. Below we lay out the intuition of the model in more detail.

Assume that each firm has at most one vacancy it seeks to fill. An unemployed worker learns about at most one vacancy and also learns her (match-specific) productivity at that

job. Given this information, she decides whether or not to apply. The firm observes the applicants and decides with which one to bargain. Once it has a chosen this applicant, the others leave and continue searching. The firm learns the match-specific productivity of the applicant, and the parties Rubinstein bargain. As a result, the worker receives a fraction  $\beta$  of her output and the firm receives the rest unless the participation constraint is binding in which case the wage just satisfies the participation constraint. It is evident that if there is any bargaining cost, the worker will not apply if the bargaining outcome would just satisfy the participation constraint. In such cases, we assume that she chooses not to apply. Some additional restrictions are required to ensure that the firm's participation constraint is not binding.

Given the distribution of productivities and the probability of being chosen by the employer, each worker chooses a reservation productivity above which he will apply for a job and below which he will not. Note that this is equivalent to choosing a reservation wage since, if chosen, the worker receives a fraction of her productivity. By the usual sequential search arguments, for a nondegenerate wage distribution, the reservation wage, and therefore, the reservation productivity rises as the arrival rate of offers increases. Hence if, for some reason, whites get offers more frequently than blacks do, whites will have a higher reservation productivity. If whites have a higher reservation productivity than do blacks, firms will know that their white applicants are, on average, more productive at their firm than are black applicants and will, therefore, always choose a white applicant over a black applicant.

Consequently, there are three equilibria – one in which whites and blacks are chosen from the applicant pool with equal probability, one in which blacks are always chosen in preference to whites, and one in which whites are always chosen in preference to blacks. If any firm deviates from the first of these equilibria by, for example, giving a slight preference to whites, it will be in the interest of all firms to discriminate in the same direction. Therefore, in Rosén's terms, only the strongly discriminatory equilibria are stable.

Since the expected wage conditional on being hired is just a fraction of the expected productivity, it should be evident that if blacks choose a lower reservation productivity, they will receive lower wages on average. In fact, if blacks earn 10% less on average than do whites, they must be 10% less productive in their matches. Finally, as is typical in models of sequential search, a faster (potential) arrival rate of offers does not necessarily result in faster unemployment exit although additional restrictions, such as log-concavity, on the distribution of match-specific productivity can ensure this.

As in the models discussed previously, separations are exogenous. Rather than addressing whether Rosén’s model can be calibrated to fit the black-white unemployment duration and wage differentials, we address endogenous separations and calibrate her model in the next section.

### 5.1.6 Endogenous Separations

Like Black and Bowlus and Eckstein, Rosén does not really address separations into unemployment. In this subsection, we show that a model that draws heavily on hers can simultaneously explain lower wages, longer unemployment duration and higher turnover for blacks.

We depart from the Rosén model in two ways. First, we assume that workers are either good or bad at a particular job and that, rather than observing the quality of the match, workers receive a signal that tells them the probability that the match is good. Second, we assume that the firm and worker Nash bargain over the wage, so that, in contrast with Rosén, outside options affect the wage. We continue to assume that each worker is matched with at most one firm and that each firm chooses to bargain with at most one worker.

By the same logic as in Rosén’s model, if all firms choose to bargain with a white whenever they have both black and white applicants, blacks will set a lower cutoff probability of being good when deciding whether to apply to a job. This will make firms prefer to bargain with whites. However, blacks will also have worse outside options, which will lower their wage relative to whites. This lower wage could, in principle, make firms prefer to bargain with blacks. Our attempts at calibration suggest that for some parameters the equilibrium with no discrimination is stable.

One can write the model more generally, but for purposes of calibration, we will assume that there are just two signals, (*H*)igh and (*L*)ow. Each unemployed worker is matched with a job each period and must decide whether or not to apply. If the worker applies, he receives expected utility  $U^a$

$$U^a = c + (1 - P)\delta U + \delta P(pV + (1 - p)\delta U) \tag{18}$$

where  $c$  is the flow utility of unemployment,  $P$  is the probability that he is chosen from the pool of applicants,  $p$  is his signal of the probability that he is a good match for this job,  $U$  is the utility of unemployment before the signal is received,  $V$  is the present value of wages

if the worker turns out to be good at this job and  $\delta$  is the discount factor. Note that if a worker applies for a job that turns out to be a bad match, by assumption it is efficient for the firm and worker to separate since the worker's productivity is very low. In this case, the worker is hurt by not receiving the flow value of unemployment and being unable to search for one period.

If the worker does not apply, he receives utility

$$U^n = c + \delta U. \quad (19)$$

Combining (18) and (19) and rearranging terms, the worker will apply when receiving the  $H$  signal but not the  $L$  signal if

$$p^H \geq U \frac{1 - \delta}{V - \delta U} > p^L. \quad (20)$$

If the first inequality is reversed, he never applies anywhere. If the second inequality is reversed, he applies to all jobs regardless of the signal. We will be interested in equilibria where whites apply only if they receive the  $H$  signal while blacks apply to all matches. For simplicity, we will assume that the signals  $H$  and  $L$  arrive with equal probability so that in the conjectured equilibrium, whites apply to half of the jobs with which they are matched and blacks apply to all jobs.

Although  $P$  does not enter condition (20) directly, being less likely to be offered a job makes blacks more likely to apply for one with which they are unlikely to be well-matched. In the model, the cost of applying for a job is that if the worker is chosen, he forgoes a new match the following period. If the worker is not chosen, applying has no cost. If a worker is unlikely to be chosen for any job for which he applies, then the cost of applying is low. In this case, even if the match appears to be bad, the worker will be willing to apply for a job in the hope of being chosen and discovering that the match is actually good. In contrast, if the worker is likely to be chosen, the cost of forgoing a new and possibly more promising match is high.

We normalize the present value of output to equal 1 and assume that the present value of wages is determined by Nash bargaining. Note that once the worker has been revealed to be a good match, turnover is inefficient. In this simple model, turnover occurs only because workers and jobs sometimes turn out to be badly matched. Thus we have

$$V = \alpha(1 + U) \quad (21)$$

where  $\alpha \in (0, 1)$  is the worker's bargaining power.

We assume that workers and firms are randomly matched using a balls and urns model. We are interested in the discriminatory equilibrium in which firms always prefer to try out a white worker if given a choice between black and white applicants. Let  $W$  and  $B$  be the expected number of white and black applicants per firm, then a standard result in the literature<sup>24</sup> is that the probability that an individual white applicant is chosen from the pool of applicants is

$$P_w = \frac{1 - e^{-W}}{W} \quad (22)$$

and the probability that an individual black applicant is chosen is

$$P_b = e^{-W} \frac{1 - e^{-B}}{B}. \quad (23)$$

To complete the model note that

$$U = c + \delta U(1 - q) + \delta Uq(1 - P) + \delta qP(E(p|apply)V + (1 - E(p|apply))\delta U) \quad (24)$$

where  $q$  is the probability that the signal is sufficiently positive that the worker applies.

Finally, for discrimination to be an equilibrium, we require that it be more profitable for firms to negotiate with a white worker if all other firms also discriminate. Thus we verify that

$$H(1 - V_w) \geq .5(H + L)(1 - V_b) \quad (25)$$

where the subscripts denote white and black.<sup>25</sup>

**Calibration** Setting the unemployment exit hazard for blacks at 80 percent of the white hazard therefore means setting  $P_b = .4P_w$ . We set the ratio of black unemployed to white unemployed workers equal to .3. Using (22) and (23), this implies that the ratio of white workers to vacancies is about 2.2 and the ratio of black workers to vacancies is about .7. Although only half of white workers apply to the vacancy with which they are match, these values imply that firms fill five-sixths of their vacancies each period.

---

<sup>24</sup>See, for example, Lang, Manove and William T. Dickens (2005). These equations can be derived either by assuming that the ratio of white and black workers to vacancies is a random variable with a Poisson distribution or by assuming that each worker is matched randomly and independently with one firm and then allowing the number of workers and firms to go to infinity while holding their ratio fixed.

<sup>25</sup>This formulation assumes that negotiating with a worker only crowds out other applicants for one period. If the firm hires the worker permanently, it can still seek new workers.

We set  $H$  equal to 1 and choose  $\alpha$  (worker bargaining power),  $\delta$  (the discount factor),  $c$  (the flow value of unemployment) and  $L$  such that the white wage is .7 and the black wage is .63 and to ensure that the requisite inequalities (whites apply only to high signal jobs, blacks apply to both, firms prefer to hire whites) are satisfied. We find that these conditions are satisfied for  $\alpha = .467$ ,  $\delta = .910$ ,  $c = .006$  and  $L = .124$ . Note that this implies that while all jobs taken by whites last, only 56% of those taken by blacks do so.

### 5.1.7 Concluding Remarks

We have shown that a very simple model with random search can generate realistic black-white wage and unemployment duration differentials and also an endogenously higher failure rate of job matches for black workers. The model does not require any prejudice on the part of employers and is thus consistent with our requirement that our explanation for discrimination not require large proportions of highly prejudiced employers. Clearly a more reasonable model would allow the quality of the match to be revealed over time so that one could make predictions about the hazard of exiting employment. The model also does not address differences in black-white differentials by skill level, a point to which we return at the end of the section on search models. Perhaps, most importantly, the disparities it predicts are too strong. We are either in one of the discriminatory equilibria or in the egalitarian equilibrium, but there is no opportunity for the extent of labor market discrimination to decline over time, a point to which we will also return.

## 5.2 Directed Search

The search models that we have presented in this section thus far have assumed that workers and firms meet randomly. However, although this assumption can greatly simplify the model solutions, it precludes workers and firms from optimally searching for or avoiding certain types of employers and workers given market conditions. Heckman (1998), in particular, has criticized empirical (audit) studies of discrimination, because they assume that workers apply randomly for jobs and cannot avoid prejudiced employers. In Black, black workers cannot avoid applying to prejudiced firms and prejudiced firms can do nothing to encourage white applicants in lieu of black applicants. In Bowlus and Eckstein, prejudiced firms may be less likely than are unprejudiced firms to randomly encounter black workers, but this is only the reduced form of an unspecified mechanism. In Rosén, workers do not bother applying to firms with which they are poorly matched, but they can do nothing to increase the arrival

of application opportunities for firms with which they are well-matched. Similarly, firms can do nothing to increase the arrival rate of matches (applications) even though vacancies are costly.

Lang, Manove, and Dickens (2005) develop a model of discrimination with directed search. In their model, firms announce wages. Workers observe the wages and decide where to apply. As in Rosén, firms are limited to hiring a single worker and workers search sequentially.<sup>26</sup> The first assumption does not appear to be essential to the equilibrium characteristics of either model, but the latter does appear critical.

In our discussion of Black, we noted that he allows firms to offer different wages to whites and blacks, and they do so in equilibrium, but this is a violation of U.S. law. In contrast, in LMD, firms can only announce a single wage and therefore cannot condition the wage on race. Therefore, firms will always hire the most productive worker (adjusted for any disutility from hiring black workers). In the simplest case where all workers are equally productive, if employers have even an infinitesimal disutility from hiring blacks, they will always hire whites in preference to blacks.

The critical difference between LMD and Rosén is that workers can choose where to apply. In both models, blacks would prefer to apply to jobs to which whites are unlikely to apply, because they know they will lose out to any whites with whom they compete for a particular job. In contrast, whites do not care about black competitors. Below, we intuitively describe the equilibrium strategies of the firms and white and black workers.

