Appalachian State University

Department of Economics Working Paper

Number 12-03 | September 2012

Wages, Employment, and Statistical Discrimination: Evidence from the Laboratory

David L. Dickinson
Appalachian State University

Ronald L. Oaxaca
University of Arizona and IZA

Department of Economics
Appalachian State University
Boone, NC 28608
Phone: (828) 262-6123
Fax: (828) 262-6105
www.business.appstate.edu/economics

Wages, Employment, and Statistical Discrimination: Evidence from the Laboratory

David L. Dickinson, Appalachian State University
and
Ronald L. Oaxaca, University of Arizona and IZA

PRELIMINARY DRAFT—DO NOT QUOTE WITHOUT PERMISSION

Abstract

When membership in a particular group conveys valuable information about an individual's skills, productivity, or other human capital characteristics, a non-prejudiced agent may still find it rational to statistically discriminate. We frame statistical discrimination in a labor market setting for a series of laboratory experiments. A main objective of our experiments is to examine how varying productivity risk along several dimensions impacts outcomes across worker groups. Our design expands upon existing research by generating laboratory data both on wage contracts and unemployment rates of directly competing worker groups. We find some evidence for statistical wage discrimination against workers with identical expected productivity but higher productivity variance. However, those same subjects are less likely to be unemployed, suggesting that our employers view hiring choice and wage contracts as substitutable. These laboratory results have interesting implications for labor markets where employers select from workers belonging to distinct statistical groups, and suggest that statistical discrimination based on wages alone may overestimate the true effect of such discrimination.

Research on statistical discrimination attempts to explain differential treatment of individuals that is not prejudice-related. Differential treatment based on lower *average* performance of one's group (e.g., minorities, females) was considered a starting point for modeling of statistical discrimination (see Phelps, 1972). However, it has since been more proper to define statistical discrimination based on group differences unrelated to *average* productivity (see Aigner and Cain, 1977; Lundberg and Startz, 1983). Theoretical models have explored various reasons why such discrimination might arise, such as differential screening or communication costs (Cornell and Welch, 1996; Lang, 1986), noisier productivity signals (see discussion in Aigner and Cain, 1977), or incomplete information (Lundberg and Startz, 1983). Field studies have uncovered evidence of statistical discrimination in mortgage lending (Ladd, 1998), auto sales (Ayers and Siegelman, 1995; Goldberg, 1996; Harless and Hoffer, 2002), sports card price negotiations (List, 2004); law enforcement decisions (Applebaum, 1996); and vehicle repair estimates (Gneezy and List 2006). More controlled laboratory studies have also examined statistical discrimination (Anderson and Haupert, 1999; Davis, 1987; Fershtman and Gneezy, 2001; Dickinson and Oaxaca, 2009; Castillo and Petrie, 2010). Findings from these laboratory studies indicate that statistical discrimination may result from aversion to risk, mistaken stereotypes, biased probability assessments, or incomplete information.

In the existing literature, discrimination is measured along a single dimension, such as vehicle pricing, labor market wages, group choice, or job assignments. However, in many instances multiple avenues for discrimination exist simultaneously and to focus on only one may produce a systematically biased view of the prevalence of statistically-based discrimination.[1] In

---

[1] In such a case, only a selected sample is actually employed because of discrimination exercised at the hiring or transaction stage. It is not immediately clear, however, in which direction would be the bias in discrimination estimates. For example, estimates of labor market discrimination would be biased downwards if females or minority workers were discriminated against in hiring, and yet discrimination estimates were based solely on wage data.

this paper, we examine statistical discrimination in a controlled experimental environment. Statistical discrimination in our study can *only* be based on productivity distribution risk attached to worker groups. Building on Dickinson and Oaxaca (2009), our key contribution is to examine an environment in which discrimination may be exercised simultaneously along the dimensions of both wages and employment rates. This more closely approximates the field environments we hope to study, where discrimination may exist in terms of labor market wages and/or hiring practices, auto sales prices and/or sales rates, mortgage rates and/or home sales.

As in Dickinson and Oaxaca (2009), subjects negotiate in a simulated labor market where worker-subjects are given an induced common-knowledge productivity distribution. In the present design, our environment allows workers of distinct productivity-distribution groups to compete against each other in negotiating with employers for a wage contract. The environment is designed such that there is equilibrium unemployment, allowing us to compare both wage and unemployment rates of workers belonging to distinct productivity-distribution groups. Additionally, these data allow us to examine the bias in discrimination estimates that would exist *if* we only had data on one dimension or the other from our experimental market (i.e., only hiring data or only wage data).

Our results indicate