### 5.2.1 White Worker's Equilibrium Strategy

Since white applicants are not impacted by black applicants' behavior, whites randomize their applications so that the expected wage (announced wage multiplied by probability of getting the job) is the same everywhere they apply. Furthermore, they apply with positive probability to a job if and only if its announced wage exceeds the common expected wage at the jobs to which they apply. More formally, let the number of white workers be Poisson distributed with mean  $Z$  and let

$$z_i = p(w_i)Z$$

---

<sup>26</sup>Lang, Manove, and Dickens present a static model, but this appears to us to be unimportant. The critical assumption in both models is that workers cannot apply for two jobs simultaneously. If they could apply to two jobs, then the fact that other firms were less likely to make an offer to a black worker would make trying to hire blacks more attractive, and it is not clear what the resulting equilibrium would look like.

be the expected number of applicants to a job paying  $w_i$ .<sup>27</sup> Then the probability that a white applicant gets that job can be shown to be

$$emp_i = \frac{1 - e^{-z_i}}{z_i}.$$

Therefore, in equilibrium we have

$$\begin{aligned} w_i \frac{1 - e^{-z_i}}{z_i} &= K & w_i > K, z_i > 0 \\ w_i \frac{1 - e^{-z_i}}{z_i} &\leq K & w_i \leq K, z_i = 0 \end{aligned}$$

where  $K$  is the common equilibrium expected wage at the jobs to which white applicants apply.

### 5.2.2 Black Worker's Equilibrium Strategy

Black applicants only get the job if no white worker applies, which, given the Poisson assumption, occurs with probability  $\exp(-z_i)$ . Like whites, blacks randomize applications so that their expected wage is the same everywhere they apply and less than that common expected wage everywhere they do not apply. In other words, denoting the expected number of black applicants by  $y_i$ , we have

$$\begin{aligned} w_i e^{-z_i} \frac{1 - e^{-y_i}}{y_i} &= J & e^{-z_i} w_i > J, y_i > 0 \\ w_i e^{-z_i} \frac{1 - e^{-y_i}}{y_i} &\leq J & e^{-z_i} w_i \leq J, y_i = 0 \end{aligned} ,$$

where  $J$  is the common equilibrium expected wage at the jobs to which black applicants apply.

### 5.2.3 Firms' Equilibrium Strategy

Firms choose the wage to maximize their profits which are given by

$$(1 - e^{-z_i})(v - w_i) + e^{-z_i}(1 - e^{-y_i})(v - d - w_i) \tag{26}$$

where  $v$  is the productivity of whites and  $d$  is the disutility from hiring blacks (or difference in productivity) which is presumed to be small. For clarification, further note that  $(1 - e^{-z_i})$

---

<sup>27</sup>The Poisson distribution of the number of workers with mean  $Z$  is the distribution that would arise if agents from a large population were to make independent and equally probable decisions to enter the job market. It is important for the LMD model that the actual number of applicants not be observable either to firms to workers, yet the mean  $Z$  is assumed to be common knowledge.

is the probability that at least one white worker applies and  $e^{-z_i}(1 - e^{-y_i})$  is the probability that no white worker applies and at least one black worker applies.

LMD show that whenever a wage offer attracts both blacks and whites, *lowering* the wage *increases* the expected number of applicants. Therefore, provided that blacks are nearly as productive as whites, it is never profit-maximizing to offer a wage that attracts both groups. Instead, in equilibrium some firms offer high wages and attract only white applicants and other firms offer low wages equal to the expected wage of white workers in high-wage firms, and attract only black applicants.

#### 5.2.4 Discussion of LMD

The strength of the LMD model is that it can generate large differentials from mild discriminatory tastes or small productivity differences. In the static model, the black/white wage ratio is just the probability that a white's job application will be successful. To get a more realistic assessment of the predictive power of the model, we need to develop a dynamic version. Our efforts in this direction suggest that we can generate a ten percent wage differential with plausible parameters. However, we do not pursue this avenue since the model has an obvious empirical failing: it implies *shorter* unemployment durations for blacks than for whites.

To see this, note that high-wage firms attracting whites and low-wage firms attracting blacks can only exist simultaneously in the long-run if they earn the same profits. Since the low-wage firms make more profit per worker when they fill their vacancy, they must have a lower probability of filling their vacancy each period, which in turn means that the expected number of applicants is lower, and each applicant has a higher probability of obtaining employment. Thus LMD can generate plausible wage differentials but not unemployment duration differentials from weak levels of prejudice.

#### 5.2.5 Continuum of Types

Lang and Manove (2003) show that, perhaps surprisingly, if there is a continuum of types rather than two types, the model generates higher unemployment among low types but *not* lower wages. They assume that all types are equally productive but that workers are ranked by some continuous trait such as skin color. They show that in this case, all firms set the same wage, workers apply randomly, and lower types have higher unemployment rates.

Intuitively, the fundamental difference between LMD and Lang and Manove (2003) is that, in equilibrium, LMD produces segregation while the latter does not. Since wage offers

cannot be conditioned on worker type, wage differences between types are not likely to arise without segregation. Furthermore, when there is complete segregation by worker type in equilibrium, there is no competition for employment between types. Therefore, one should not expect less preferred types to have higher unemployment. In fact, we have shown that, given their lower wages, less preferred types have *lower* unemployment in equilibrium. However, without segregation, different types of workers compete for the same job, and the less preferred types suffer *greater* unemployment.

### 5.2.6 Lessons from Directed Search Models

In summary, the general lesson from the Lang and Manove and LMD models is that to the extent that firms' equilibrium strategies allow disadvantaged workers to segregate themselves from other workers, we should expect lower types to have lower wages. To the extent that they are unable to do so, we should expect them to have higher unemployment.

LMD present an example in which there are workers with high and low discount rates within each racial group. They show that there are four wages in equilibrium and some pooling of white (high discount rate) and black (low discount rate) applicants at the next to lowest wage. In this setting, blacks with high discount rates have the fastest rate of exit from unemployment while low discount rate blacks have the slowest rate of exit. They find confirmation of greater heterogeneity in exit rates among blacks in Van den Berg and van Ours (1996).

Lang and Manove present an example with three types. In the equilibrium, there are three wages. The preferred type always applies to high wage jobs; the middle type mixes between the high and middle wage jobs while the low type mixes between the high and low-wage jobs. As in the example in LMD, the lowest type has both the fastest and slowest rate of exit from unemployment. In addition, they show that there are parameter values for which the mean exit rate is fastest for the high types and slowest for the low types.

Alternatively, it seems likely that a hybrid of directed and random search models could produce the desired predictions. If workers do not observe all posted wages, but only a subset, then there is some chance that a black worker will observe only jobs aimed at whites and apply there with a low probability of employment and that a white worker will observe only jobs aimed at blacks and apply there with a high probability of employment. However, such a model has not been worked out.

Despite this positive assessment, it is not clear to us how robust the directed search models are to natural changes. In these directed search models where small differences

are magnified, there will be strong incentives to be slightly better than everyone else. If, for example, education increases a worker's desirability, then we would expect workers to increase their employment opportunities by investing heavily in education. If all workers are *ex ante* identical except for race, we would expect workers to choose their level of education so that expected earnings net of education costs were the same at all levels of education. Blacks might choose more or less education, on average, than do whites, but any earnings and employment differentials would be fully explained by the difference in education. Therefore it is not clear that such models can generate unexplained wage and employment differentials.

Moreover, as we have noted above, the assumption that workers can only apply to a single job at a time is restrictive. If workers can apply to more than one job, employers must also take account of the preferences of other employers. With multiple applications, if all other employers hire whites in preference to blacks, any particular employer may choose to offer employment to blacks in preference to whites because their offer is more likely to be accepted.<sup>28</sup>

### 5.3 Concluding Remarks on Search Models

How well can search models fit the basic facts outlined in section 3? Models of random search predict both lower wages and longer unemployment durations for blacks. Those in which only prejudiced firms engage in employment discrimination (Black; Bowlus/Eckstein) do not produce sufficiently large wage and/or unemployment duration gaps when only a relatively small fractions of firms are prejudiced. When discrimination is an equilibrium strategy for all firms (Rosén), it is possible to fit these empirical parameters quite well. On the other hand, when discrimination is a unique equilibrium, the model cannot explain changes in the earnings and/or unemployment gap.

In contrast, current models of discrimination with directed search produce either wage discrimination or longer unemployment duration but not both although it is possible to generate both with modest adjustments. And extensions of these models *might* be able to explain simultaneous reduction in the earnings gap and increases in the unemployment gap. Perhaps more significantly, there have been recent developments in directed search models, and the implications of discrimination in such models have yet to be investigated. Manolis Galenianos and Philipp Kircher (2009) allow multiple applications; Peters (undated) allows for heterogeneity among both firms and workers. In Shouyong Shi (2009), firms offer wage-tenure contracts and workers engage in on-the-job search. In none of these is introducing

---

<sup>28</sup>We note that this concern is not particular to directed search models but also applies to Rosén.

discrimination likely to be trivial or to produce results that are simple extensions of existing discrimination models with directed search.

Furthermore, none of the search models explains why the wage gap disappears at high skill levels. One view is that affirmative action rules and more vigorous enforcement of equal employment opportunity protect more skilled workers from employment discrimination, but they are less effective for low skilled workers. But this fails to explain why there is still an unemployment differential between high-skill blacks and whites.

## 6 Statistical Discrimination

The second major branch of the discrimination literature focuses on the implications of imperfect information about worker's training or productivity. Edmund S. Phelps (1972) suggested that employers have greater difficulty assessing the productivity of black workers than of white workers and therefore treat individual black workers more like the black average. In a context of *de facto* and *de jure* discrimination in education, housing, and other areas outside the labor market, this implied that most blacks would receive low wages. But subsequent work in this area has typically assumed that blacks and whites would be similar in the absence of labor market discrimination. Dennis Aigner and Glen Cain (1977) formalized Phelps using a model in which an imperfect signal of the worker's productivity is noisier for black than for white workers, but in their model, this does not produce differences in the average wages of blacks and whites. Later in this section, we will describe a literature that builds in part on the Phelps/Aigner/Cain approach to produce wage differentials.

Arrow (1973) and Michael A. Spence (1973) developed sorting models in which employers' beliefs about the low productivity of blacks deterred them from investing in productive signals such as education. However, such models fell out of favor because these beliefs could be maintained only if no blacks invested in the signal, which was empirically incorrect. Stephen Coate and Glenn C. Loury (1993) show that such negative stereotypes can be sustained in equilibrium by the investment decision of workers if the productive investments are only imperfectly observed. More recent papers have developed dynamic versions of the model examining effects on promotion.

### 6.1 Using Race for Inference

Both branches of the statistical discrimination literature require that the market use race to infer information about productivity. We therefore begin with a review of a paper by List

(2004) that, while not about the labor market, provides direct evidence that sellers use race to infer reservation price. We then discuss Joseph G. Altonji and Charles R. Pierret (2001) which develops and tests a model of employer learning in which employers rely, in part, on race to infer productivity.

### **6.1.1 Taste or Statistical Discrimination?**

While not about the labor market, an important study by John A. List (2004) takes an experimental approach to determining whether sportscard vendors use statistical information about race and other attributes and whether there is evidence of taste-based discrimination. This is one of the few studies that attempt to identify the nature of discrimination rather than its mere presence and is therefore worth discussing in detail here.

At a regional sportscard show, buyers who approached the experimenter's table inquiring about a specific card (1989 Upper Deck Ken Griffey Jr. PSA graded "9" baseball card) were asked to participate in an experiment for a small monetary reward. These subjects were told to purchase the card for the lowest possible price below a predefined reservation value – low and high. In a complementary experiment for sellers, experimenters approached subjects entering the sportscard show and asked if they were intending to make a sale at the show. If they answered yes and they possessed the Griffey card, they were asked to participate in the experiment and to sell the card at the highest possible price above a predetermined reservation price.

List compares the initial and final offers made and received across age and racial groups, controlling for various subject characteristics and dealer-specific fixed effects. Both buyers and sellers made initial offers to minorities (women, nonwhites, and older agents) that were inferior to those they made to younger white males (age 20-30). Furthermore, discrimination was much more pronounced among sellers than among buyers. Sellers' initial offers to minorities were about 30 percent higher than their offers to majority buyers. For both buyers and sellers, bargaining reduced the disparities so that there was less discrimination in final than in initial offers. In fact, when buyers were experienced, final offers to minorities and majorities were similar. However, the minorities had to spend more bargaining time to reach these final offers.

List uses three complementary experiments to determine the source of the discrimination. He considers three possible explanations: distaste towards minorities, inferior bargaining skills of minorities, or statistical discrimination. First, in "the dictator game" dealers were given \$5 to share with a partner whose sex, age, and race they knew. There were

no statistically significant differences in the amounts transferred to minority and majority partners except that white women receive *greater* transfers. This suggests that taste-based discrimination does not explain the offer disparities.

Second, List used a “Chamberlain experiment” in which buyers and sellers bargain over sports cards. When sellers knew that buyer reservation values had been assigned randomly, outcomes were unrelated to minority status. Only when sellers were unsure how reservation values were determined did a difference emerge. This shows that the sellers’ behavior is not driven by their belief that minorities are less effective bargainers and suggests that it may reflect their beliefs about the distribution of reservation values.

Therefore, List used a second-price auction to elicit buyers’ willingness to pay. Minority reservation price distributions were much more disparate than those of the majority. To discern whether dealers were aware of these distribution differences, List asked dealers to match distributions to the buyer type. Dealers generally matched these correctly, with the experienced dealers being more informed about the disparities.

Thus List provides strong evidence that at least some agents use information about statistical distributions when choosing their strategies for dealing with members of different groups.

### **6.1.2 Evidence from the Labor Market**

Building on Henry S. Farber and Robert Gibbons (1996) study of wage dynamics with employer learning, Altonji and Pierret (2001) test the hypothesis that firms use race to infer productivity. Although it does not do justice to the complexity of the analysis in the paper, the following simple example gives the underlying intuition.

There are four types of variables that may influence wages: race, and non-race correlates of productivity that are observed by a) both the market and the econometrician, b) only the market and c) only the econometrician initially but learned by the market over time. For simplicity, we ignore variables observed by both the market and the econometrician or only by the market and consider only race and a variable,  $z$ , that is perfectly correlated with productivity and that is initially observed by only the econometrician. For even greater simplicity, we suppose that there are only two periods. In period 0, firms do not observe  $z$  and therefore pay workers on the basis of race. In period 1, firms observe  $z$  and pay workers on that basis.

In this case, the wage equation is

$$E[w_{i0}|b, z] = \beta_1 + \beta_2 b_i + 0z_i \quad (27)$$

in period 0 and

$$E[w_{i1}|b, z] = 0 + 0b_i + \beta_3 z_i \quad (28)$$

in period 1 where  $b$  is a dummy variable for black. Combining the two periods yields

$$E[w_{it}|s, b, z] = \beta_1 + \beta_2 b_i + 0z_i + \beta_4 t + \beta_3 z_i t + \beta_5 b_i t \quad (29)$$

where  $t$  is a dummy variable for period 1.

Note that, since in period 0, the market observes only race,  $\beta_1$  is the average productivity of whites and  $\beta_2$  is the average productivity of blacks. Moreover,  $\beta_4 = -\beta_1$  and  $\beta_5 = -\beta_2$ . The important point stressed by Altonji and Pierret is that, more generally, the coefficient on the black-time (or black-experience) interaction  $\beta_5$  should be positive if blacks arrive in the labor market with lower average productivity and the relative productivity of blacks and whites does not change over time. This is because employers statistically discriminate against blacks early in their career but as information about their true productivity is revealed, the weight placed on race becomes smaller.

However, Altonji and Pierret find that when they include a measure of productivity that should not be available to the market initially but should be correlated with the information the market learns over time (AFQT), the coefficient on black times experience is actually negative. Thus their results are inconsistent with a model in which wage differentials reflect average productivity differences, firms use race to infer productivity, firms learn the productivity of whites and blacks at the same rate, and the relative productivity of blacks and whites is constant over time.

In our discussion of the empirical regularities, we noted that, conditional on AFQT, the wage gap between young black and white men is higher in the NLSY97 than it was in the NLSY79. Moreover, inequality increased significantly over the period covered by Altonji and Pierret's data, which is likely to be reflected in a larger black-white wage differential. This suggests that the assumption of constant relative productivity is likely to be violated.

In light of this evidence for changing black-white relative productivity, there is a second

test implicit in Altonji/Pierret. Suppose that instead of estimating (29), we estimate

$$E[w_{it}|s, b, z] = \beta_1 + \beta_2 b_i + \beta_6 z_i + \beta_4 t + \beta_5 b_i t. \quad (30)$$

In other words, we have left out the interaction between time (or experience) and productivity. Because this important term has been left out, unlike (29), (30) cannot fit wages perfectly. The coefficient  $\beta_6$ , which would be zero in the correctly specified equation will now be between 0 and 1. If it were zero, we would fit wages in period 0 perfectly. If it were 1, we could fit wages in period 1 perfectly. Since we seek to minimize squared deviations, OLS will choose a slope between the two. This means that the wages of low productivity workers will be underestimated in period 0 (since in the “true” wage, they are not really penalized for their low unobservable low productivity) and the wages of low productivity workers will be overestimated in period 1. Since blacks are on average less productive, this implies that the estimate of  $\beta_2$  will be biased upwards and the estimate of  $\beta_5$  will be biased downwards.

Thus, if we add an interaction between the productivity measure and time to equation (30) to get (29), we would expect our estimate of  $\beta_2$  to fall and of  $\beta_5$  to rise, which is exactly what Altonji and Pierret find. Thus while their results are inconsistent with a world in which the productivity differential (conditional on other variables) between blacks and whites is constant with respect to experience but information on race is used efficiently to estimate productivity, it is suggestive of a model in which the productivity differential *worsens over time* but race is used as a factor in inferring productivity.

## 6.2 Screening Discrimination

The AP specification assumes that productivity and education affect black and white wages in the same way. Yet models of statistical discrimination typically assume that firms have more difficulty observing the productivity of blacks or learn blacks’ (or, more commonly, one abstractly defined group’s) productivity more slowly. This means that the coefficients on  $p$  and  $p*t$  should differ by race. Lang and Manove (2011) argue that statistical discrimination will also result in blacks and whites having different education coefficients. As we will discuss shortly, if the market has more difficulty assessing the productivity of blacks than of whites, then relative to whites, blacks will have less incentive to make unobservable investments and more incentive to make observable investments, and both of these outcomes can be viewed as discriminatory. Cornell and Welch (1996) introduced the term “screening discrimination”

in a setting in which employers hire the “best applicant” and therefore tend to hire workers from the group about which they have the best information. However, the term has come to describe the class of models in which differential observability of productivity leads to discriminatory outcomes.

### 6.2.1 Evidence on differential observability

Lang (1986) describes how differences in speaking and listening patterns can generate misunderstanding between blacks and whites. Jefferey Grogger (2008) examines the relation between speech patterns and wage inequalities, using audio data from validation interviews administered to respondents from the NLSY97. Excerpting samples of speech from these recordings, Grogger recruits listeners to answer questions about their perception of the speaker, including his/her race. Merging these responses with wage data from the NLSY97, he finds that black speakers whose recordings were identified as black earned about 12 percent less than whites with comparable measured skill levels.

Recent research has focused directly on whether productivity proxies not observed directly by the market are reflected more in the wages of whites than of blacks. The evidence is somewhat mixed. When interpreting this evidence it is also important to remember that all such tests implicitly assume that AFQT, the proxy used in all the studies, is an equally good predictor of black and white productivity, an assumption supported by Alexandra K. Wigdor and Bert F. Green (1991).

Peter Arcidiacono, Bayer, and Aurel Hizmo (2010) find that any ability captured by AFQT score is reflected in the initial earnings of both black and white college graduates. In contrast, among high school graduates, the effect of AFQT on earnings is initially very close to zero but rises steeply with experience. However, they find no difference in the initial level or speed of employer learning for blacks and whites. Looking at older workers with considerable potential market experience, Lang and Manove (2011) also find similar effects of AFQT on the earnings of black and white males with at least a high school diploma but find that, unlike white dropouts, black dropouts are not rewarded for AFQT.

As we pointed out in our analysis of Altonji and Pierret, if employers have more difficulty observing or learning productivity of black workers, the coefficients of  $p$  and  $p*t$  should differ across race. Joshua C. Pinkston (2006) carries out Altonji and Pierret’s analysis separately for black and white men to test this prediction. He shows that education has a greater impact on wages for black men than for white men at the start of their working careers. As predicted, as workers gain experience, the importance of education declines much more rapidly for black

than for white men although the estimates are imprecise and the difference is not statistically significant. Furthermore, the effect of AFQT scores on log wages increases with experience for black men but does not change for white men, and this difference is statistically significant. Thus Pinkston's results are consistent with lower initial observability of the productivity of black men.

### 6.2.2 Static Models

Most of the literature follows Aigner and Cain in assuming that productivity (conditional on other observables) is normally distributed with known mean and variance but that observed productivity equals actual productivity plus normally distributed measurement error. Using standard results in the statistical literature, this implies that expected productivity given the signal is a weighted average of mean productivity and observed productivity. The greater the variance of the measurement, the more weight that is placed on the mean and the less on observed productivity.

While there are a number of routes whereby greater uncertainty about productivity can affect wages, much of the focus in the literature has been on human capital investment. Shelly J. Lundberg and Richard Startz (1983) show that members of groups subject to more measurement error undertake less *unobservable* investment in their productivity. In essence, because the investment, itself, is not observed and blacks get less benefit from the productivity increase, they have less incentive to make such investments than do otherwise comparable whites. Consequently, even if two groups are *ex ante* identical, the one with greater measurement error will end up with lower mean productivity. Moreover, high productivity blacks will be hurt the most.

However, there is a long literature going back to Arrow and Spence that argues that if productivity is difficult to observe, productive workers will have an incentive to invest in *observable* signals of their productivity. Lang and Manove (2011) have investigated the case where investment is observable and show that the group with more measurement error will over-invest more in the observable signal. They provide evidence that among blacks and whites with similar AFQT scores and educational attainment at the time of taking the AFQT, blacks go on to get more additional education. If blacks get more education than whites of similar ability do, then at a given level of education, blacks will be less able than whites are and will receive lower wages. However, conditional only on ability and not education, blacks' higher educational attainment should raise their wages.

Therefore, to explain why blacks earn less conditional on ability and why the wage gap

is larger when we also control for education requires a combination of the Lundberg/Startz and Lang/Manove arguments. However, combining these two models is likely to run into problems. When there are only observable investments, overinvestment tends to increase with innate ability. This happens because the least able worker has no incentive to signal his (low) ability while very able workers have to overinvest more to distinguish themselves from the somewhat able. Moreover, to the extent that ability and unobservable investments are complements, we would expect underinvestment of this form to be more severe among the more able. Thus a hybrid model would tend to falsely predict that the black-white wage gap should increase with education.<sup>29</sup>

One way to solve this problem is to assume that education affects the information structure. Arcidiacono, Bayer and Hizmo (2010) find that the market knows all the information included in AFQT when college graduates enter the labor market. Consistent with this finding, Lang and Manove (2011) assume that  $\lambda$  increases with education and that there is no *asymmetric* information between the worker and employers at a sufficiently high level of education. Based on this assumption, they predict that blacks and whites with high and low levels of ability will have similar levels of education but that blacks with intermediate levels of ability will get more education than do comparable whites. Using AFQT as a proxy for ability they confirm this prediction.

They also predict that blacks and whites will have similar wages at high and low levels of education. Allowing for unobserved investments would not change the prediction for those with high levels of education since at high levels of education productivity is fully revealed and thus investment is efficient. However, at low levels of education, blacks would do less unobservable investing.

One major objection to statistical discrimination models is that the market learns worker productivity much too quickly (Lange, 2005) for educational signaling and statistical discrimination to be important in the long run. We have not developed a realistic calibration of a model with both observed and unobserved investment and in which the market learns productivity quickly. But it is straightforward to create large differences in a simple and unrealistic model.

To see this, suppose that workers can get either 0 units (uneducated) or 1 unit (educated) of education. A unit of education is completely unproductive. However, there is an unobservable investment that is productive. Further assume that the market can ob-

---

<sup>29</sup>Our wording is deliberately cautious. There may be assumptions that do not produce this prediction. We do not know what would happen, for example, if error terms were not normal, education were treated as discrete or there were other departures from the standard model.

serve perfectly the productivity of all whites and of educated blacks but cannot observe the productivity of uneducated blacks at all and thus pays the same wage to all uneducated blacks. It should be evident that all whites will be uneducated since there is no benefit from education and each will choose the optimal level of the unobserved investment since their productivity is observed even though their investment is not. It is easy to choose parameters in which all blacks choose to become educated. Conditional on being educated, blacks also choose the optimal level of unobserved investment. However, because they invest in education and therefore spend less time in the labor force, the optimal level of unobserved investment is lower for blacks than it is for whites. Note also, that *in equilibrium* the market learns productivity immediately; hence learning is indeed very fast.

Thus static models of screening discrimination can explain some key empirical regularities. Most notably, they show how black men earn less than apparently similar white men but that this differential disappears at high skill levels. Furthermore, these models explain a rather surprising pattern of education differences between apparently similar blacks and whites. What we have not established is whether a more realistic model with modest differences in the market's ability to observe the productivity of blacks can generate empirically relevant differences in education and earnings.

### 6.2.3 Dynamic Models

We have already noted that the black-white wage gap has increased over time in the NLSY79. In addition, there is considerable underrepresentation of blacks at the highest occupational levels. David Bjerck (2008), for example, points out the very low representation of blacks among baseball managers. It is unclear whether the trends in the NLSY79 represent experience or time effects, and, as discussed earlier, the labor market performance of highly skilled blacks is similar to that of their white counterparts. Nevertheless, it is interesting to explore the implications of screening discrimination for the evolution of job assignment over the life-cycle. Although they are quite different in their formal models, the underlying mechanisms in Bjerck and Altonji (2005) are similar, and we will focus on the former.

The essential assumptions behind both models are that 1) jobs are differentially responsive to skill so that it is beneficial to match workers to the job appropriate to their skill level, 2) higher level (more skill responsive) jobs are more informative about a worker's true productivity, and 3) that firms can only commit to wage offers, not to particular job placements. In Altonji, workers whom the market believes are more highly skilled are initially placed in higher level jobs, are appropriately matched faster and therefore increase their

earnings faster.

In Bjerck's model, there are two skill levels, high and low, and three job levels, low, career and director. Low-skill workers are most productive at the lowest jobs and least productive at the director jobs while the opposite is true for high-skill workers. This ensures that there will be two critical levels of beliefs,  $p$ , about skill level such that the expected productivity of those with  $p < p_1$  is highest in the low jobs,  $p_1 < p < p_2$  is highest in career jobs, and  $p > p_2$  is highest in director jobs. Since  $p$  (or the information needed to derive it) is common knowledge, firms can commit only to a wage and not to a job assignment, and workers are fully mobile, firms will always assign workers to the job in which they have the highest expected productivity based on current information.

We can immediately see how in a model of this type initial information can affect future earnings. In an extreme case (which Bjerck does not assume), low jobs would provide no information. In this case, any worker who entered the labor market with  $p < p_1$  would remain in a low job forever. Suppose that  $\bar{p} < p_1$  for both blacks and whites but employers cannot distinguish among new black entrants and therefore assign them all  $p_b = \bar{p}$ . In contrast, the market recognizes two types of whites, those with  $p_a < \bar{p}$  and those with  $p_1 < p_c < p_2$ . It will assign all black workers (with  $p_b$ ) and all white workers with  $p_a$  to low jobs where they will remain forever, and all white workers with  $p_c$  to career jobs. The greater initial information about white workers will not only give them higher initial wages since they are better matched initially, but the wage differential will grow over time as information about the whites initially assigned to career jobs accrues and they are increasingly better matched. In this extreme example, only whites initially assigned to career jobs ever make it to the top level.

Bjerck's model is less extreme because he allows the market to continue to learn about worker productivity even when the worker is employed in a low job. Nevertheless, the intuition remains the same. If either the mean  $p$  is lower for blacks than for whites or the market acquires information about whites more rapidly, then it will take the best whites less time to reach the top jobs than it takes equally skilled blacks. Equivalently, blacks will be underrepresented in these jobs relative to their proportion among the highly skilled.

#### 6.2.4 Concluding Remarks

The models discussed in this section focus almost exclusively on wages. In principle, statistical discrimination could affect hiring and thus employment and unemployment. Thus, in Cornell and Welch (1996), firms hire the best worker who applies, and because employers

are less able to assess the productivities of blacks than they can the productivities of whites, as long as there is some probability of having more than one white competitor for the job, black applicants have less than a proportional chance of getting the job. However, they do not embed this in a model of job search. Lang, Manove and Dickens (2005) note in passing that greater uncertainty about the productivity of blacks can generate the preference for white applicants assumed in their model but do not analyze the combined model formally. Therefore, thus far, this literature has provided very little insight into racial differences in unemployment incidence and duration except that we have suggested that in a dynamic version of the model, blacks might accept lower wages in order to be in jobs that better reveal their productivity, which could, in turn, result in their being fired more frequently.

However, the screening discrimination literature has recognized the importance of within-group heterogeneity. Variants of the model can not only produce large wage differentials but explain important patterns such as the larger gap among relatively low-skill workers and differences in education between blacks and whites.

## 6.3 Rational Stereotyping

The second strand of statistical discrimination examines how employers' stereotypes about the productivity of the members of a particular group differentiates firms' hiring, job assignment, wage, and/or promotion decisions across worker groups even when the groups are ex-ante equally productive. Building on Phelps (1972) and Arrow (1973), Coate and Loury's (1993) work on self-fulfilling stereotypes serves as the foundation for much of the recent work in this strain of labor market discrimination models. Since the underpinning assumption of these models is that employers hold negative beliefs about the quality of black workers, we begin this section with a little survey and experimental evidence demonstrating the existence and persistence of stereotypes. We then build upon Coate and Loury's basic framework to introduce dynamic models of self-fulfilling beliefs with implications for promotion.

### 6.3.1 Negative Stereotypes and Their Persistence

There is considerable evidence that employers have negative perceptions of inner-city black men.<sup>30</sup> The 1988 Urban Poverty and Family Life Study's survey of 179 Chicago employers revealed that many employers described inner-city black males as uneducated, irresponsible,

---

<sup>30</sup>See Harry Holzer (1996), Philip Moss and Chris Tilly (2001), Joleen Kirschenman and Kathryn Neckerman (1991), Monica Birenat and Diane Kobrynowicz (1997), Wilson (1996), and Devah Pager, Bruce Western, and Bart Bonikowski (2008).

unreliable, and dishonest (Wilson, 1996). Of the employers surveyed, 74 percent expressed negative views of inner-city black men, asserting that inner-city black workers bring traits that negatively influence job performance. Interestingly, these negative views of urban black men were not limited to white employers. Of the fifteen employers surveyed who were African American, twelve expressed views that were negative, suggesting that these perceptions are not driven by employers seeking to justify their racial animosity. This conclusion is reinforced by the fact that the majority of employers showed positive attitudes toward black women (Wilson, 1996).

Moss and Tilly (2001) document similar perceptions of black workers from a multi-city telephone survey of managers of roughly 8,000 firms in Atlanta, Boston, Detroit, and Los Angeles between 1992 and 1995. Depending on the city, 15 to 33 percent of the employers said that blacks lag in hard skills, interaction skills, or motivation.

It is not hard to understand how such stereotypes could have arisen. For much of U.S. history, blacks faced strong obstacles to obtaining human capital in the form of *de facto* or *de jure* school, housing and social segregation. And this segregation would also have limited their ability to adopt white speech patterns and other aspects of social behavior. However, while segregation and other obstacles have not disappeared, they have certainly diminished. Wouldn't we expect blacks to have dramatically increased their investment in human capital and other skills?

Rational stereotyping models explain that such stereotypes can be self-enforcing so that because employers hold negative views of them, blacks are less likely than are whites to invest in the requisite skills for good jobs, and because blacks are less likely to invest, employers' negative views are justified.

Roland Fryer, Jacob Goeree, and Charles Holt (2001) demonstrate the persistence of negative stereotypes in a classroom experiment in which workers have the choice of investing to raise their productivities. Employers observe a test outcome (red or blue) with blue being more likely if the worker invested. Purple workers draw their cost of investment from a distribution with a higher mean for the first 10 rounds of the experiment and from the same distribution for the following 50 rounds. Having observed the worker color and the test outcome, the employer must decide whether to hire that worker or not. The results show that purple workers were less likely to invest and get hired and this rational negative stereotyping on hiring and investment remained *even after* the investment cost distributions were equalized. We turn now to models in which such stereotypes can persist.

### 6.3.2 Coate and Loury’s Model of Self-Fulfilling Stereotypes

Coate and Loury (1993) demonstrate that even when whites and blacks are ex-ante equally productive, employers’ negative beliefs about black workers can be perpetuated by the workers’ investment decisions when that investment is difficult to observe. While Coate and Loury is well-known, it is worth discussing here since it serves as the framework for more recent models of self-perpetuating beliefs. This is a model of job assignment rather than wage determination although wages can be incorporated into the main model without much complication.<sup>31</sup>

There are many workers and firms. Workers belong to two identifiable groups: black and white. The workers also are differentiated by their cost of investment  $c$ , which in the original paper is exogenously drawn from  $U[0, 1]$ . After observing his cost of investment, the worker makes a dichotomous investment decision before entering the labor market, choosing to invest (“qualified”) or not to invest (“unqualified”).

Firms can observe the worker’s group membership, but not whether the worker has invested. Instead, they observe a noisy signal  $\theta$  which depends on the worker’s investment decision. The cdfs of the signals for qualified and unqualified workers are given by  $F_q(\theta) \leq F_u(\theta)$  so that higher values of the signal are more likely if the worker is qualified. Having observed the worker’s group and his signal  $\theta$ , the firm’s only decision is whether to assign him to one of two tasks: easy ( $E$ ) or hard ( $H$ ).

Productivities are such that it is optimal to assign unqualified workers to the easy task and qualified workers to the hard task. If there is uncertainty about whether a worker is qualified, then there is a critical probability that the worker is qualified, above which he should be assigned to the hard task and below which to the easy task. Workers receive a wage of  $w$  if they are assigned to the hard task. The wage and the firm’s net return from assigning workers to the easy task are normalized to zero. In the example below, we will endogenize the wages since we believe this adds further insights.

Firms have a prior belief  $\pi \in [0, 1]$  that a worker is qualified. This belief may depend on group membership. Based on the signal  $\theta$ , firms update their initial beliefs. Hence, for a given  $\pi$ , there will be a critical value of the signal such that the worker will be assigned to the hard task if and only  $\theta$  exceeds this value. We write this as

$$s = s^*(\pi). \tag{31}$$

---

<sup>31</sup>For example, see the numerical example presented in Lang (2007) pages 277-280.

$s$  is decreasing in  $\pi$ , meaning that the better the prior belief, the lower the required signal for assignment to the hard task.

Given this signal standard, workers must decide whether the expected benefit of investment is greater than his cost or

$$w[F_q(s) - F_u(s)] > c. \tag{32}$$

If  $c \sim U[0, 1]$ , a fraction  $\pi^* = w[F_q(s) - F_u(s)]$  will become qualified given  $s$ . Given the assumptions about the distribution of  $\theta$ , the fraction of qualified workers is initially increasing then decreasing in  $s$ .<sup>32</sup>

In equilibrium, the firm's prior beliefs about the fraction of qualified workers are confirmed by the investment decisions of the workers. Therefore, we can define the equilibrium pair of prior beliefs  $(\pi_w, \pi_b)$  as those solving

$$\pi_g = w[F_q(s^*(\pi_g)) - F_u(s^*(\pi_g))] \tag{33}$$

for  $g \in \{w, b\}$ .

A discriminatory equilibrium can occur whenever (33) has multiple solutions. Then employers can believe that blacks are less likely to have invested (i.e.  $\pi_w > \pi_b$ ), and knowing that employers hold such a negative stereotype, workers confirm the employers' beliefs by their investment decisions. Even though both blacks and whites have the same skill and investment cost distribution, firms prior beliefs actually produce groups of different productivity.<sup>33</sup>

---

<sup>32</sup>This is easiest to see if there is no signal that is observed only if the worker is qualified or only if the worker is unqualified, that is any signal can be produced by either a qualified or unqualified worker. In this case, whenever  $\pi$  is 0 or 1, no worker invests since the posterior belief will always still be 0 if  $\pi$  is 0 and 1 if  $\pi$  is 1. For other values of  $\pi$ , there will be a positive return to investing and workers with a sufficiently low cost of investing will do so.

<sup>33</sup>Andrea Moro (2009) and Moro and Peter Norman (2004) have criticized the linearity of the production technology in Coate and Loury which implies that the expected marginal productivities of workers depend only on their own signal and the aggregate investment of their own group. Moro argues that in this environment, statistical discrimination only arises as a result of a type of coordination failure in which the minority group fails to coordinate on a "good" equilibrium. The dominant group has nothing to lose if the disadvantaged group could solve the coordination failure. Moro and Norman consider a production function that exhibits complementarity between the two tasks. Hence, the expected marginal product in the high-skill job of a given worker depends negatively on aggregate investment in human capital from members of the other group, because when more members of the other group acquire human capital, the higher aggregate availability of skills decreases the marginal product of a skilled worker. Therefore, the incentive to acquire skills decreases when more members of the other group acquire skills. The complementarity generates incentives for groups to specialize and asymmetric equilibria may exist even if there is a unique symmetric equilibrium.

Table 1: Rational Stereotypes with Endogenous Wages: Example

	Signal Distribution		Posterior $P(\text{qualified})$		Task Assignment	
	Unqualified	Qualified	High Prior	Low Prior	High Prior	Low Prior
L	.7	.1	.16	.10	E	E
M	.2	.4	.72	.61	H	E
H	.1	.5	.87	.79	H	H

To better clarify the workings of the Coate/Loury model, we present a simpler example. Workers emit three signals L, M and H with probabilities given in table 1. There are three costs of investing. Approximately 43.7% of workers are low cost and the same proportion are high cost while the remainder are medium cost. If firms believe that both low and medium cost workers get qualified, their posterior beliefs given the signal are given in the column labeled “high prior.” If they believe only low cost individuals invest, their posterior belief is given by the column labeled “low prior.”

Suppose now that the productivities of qualified and unqualified workers in the easy and hard jobs is such that it is optimal to assign a worker to the hard job if the probability he is qualified is at least two-thirds. Then, with the high prior, firms will assign all those workers with a signal of M or H to the hard task, but with the low prior will require a signal of H.

Note that with a high prior, investing raises a worker’s probability of being place in the hard task from .3 to .9 or 60 percentage points, while with the low prior the figures are .1 and .5 or 40 percentage points. With exogenous wages,  $w_E$  and  $w_H$ , we will have two equilibria if the costs of investing satisfy

$$\begin{aligned}
 c_l &< .4(w_H - w_E) < c_m \\
 &< .6(w_H - w_E) < c_h.
 \end{aligned}
 \tag{34}$$

In this case, low-cost workers always and high-cost workers never invest but those in the middle invest in the high-prior but not the low-prior equilibrium.<sup>34</sup>

We have cooked the numbers to make it easy to endogenize the wage. The fraction of workers assigned to the hard task who are actually qualified is .795 with either prior. Therefore, if the wage cannot be conditioned on the signal,  $w_H$  is independent of the equilibrium. If all workers are equally productive in the easy task,  $w_E$  is also independent of the equilibrium. Condition (34) applies, and one must simply choose  $c_m$  and productivities for unqualified and qualified workers in each job to ensure that it holds. Of course, in the

---

<sup>34</sup>We ignore the equilibrium in which firms believe that no one invests and in which there is no investment.

high-prior equilibrium firms should be willing to pay more to workers with an  $H$  signal than to those with an  $M$  signal. In this case (34) firms would no longer apply, but choosing parameters to ensure the existence of two equilibria remains straightforward.

The model predicts that blacks should earn less than whites do both unconditionally and conditional on the signal. It further predicts that the wage differential should be highest at an intermediate level of the investment cost distribution where blacks are not only paid less conditional on their signal but also invest less. Finally, it makes no prediction regarding wages conditional on job assignment.

Therefore, one concern about the static rational stereotype model is the relation between its predictions about wages and the empirical regularities. The model does explain why blacks earn less than observationally equivalent whites *if the “equivalent factors” are not proxies for the cost of investment or the signal*. If, for example, we interpret AFQT as a proxy for investment costs, the model does not predict the convergence on earnings at high, and possibly low, AFQT. On the other hand, we might choose to interpret AFQT as a proxy for the unobserved investment, in which case the model predicts counterfactually that the effect of AFQT on wages would be smaller for blacks than for whites.

Perhaps the most important contribution of Coate and Loury is its discussion of affirmative action which they define as a policy that requires workers from each group to be assigned to the hard task in proportion to their representation in the overall worker population. They show that under some conditions, a “patronizing equilibrium” exists. In this equilibrium, firms’ negative stereotypes worsen as a result of affirmative action. Because firms believe that black workers are less qualified on average, they set a lower standard for blacks to meet the affirmative action requirement. Under certain parameters, this further reduces the investment incentives of the black workers, and they will be even less qualified than before the anti-discriminatory policy was in place. A patronizing equilibrium is most likely to occur when blacks make-up a small proportion of the population, because the expected cost of lowering the standard for blacks is smaller than raising the standard for whites to achieve parity.

Before moving on to dynamic versions of the model, we make a few closing remarks that apply generally to the static and dynamic models.

1. We note that the general message of the Coate/Loury model is that investment by each member of a group provides positive externalities to all group members. It is not obvious that this is true when the groups are different *ex ante*. It is relatively easy to construct examples in which if more blacks have a high cost of investing, some

blacks who would not invest if they were white will invest in the hope of distinguishing themselves from the mass of noninvestors.<sup>35</sup> This is important because the underlying assumption in the rational stereotyping literature is that there would be no differences between blacks and whites in the absence of employers' stereotypes. Once premarket factors, including premarket discrimination, affect the skills workers bring to the labor market, it is no longer self-evident that negative stereotypes are harmful. Instead the model is consistent with the view that "if you're black, you have to work twice as hard to get ahead" is motivating rather than demotivating.

2. As we discussed in the case of screening discrimination, the assumption that all investment is unobserved may be critical. It seems likely that blacks would have a greater incentive than whites to signal that their cost of investment is low. Whether allowing an additional signal would eliminate multiple equilibria or otherwise substantially alter the model has not been explored.
3. Because group membership is so important for the model, it is problematic that how groups are defined is arbitrary and changes over time. Many of the stereotypes discussed earlier in this section applied to inner-city black men. Can individuals remove themselves from this group by moving from the inner city or by changing dress or speech style? More broadly, the definition of white has changed over time to include southern Europeans who were not clearly "white" a century ago.

### 6.3.3 Models with Promotion

This negative summary is somewhat mitigated by the existence of models of promotion. If the initial hiring equilibrium is discriminatory, firms believe that black workers are less likely to have invested and will set a higher signal standard for black workers to be assigned

---

<sup>35</sup>Suppose 80% of white workers have a very low cost of investing and 20% have a cost of 4. In contrast, 80% of blacks have a very high costs of investing and 20% have a cost of 4. Further assume that qualified workers give off a high signal half the time and a low signal half the time while unqualified workers give off the high signal only 10 percent of the time and the low signal 90 percent of the time. Finally assume that workers in the easy task produce 0, qualified workers in the hard task produce 10 and unqualified workers in the hard task produce -2. For whites, the unique interior solution is that workers with the low cost invest and those with a cost of 4 do not. All workers are assigned to the hard task but those with the high signal earn about 3.1 more than those with the low signal. For blacks the unique interior solution is that those with a cost of 4 invest while the high cost types do not. Those with an  $L$  signal are assigned to the easy task and earn 0. Those with an  $H$  signal are assigned to the hard task and earn about 4.7. Note that because a higher proportion of blacks than of whites with the high signal are unqualified, blacks are worse off both conditional on their signal and conditional on being assigned to the high task, but the externality increases their incentive to invest.

to the harder task. Because the blacks who invest are drawn from a lower part of the cost distribution, among those placed in the hard task, the distribution of costs can be lower for blacks than for whites. In the example in Table 1 above, almost 80% of blacks promoted have a low-cost of investing compared with less than half of the whites.<sup>36</sup> This suggests that employers might believe that blacks assigned to the hard task are more likely than are whites to continue to invest in themselves after being assigned to the hard task and therefore be more likely to receive subsequent promotion.

Fryer (2007) shows that such belief-flipping equilibria can exist if there are very strict hiring standards at the hiring and liberal promotion standards. If firms do not gain much from promoting a qualified worker (instead of leaving him in the lower level job), then they are less likely to take risks in the promotion stage and may adopt a very strict standard for both blacks and whites. However, if the gains from promotion are too large, then firms are likely to be very liberal in their promotion standards for both worker groups. Only for intermediate values of profit margins can we have strict hiring standard for blacks and liberal hiring standards for promoting blacks in equilibrium.<sup>37</sup> Thus Fryer's model has potentially testable empirical content, but we are unaware of any attempts to test it.

In Fryer, blacks are over-represented in the easy job but can, under some conditions, also be over-represented in the highest jobs. Jee-Yeon K. Lehmann (2011) examines law firms and finds a very different situation. Conditional on measured characteristics, most notably law school quality and grades, blacks are more likely to be hired into the most prestigious entry-level jobs but are less likely to be promoted. However, conditional on being assigned tasks, such as meeting with clients and planning strategy, that further promotion, black and white associates are equally likely to be promoted to partner.

She shows that this can be the direct outcome of an anti-discrimination or affirmative action policy in which the managing partner or some other central group controls initial hiring, but task assignment is decentralized to the partners working with individual associates. The central hiring committee may want more black associates or may be willing to "take a chance" in order to have more black partners, but individual partners put less weight on the collective goal. Knowing the hiring committee's behavior, individual partners require a higher signal in order to be willing to assign black associates to the more challenging tasks.<sup>38</sup>

---

<sup>36</sup>Note that because investment decisions in the first stage would take account of the possibility of future promotion, to maintain the one-period equilibrium as the equilibrium of the two-period game, we would have to adjust some of the parameters, but that is straightforward.

<sup>37</sup>Like Coate and Loury, Fryer does not endogenize wages, but it seems unlikely that this would greatly affect the results.

<sup>38</sup>While the main conclusions of the model are not limited to the market for lawyers, Lehmann motivates

### 6.3.4 Concluding Remarks

The strength and weakness of the rational stereotype models is that they can explain the persistence of discrimination between groups with no underlying differences. Thus, one does not need to rely on strong or weak prejudice or difficult to verify differences in the ability of the market to evaluate workers. But it is not clear that the mechanisms underlying the rational stereotype model are operative when there are real underlying differences between the groups. Indeed the effect of these real differences on firms' inferences and workers' incentives seems to us to be one of the largely unexplored areas in the theory of race discrimination. As we have noted, it seems to us that if, for example, a higher proportion of blacks than of whites has a high cost of investing, blacks could either have less incentive to invest because they cannot shift employers' beliefs that they are unskilled or more incentive because there is more value in distinguishing themselves from the large mass of unskilled workers.

We have also noted the limited empirical content of the rational stereotype model. It is sufficiently flexible to support higher or lower promotion rates for blacks, and it is unclear for what one should control to test any predictions about wages. This is reflected in the near absence of tests of the model and most of the few tests that have been conducted are based on experiments that do not allow interdependencies between and among worker and firm actions that are required for the existence of multiple equilibria.<sup>39</sup>

## 7 A Note on Audit Studies

There is an extensive set of "audit" studies examining race discrimination in various settings. While it might have been natural to discuss these in the context of the empirical regularities, it is helpful to review them in the context of the theories.

In the employment context, the audits involve applications by similar blacks and whites for identical or similar jobs. Resumes are typically randomized so that they are orthogonal to race, and when in-person applications are used, the white and black applicants are trained to act similarly. Such studies almost universally find worse outcomes for blacks than for whites. Marc Bendick (2007) reviews ten audit studies of employment discrimination on the

---

her model with evidence from the legal field in which firms typically act institutionally in hiring but leave work assignments to individual partners.

<sup>39</sup>One purported test is really a test of a two-armed bandit theory. Do subjects recognize that the probabilities for the "other arm" have improved. Since the probabilities simultaneously deteriorate on the "current arm," it is not surprising that they experiment and learn about the change. Another essentially asks whether subjects invest more when the incentive to invest is higher.

basis of race. All find better outcomes for whites than for blacks although the differences are not always statistically significant at conventional levels. One important point that is sometimes missed is that even if such studies reveal discriminatory behavior, they do not tell us whether it is motivated by prejudice or by statistical discrimination. Therefore, they are generally not helpful for distinguishing among the theories discussed in this paper.<sup>40</sup>

Using human beings to audit employers inevitably raises the concern that the auditors' behavior or appearance (other than race) differed in ways that biased the study. Economists, at least, appear to prefer studies in which this element is removed. Two studies (Bertrand and Mullainathan, 2004; LeeAnn Lodder, Scott McFarland and Diana White, 2003) rely on written applications and resumes with names that signal race without explicitly stating it. In addition, Marc Bendick, Charles Jackson, and Victor Reinoso (1994) cite a study that uses involvement in organizations (e.g. the NAACP) to signal race. Bertrand and Mullainathan assigned each resume a common white name (such as Emily and Greg) or a distinctively African-American-sounding name (such as Lakisha and Jamal). They sent fictitious resumes in response to newspaper help-wanted ads in Chicago and Boston and measured the call back rates for interviews. Overall, 9.7% of the "applicants" submitting resumes with white-sounding names were called back for an interview compared to only 6.5% of the applicants with black-sounding names. Furthermore, African-Americans experienced a significantly smaller increase in the callback rates for improvement in their credentials.<sup>41</sup> Lodder, McFarland and White (2003) obtained similar results. Apparently black applicants received calls for interviews 26% of the times compared with 31% for white applicants. However, unlike the former study, the latter did not find that resume quality benefits whites more than it does blacks.

In contrast, Fryer and Stephen Levitt (2004) look directly at the effect of having a distinctively black name on adult outcomes of blacks. They find worse outcomes for those with black names but note that black names are also associated with lower maternal education and income. When they control for mother's socioeconomic status, Fryer and Levitt find that the relation between adult outcomes and names is socially inconsequential.

---

<sup>40</sup>In their discussion of their results, Bertrand and Mullainathan (2004) also note that both statistical and taste-based models of discrimination could be formulated to fit the results from their audit study. For example, the finding that employers located in more African American neighborhoods are less discriminating is consistent with both models based on employer/customer prejudice in a neoclassical or search framework.

<sup>41</sup>There are a number of concerns about audit studies in general and the use of names, in particular. In particular, names may signal more than just race. However, since our focus here is on the relation between theory and the audit studies, we have not undertaken a full review of the approach. For further discussion, see Heckman (1998) and Lang (2007, pp 294-7).

There are at least three reactions to this body of research. The first is that it shows that names in the audit study were merely signaling social class. We think this is incorrect. If employers are less likely to interview applicants with black names because they are signaling social class, then even high social-class blacks with black-sounding names (and those who are more likely to be higher ability and more likely to get an interview) should also be less likely to get an interview. Then, even controlling for social class, this would mean that individuals with distinctively black names should face worse outcomes.

The second reaction is that it proves that discrimination by some employers has no harmful effects. Even if 15 to 30 percent of employers discriminate, 70 to 85 do not, and this is sufficient to ensure that there is no discrimination at the level of the market. Either information about which employers discriminate is sufficiently widespread that blacks do not apply to them, or the job search process is sufficiently fast and low cost that a modest reduction in the arrival rate of offers is inconsequential. According to this perspective, this group of studies proves the validity of the Becker model.

Finally, if an important minority of employers discriminates against blacks, then having a black-sounding name could be harmful or beneficial. Individuals with black names would get fewer interviews but if the discriminating employers would never hire blacks anyway, this is a benefit since the interview time can be used more productively. On the other hand, if the discriminating employers are not infinitely prejudiced, some fraction of the time, they will decide that the black interviewee is the best candidate and not being called for an interview will be costly. It is not clear *a priori* which effect should dominate. According to this view, the audit study shows that there is discrimination against individuals with black-sounding names, and the Fryer-Levitt study shows that the reason they suffer discrimination is because they are black, not some other reason.

We do not attempt to choose between the last two views. Our point is that the choice of theory is very important for interpreting the studies. If we analyze them in the light of the Becker model, they suggest that the fraction of discriminating employers is sufficiently small that the market has, in most contexts, eliminated discrimination. If we analyze them using a perspective based on Black or Lang, Manove and Dickens, this degree of discrimination can produce quite notable wage differentials. As we have already discussed, if 30% of firms will not hire a black, then, using Black's model, we can get close to the unemployment duration differential and easily explain the existing wage differentials. As already discussed, LMD cannot fit the unemployment duration data. However, it can easily produce a 10% wage differential with only a very modest proportion of discriminating firms.

## 8 Towards A Synthesis

Readers will, of course, have their own preferences for models of unemployment. Some may find lower wages as sufficient to explain unemployment among blacks since lower wages will make blacks more likely to choose leisure or home production over market work. We find it hard to believe that blacks are more likely to enter unemployment and to remain there longer than apparently comparable whites because they find it optimal to take longer and more frequent vacations although we recognize that others disagree.

Therefore, the higher incidence of unemployment among blacks suggests to us that we require a model in which blacks are more likely to take jobs for which they turn out to be poorly suited. We have already suggested that Rosen's model could be reformulated so that workers receive a signal of the probability that they are well matched for a job. In her equilibrium, they would set a lower reservation probability and therefore be more likely to discover that the match is not good. It is also possible that, for many of the same reasons used to justify the assumption that firms are less able to evaluate black applicants, blacks are less able to judge how well they are matched to individual jobs. This would both justify a preference on the part of firms for hiring whites and explain why blacks are more likely to exit employment for unemployment. Similarly, if firms have greater difficulty evaluating black applicants, it is plausible that they will prefer to hire whites and when they hire blacks will be more likely to have "made a mistake" although we suspect that this will depend on the details of the model.

The longer unemployment durations among blacks suggest to us that search must be an element of any model of discrimination. But we have argued that the model must generate the differences from modest levels of discrimination. We have seen that models in which longer unemployment durations are driven by the presence of firms with strong discriminatory tastes require an implausibly high proportion of discriminatory firms to generate empirically relevant duration differences. Therefore, we are inclined towards search models in which firms choose the "best" applicant and in which blacks and whites apply for the same jobs at least some of the time. We have noted that, as in the case of Lang, Manove and Dickens (2005), simply having firms hire whites in preference to blacks need not generate longer unemployment durations for blacks if blacks avoid applying to jobs to which whites apply. There are a variety of mechanisms that will generate direct competition between blacks and whites. The simplest is random search since there is no opportunity for avoiding direct competition. However, directed search models can also produce such competition if there is sufficient worker and/or firm heterogeneity of the right type such as differences in risk

aversion or discount rates among workers.

Within a random search model, poorer assessment of the job match by either firm or worker should produce a wage differential. Given that Rosen's model can produce an empirically plausible wage differential, we expect that a revised version of the model would as well. Directed search can only simultaneously match the unemployment and wage differentials if there is some, but not complete, overlap in where whites and blacks apply.

We have already seen that differences in the observability of the productivity of black and white workers can generate wage differentials in models without search. Adding search might increase the differentials in some models. Moreover, if information improves with skill, we can explain the convergence in labor market outcomes of high-skill whites and blacks.

## 8.1 Implications for Policy

Since we have concluded that none of the existing models of race discrimination in the labor market explains the major empirical regularities, it should not be surprising that we are reluctant to draw strong policy conclusions from the existing literature. Nevertheless, policy-makers will not wait for economists to solve the puzzle of labor market discrimination before acting, and we do believe that the current literature provides at least some guidance.

First, much of the difference in labor market outcomes between blacks and whites undoubtedly reflects the skills workers bring to the labor market. The models we have discussed, especially those with dynamic elements, show how premarket investment decisions may be affected by expectations about how workers will be treated in the labor market. Therefore, labor-market oriented policies can affect these investments.

Still, it would be foolish to ignore policies that directly affect premarket factors. Addressing such factors as neighborhood and school segregation (Edward Glaeser and David Cutler, 1997; William J. Collins and Robert A. Margo, 2000; David Card and Jesse Rothstein, 2007) appears to be important, possibly because segregation perpetuates differences in networks, speech patterns, and modes of interactions that underlie models of screening discrimination. To the extent that segregation and/or other factors create information problems emphasized by models of statistical discrimination, it is intuitive to look to policies that can reduce these information disparities.

Generally, since employers appear to have fairly good information about college graduates, the focus of such efforts should be on those entering the labor market directly after high school graduation or after dropping out. For example, building relations between the labor market and guidance counselors in schools with large minority populations might reduce

labor market discrimination. More generally, providing potential employers with timely and accurate information about high school performance would create incentives for students to invest in themselves. It is striking that Massachusetts, which has put considerable resources into developing high school exit exams that are generally viewed as among the best in the country, does not allow performance indicators from these exams to be placed on student transcripts. Instead, they can only be used to permit or deny graduation, thereby preventing high school dropouts from establishing their strong performance on statewide exams and students who would otherwise have graduated from high school from having their accomplishments confirmed by a recognized form of certification.

On the employer side, information may be improved by affirmative action policies that require more outreach and more thorough evaluation of candidates. Holzer and David Neumark (2000) survey employers to assess how affirmative action influenced their recruiting and hiring practices. Firms engaging in affirmative action tended to recruit and screen more extensively, casting a wider net across all worker groups, a finding confirmed by Alexandra Kalev, Frank Dobbin, and Erin Kelly (2006). These firms also had more formally defined, careful evaluation practices for their job applicants and employees that paid less attention to traditionally stigmatized worker characteristics (e.g. welfare reciprocity).<sup>42</sup>

Furthermore, consistent with the models that we have discussed, they find that firms using affirmative action had a greater proportion of minorities in their workforce, showed greater willingness to hire minorities, and received more minority job applications. Screening discrimination should be less important in firms that acquire more information, particularly about African-American candidates. To the extent that potential applicants are aware that mechanisms are in place to improve the quality of evaluation and to reduce any effects of weak prejudice, minorities should be more likely to apply to such firms. Both factors will increase the actual hiring rate and increase the productivity of the workers who are actually hired.<sup>43</sup> Holzer and Neumark find that the performance ratings of blacks who are hired are higher in firms using affirmative action, but they do not find effects on whites, and they find adverse effects on Hispanic men.

---

<sup>42</sup>They were also more likely to provide training after hiring. This could reflect the greater benefit of careful screening when the firm intends to invest more in its workers or the greater return to investing in workers who have been carefully screened. Such practices appear to be complements, and it is not obvious that one causes the other.

<sup>43</sup>W. Bentley MacLeod (2003) extends the standard principal-agent model to incorporate the impact of subjective evaluations. He shows that prejudiced evaluation of an individual can lead to lower pay and performance. Hence, the adoption of a more formal evaluation process which reduces the subjective nature of performance evaluations may provide a greater incentive for workers to be more productive on the job.

However, it is important to note that there are costs to programs that create formal evaluation procedures and increase the time and effort to objectively evaluating candidates. Therefore, even if these policies can increase the productivity of their hires, firms will not necessarily adopt them voluntarily. Thus, there is a potential role for policy to increase the adoption of such programs.

A more controversial policy would encourage firms to diversify their hiring staff. Michael A. Stoll, Stephen Raphael, and Holzer (2004) show that at establishments with a black hiring officer, the proportion of black applicants is 27 percentage points higher than in establishments with a non-black hiring officer. Furthermore, they find that when the hiring officer is black, the probability that a black applicant is hired is about 20 percent higher. These differences decrease when they control for observable differences across establishment but remain significant at conventional levels. In a more recent study, Laura Giuliano, David I. Levine, and Jonathan Leonard (2009) use personnel data from a large U.S. retail firm and also find that non-black managers hire more whites and fewer blacks than black managers do. It is difficult to establish conclusively that these differences are causal, and if so, whether they reflect white hiring officers' prejudice or information/language problems. However, they suggest that the identity of the hiring officer is consequential.

The most controversial policy would set different hiring standards for blacks and whites, possibly through the use of quotas. The theoretical justification for this form of affirmative action is weak. As discussed earlier, even when blacks and whites are *ex ante* identical, affirmative action of this form can worsen rather than eliminate stereotypes. When factors outside the labor market create *ex ante* differences, setting different hiring standards can again increase or decrease the incentive for black workers to invest in themselves.

## 8.2 Concluding Remarks

Despite our finding that no single existing theory can account for the broad empirical regularities we discussed in section 3, we remain hopeful in light of the significant progress that has been made in models of discrimination over the last decade or two. The groundwork appears to have been laid for a synthesis of theories that can explain key differentials in the black-white labor market outcomes in the U.S. more completely. Exploration of such models can trigger further empirical investigations and better inform and guide policies towards reducing racial inequalities in the labor market.

# References

- Aigner, Dennis, and Glen Cain. 1977. "Statistical Theories of Discrimination in Labor Markets." *Industrial and Labor Relations Review*, 30(2): 175-87.
- Akerlof, George A. 1985. "Discriminatory, Status-based Wages among Tradition-oriented, Stochastically Trading Coconut Producers." *Journal of Political Economy*, 93(2): 265-276.
- Akerlof, George A. 1997. "Social Distance and Social Decisions." *Econometrica*, 65(5): 1005-1028.
- Akerlof, George A., and Rachel E. Kranton. 2000. "Economics and Identity." *Quarterly Journal of Economics*, 115(3): 715-753.
- Altonji, Joseph G. 2005. "Employer Learning, Statistical Discrimination and Occupational Attainment." *American Economic Review*, 95(2): 112-117.
- Altonji, Joseph G., Prashant Bharadwaj, and Fabian Lange. 2008. "Changes in the Characteristics of American Youth: Implications for Adult Outcomes." *NBER Working Paper No. 13883*.
- Altonji, Joseph G., and Charles R. Pierret. 2001. "Employer Learning and Statistical Discrimination." *Quarterly Journal of Economics*, 116(1): 313-50.
- Anderson, Donna M., and Michael J. Hauptert. 1999. "Employment and Statistical Discrimination: A Hands-On Experiment." *The Journal of Economics*, 25(1): 85-102.
- Antonovics, Kate. 2006. "Statistical Discrimination and Intergenerational Income Mobility." <http://weber.ucsd.edu/~kantonov/AAJOLE.pdf>.
- Arcidiacono, Peter, Patrick Bayer, and Aurel Hizmo. 2008. "Beyond Signaling and Human Capital: Education and the Revelation of Ability." NBER Working Paper 13951.
- Arrow, Kenneth J. 1972. "Some Mathematical Models of Race in the Labor Market. " In *Racial Discrimination in Economic Life*, ed. A.H. Pascal, 187-203. Lexington, MA.: D.C. Heath.
- Arrow, Kenneth J. 1973. "The Theory of Discrimination." In *Discrimination in Labor Markets*, ed. Orley Ashenfelter and Albert Rees, 3-33. Princeton, NJ: Princeton University Press.

- Arrow, Kenneth J. 1998. "What Has Economics to Say about Racial Discrimination?" *Journal of Economic Perspectives*, 12(2): 91-100.
- Austen-Smith, David, and Roland Fryer. 2005. "An Economic Analysis of Acting White." *Quarterly Journal of Economics*, 120(2): 551-583.
- Bayer, Patrick, Stephen L. Ross, and Giorgio Topa. 2008. "Place of Work and Place of Residence: Informal Hiring Networks and Labor Market Outcomes. " *Journal of Political Economy*, 116(6): 1150-1196.
- Becker, Gary S. 1971. *The Economics of Discrimination*, 2nd edition. Chicago, IL: Chicago University Press.
- Bendick, Marc, Jr. 2007, "Situation Testing for Employment Discrimination in the United States of America." *Horizons Stratégiques*, 3(5): 17-39.
- Bendick, Marc, Jr., Charles Jackson, and Victor Reinoso. 1994. "Measuring Employment Discrimination through Controlled Experiment." *The Review of Black Political Economy*, 23(1): 25-48.
- Bertrand, Marianne, Dolly Chugh, and Sendhil Mullainathan. 2005. "Implicit Discrimination." *American Economic Review*, 95(2): 94-98.
- Bertrand, Marianne, and Sendhil Mullainathan, Sendhil. 2004. "Are Emily and Brendan More Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination." *American Economic Review*, 94(4): 991-1013.
- Biernat, M., and Kobrynowicz, D. 1997. "Gender- and Race-based Standards of Competence: Lower Minimum Standards But Higher Ability Standards for Devalued Groups." *Journal of Personality and Social Psychology*, 72: 544-447.
- Bjerk, David. 2007. "The Differing Nature of Black-White Wage Inequality Across Occupational Sectors. *Journal of Human Resources*, 42(2): 398-434.
- Bjerk, David. 2008. "Glass Ceilings or Sticky Floors? Statistical Discrimination in a Dynamic Model of Hiring and Promotion." *Economic Journal*, 118(530): 961-982.
- Black, Dan A. 1995. "Discrimination in an Equilibrium Search Model." *Journal of Labor Economics*, 13(2): 309-333.

- Black, Dan A., Amelia Haviland, Seth Sanders, and Lowell J. Taylor. 2006. "Why Do Minority Men Earn Less? A Study of Wage Differentials Among the Highly Educated." *The Review of Economics and Statistics*, 88(2): 300-313.
- Black, Dan A., Natalia Kolesnikova, Seth G. Sanders, and Lowell J. Taylor. 2010. "The Role of Location in Evaluating Racial Wage Disparity." Federal Reserve Bank of St. Louis Working Paper.
- Borjas, George J., and Stephen G. Bronars. 1989. "Consumer Discrimination and Self-Employment." *Journal of Political Economy*, 97(3): 581-605.
- Bowles, Samuel, Glenn C. Loury, and Rajiv Sethi. 2010. "Group Inequality," Sante Fe Institute Working Paper.
- Bowlus, Audra J., and Zvi Eckstein. 2002. "Discrimination and Skill Differences in an Equilibrium Search Model." *International Economic Review*, 43(2): 1309-1345.
- Braddock, Jomills H. II. 1980. "The Perpetuation of Segregation Across Levels of Education: A Behavioral Assessment of the Contact-Hypothesis." *Sociology of Education*, 53(3): 178-186.
- Braddock, Jomills H., and McPartland, J.M. 1987 "How Minorities Continue to Be Excluded from Equal Employment Opportunities: Research on Labor Market and Institutional Barriers." *Journal of Social Issues*, 43(1):5-39.
- Brown, Charles. 1984. "Black-White Earnings Ratios Since the Civil Rights Act of 1964: The Importance of Labor Market Dropouts." *The Quarterly Journal of Economics*, 99(1):31-44.
- Card, David, and Alan Krueger. 1993. "Trends in Relative Black-White Earnings Revisited," *American Economic Review*, 83(2):85-91.
- Card, David, and Jesse Rothstein. 2007, "Racial Segregation and the Black-White Test Score Gap." *Journal of Public Economics*, 91(11-12): 2158-2184.
- Carneiro, Pedro, James J. Heckman, and Dimitry Masterov. 2005. "Labor Market Discrimination and Racial Differences in Pre-Market Factors." *Journal of Law and Economics*, 48(1): 1-39.

- Chandra, Amitabh. 2000. "Labor Market Dropouts and the Racial Wage Gap: 1940-1990." *American Economic Review, Papers and Proceedings*, 90(2): 333-338.
- Charles, Kerwin, and Jonathan Guryan. 2008. "Prejudice and The Economics of Discrimination." *Journal of Political Economy*, 116(5): 773-809.
- Charles, Kerwin K., and Jonathan Guryan. 2011. "Studying Discrimination: Fundamental Challenges and Recent Progress." *Annual Review of Economics*, 3: 479-511.
- Charles, Kerwin K., and Patrick Kline. 2006. "Relational Costs and the Production of Social Capital: Evidence from Carpooling." *Economic Journal*, 116(511):581-604.
- Clark, Kim B., and Lawrence H. Summers. 1979. "Labor Market Dynamics and Unemployment: A Reconsideration." *Brookings Papers on Economic Activity*, 1979(1): 13-72.
- Coate, Stephen, and Glenn C. Loury. 1993. "Will affirmative-action policies eliminate negative stereotypes?" *American Economic Review*, 83(5): 1220-1240.
- Collins, William J., and Robert A. Margo. 2000, "Residential Segregation and Socioeconomic Outcomes: When Did Ghettos Go Bad?" *Economic Letters*, 69(2): 239-243.
- Cornell, Bradford, and Ivo Welch. 1996. "Culture, Information, and Screening Discrimination." *Journal of Political Economy*, 104(3): 542-571.
- Darity, William A., Jr., and Patrick L. Mason. 1998. "Evidence on Discrimination in Employment: Codes of Color, Codes of Gender." *Journal of Economic Perspectives*, 12(2): 63-90.
- Dawkins, Casey J., Qing Shen, and Thomas W. Sanchez. 2005. "Race, Space, and Unemployment Duration." *Journal of Urban Economics*, 58(1): 91-113.
- DellaVigna, Stefano, and M. Daniele Paserman. 2005. "Job Search and Impatience." *Journal of Labor Economics*, 23: 527-588.
- Dickens, William T., and James R. Flynn. 2001. "Heritability Estimates versus Large Environmental Effects: The IQ Paradox Resolved." *Psychological Review*, 108(2): 346-369.

- Dickens, William T., and Thomas J. Kane. 1999. "Racial Test Score Differences as Evidence of Reverse Discrimination: Less than Meets the Eye." *Industrial Relations*, 38(3):331-363.
- Fadlon, Yariv. 2009. "Statistical Discrimination and the Implications of Employer-Employee Racial Matches." <http://people.vanderbilt.edu/~yariv.fadlon/JMP.pdf>.
- Farber, Henry S., and Robert Gibbons. 1996. "Learning and Wage Dynamics." *The Quarterly Journal of Economics*, 111(4): 1007-1047.
- Flinn, Christopher J., and James J. Heckman. 1983. "Are Unemployment and Out of the Labor Force Behaviorally Distinct Labor Force States?" *Journal of Labor Economics*, 1(1): 28-42.
- Fryer Jr., Roland G. 2007. "Belief Flipping in a Dynamic Model of Statistical Discrimination." *Journal of Public Economics*, 91(5-6): 1151-1166.
- Fryer Jr., Roland G., Jacob K. Goeree, and Charles A. Holt. 2005. "Experience-Based Discrimination: Classroom Games." *Journal of Economic Education*, 36(2):160 - 170.
- Fryer Jr., Roland G., and Paul Torelli. 2010, "An Empirical Analysis of 'Acting White'." *Journal of Public Economics*, 94: 380-396.
- Fryer Jr., Roland G., and Steven D. Levitt. 2004, "The Causes and Consequences of Distinctively Black Names." *Quarterly Journal of Economics*, 119(3): 767-805.
- Galenianos, Manolis, and Philipp Kircher. 2009. "Directed Search with Multiple Job Applications." *Journal of Economic Theory*, 144 (2009): 445-471.
- Giuliano, Laura, David I. Levine, and Jonathan Leonard. 2009. "Manager Race and the Race of New Hires." *Journal of Labor Economics*, 27(4): 589-632.
- Glaeser, Edward, and David Cutler. 1997. "Are Ghettos Good or Bad?" *Quarterly Journal of Economics*, 112( 3): 827-872.
- Glaeser, Edward, and Jacob Vigdor. 2001. "Racial Segregation in the 2000 Census: Promising News." *Brookings Institution Survey Series*.
- Greenwald, Andrew G., Mahzarin R. Banaji, Laurie A. Rudman, Shelly D. Farham, Brian A. Nosek, and Deborah S. Mellott. 2002. "A Unified Theory of Implicit Attitudes, Stereotypes, Self-Esteem, and Self-Concept." *Psychological Review*, 109(1): 3-25.

- Greenwald, Andrew G., Debbie E. McGhee and Jordan L. K. Schwartz. 1998. "Measuring Individual Differences in Implicit Cognition: The Implicit Association Test." *Journal of Personality and Social Psychology*, 74: 1464-1480.
- Grogger, Jeffrey. 2008, "Speech Patterns and Racial Wage Inequality." Harris School Working Paper Series 008-13.
- Heckman, James J. 1998. "Detecting Discrimination." *Journal of Economic Perspectives*, 12(2): 101-16.
- Holzer, Harry. 1987. "Informal Job Search and Black Youth Unemployment." *American Economic Review*, 77(3): 446-52.
- Holzer, Harry. 1996. *What Employers Want: Job Prospects for Less-Educated Workers*. New York: Russell Sage Foundation.
- Holzer, Harry, and David Neumark. 2000. "Assessing Affirmative Action." *Journal of Economic Literature*, 38(3): 483-568.
- Johnson, William, and Derek Neal. 1998. "Basic Skills and the Black-White Earnings Gap." In *The Black-White Test Score Gap*, ed. Christopher Jencks and Meredith Phillips, Washington, DC: Brookings Institution Press.
- Juhn, Chinhui. 2003. "Labor Market Dropouts and Trends in Wages of Black and White Men." *Industrial & Labor Relations Review*, 56(4), Article 4.
- Kalev, Alexandra, Frank Dobbin, and Erin Kelly. 2006. "Best Practices or Best Guesses? Assessing the Efficacy of Corporate Affirmative Action and Diversity Policies." *American Sociological Review*, 71(4): 589-607.
- Kirschenman, Joleen, and Kathryn M. Neckerman. 1991. "'We'd Love to Hire Them, But...': The Meaning of Race for Employers." In *The Urban Underclass*, ed. Christopher Jencks and Paul E. Peterson, Washington, DC: Brookings Institution Press.
- Kim, Young-Chul, and Glenn C. Loury. 2009. "Group Reputation and the Dynamics of Statistical Discrimination," Department of Economics, Brown University Working Paper.
- Lang, Kevin. 1986. "A Language Theory of Discrimination." *Quarterly Journal of Economics*, 101(2): 363-382.

- Lang, Kevin. 2007. *Poverty and Discrimination*. Princeton, NJ: Princeton University Press.
- Lang, Kevin, and Michael Manove. 2003. "Wage Announcements with a Continuum of Types." *Annales d'Economie et de Statistique*, 71-72: 223-244.
- Lang, Kevin, and Michael Manove. 2011. "Education and Labor Market Discrimination." *American Economic Review*, 101(4): 1467-1496.
- Lang, Kevin, Michael Manove, and William T. Dickens. 2005. "Racial Discrimination in Markets with Announced Wages." *American Economic Review*, 95(4):1327-40.
- Lange, Fabian. 2007. "The Speed of Employer Learning." *Journal of Labor Economics*, 25(1): 1-35.
- Lehmann, Jee-Yeon K. 2011. "A Dynamic Model of Statistical Discrimination under Affirmative Action: Evidence from the Early Career Evolution of Lawyers." [http://www.uh.edu/~jlehman2/papers/promotion\\_lawyers\\_lehmann.pdf](http://www.uh.edu/~jlehman2/papers/promotion_lawyers_lehmann.pdf).
- Levin, Jonathan. 2009. "The Dynamics of Collective Reputation." *The B.E. Journal of Theoretical Economics*, 9(1), Article 27.
- List, John A. 2004, "The Nature and Extent of Discrimination in the Marketplace: Evidence From the Field." *Quarterly Journal of Economics*, 119(1):49-89.
- Lodder, LeeAnn, Scott McFarland, and Diana White. 2003, *Racial Preference and Suburban Employment Opportunities*. Chicago: Legal Assistance Foundation of Chicago.
- Loury, Glenn. 1998. "Discrimination in the Post-Civil Rights Era: Beyond Market Interaction." *The Journal of Economic Perspectives*, 12(2):117-126.
- Lundberg, Shelly J., and Richard Startz. 1983. "Private Discrimination and Social Intervention in Competitive Labor Markets." *American Economic Review*, 73(3): 340-7.
- MacLeod, W. Bentley. 2003. "Optimal Contracting with Subjective Evaluation." *American Economic Review*, 93(1): 216-240.
- Massey, Douglas S., and Denton Nancy A. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, MA: Harvard University Press.

- Mitchell, G., and Tetlock, P.E. 2006. "Antidiscrimination Law and the Perils of Mindreading." *Ohio State Law Journal*, 67(5): 1023-1122.
- Moro, Andrea, and Peter Norman. 2004. "A General Equilibrium Model of Statistical Discrimination." *Journal of Economic Theory*, 114(1): 1-30.
- Moss, Philip, and Chris Tilly. 2001, "Why Opportunity Isn't Knocking: Racial Inequality and the Demand for Labor." In eds., Alice O'Connor, Chris Tilly, and Lawrence D. Bobo, *Urban Inequality: Evidence from Four Cities*, New York: Sage Publications, 444-495.
- Neal, Derek. 2004. "The Measured Black-White Wage Gap Among Women is Too Small." *Journal of Political Economy*, 112(1): S1-28.
- Neal, Derek A. 2006. "Why Has Black-White Skill Convergence Stopped?" In *Handbook of Economics of Education*, edited by Eric Hanushek and Finis Welch, Elsevier, 511-576.
- Neal, Derek A., and William R. Johnson. 1996. "The Role of Premarket Factors in Black-White Wage Differences." *Journal of Political Economy*, 104(5): 869-95.
- O'Neill, June. 1990. "The Role of Human Capital in Earnings Differences Between Black and White Men." *Journal of Economic Perspectives*, 4(4): 25-45.
- Pager, Devah, Bruce Western, and Bart Bonikowski. 2009. "Race at Work: The Realities of Race and Criminal Record in the NYC Job Market." In *Inequality and Society: Social Science Perspectives on Social Stratification*, edited by Jeff Manza and Michael Sauder. New York: W.W. Norton and Company.
- Peters, Michael. 2009. "Unobservable Heterogeneity in Directed Search." Department of Economics, University of British Columbia Working Paper.
- Phelps, Edmund S. 1972. "The Statistical Theory of Racism and Sexism." *American Economic Review*, 62(4): 659-661.
- Pinkston, Joshua C. 2006. "A Test of Screening Discrimination with Employer Learning." *Industrial and Labor Relations Review*, 59(2): 267-84.
- Ritter, J.A., and L.J. Taylor. 2011. "Racial Disparity in Unemployment." *Review of Economics and Statistics*, 93:30-42.

- Rodgers, William M., III, and William E. Spriggs. 1996. "The Effect of Federal Contractor Status on Racial Differences in Establishment-Level Employment Shares: 1979-1992." *American Economic Review*, 86(2): 290-93.
- Rosen, Asa, 1997. "An Equilibrium Search-Matching Model of Discrimination," *European Economic Review*, 41(8): 1589-1613.
- Rosenfeld, Michael J. 2007. "The Steady Rise of Non-traditional Romantic Unions: The Case of Interracial and Intercultural Marriage: A briefing paper prepared for the Council on Contemporary Families. <http://www.contemporaryfamilies.org/marriage-partnership-divorce/unions.html>.
- Rooth, Dan-Olof. 2007. "Implicit Discrimination in Hiring – Real World Evidence." CReAM Discussion Paper No 05/07.
- Sasaki, Masaru. 1999. "An Equilibrium Search Model with Coworker Discrimination." *Journal of Labor Economics*, 17(2): 377-407.
- Shi, Shouyong. 2009. "Directed Search for Equilibrium Wage-Tenure Contracts." *Econometrica*, 77(2): 561-584.
- Smith, James P., and Finis R. Welch. 1989. "Black Economic Progress After Myrdal." *Journal of Economic Literature*, 27(2): 519-64.
- Spence, A. Michael. 1973. "Job Market Signaling." *Quarterly Journal of Economics*, 87(3): 355-374.
- Stoll, Michael A., Stephen Raphael, and Harry J. Holzer. 2004. "Black Job Applicants and the Hiring Officer's Race." *Industrial and Labor Relations Review*, 57(2): 267-287.
- Stratton, Leslie S. 1993. "Racial Differences in Men's Unemployment." *Industrial and Labor Relations Review*, 46(3): 451-63.
- Tomaskovic-Devey, Donald, Melvin Thomas, and Kecia Johnson. 2005. "Race and the Accumulation of Human Capital Across the Career: A Theoretical Model and Fixed Effects Application." *American Journal of Sociology*, 111:58-89.
- van den Berg, Gerard J., and Jan C. van Ours. 1996, "Unemployment Dynamics and Duration Dependence." *Journal of Labor Economics*, 14(1): 100-125.

- Western, Bruce and Becky Pettit. 2005. "Black-White Wage Inequality, Employment Rates, and Incarceration." *American Journal of Sociology*, 111(2): 553–78.
- Wigdor, Alexandra K., and Bert F. Green, Jr. 1991. *Performance Assessment for the Workplace, Vol. 1*. National Academy Press.
- Wilson, William Julius. 1978. *The Declining Significance of Race: Blacks and Changing American Institutions*. Chicago: University of Chicago Press.
- Wilson, William Julius. 1996. *When work disappears: The world of the new urban poor*. New York: Alfred A. Knopf.
- Weinberg, Bruce A., Patricia B. Regan, and Jeffrey J. Yankow. 2004. "Do Neighborhoods Affect Hours Worked? Evidence from Logitudinal Data." *Journal of Labor Economics*, 22(4): 891-924.
- Ziegert, Jonathan C., and Paul J. Hanges. 2005. "Employment Discrimination: The Role of Implicit Attitudes, Motivation, and a Climate for Racial Bias." *Journal of Applied Psychology*, 90: 553-562.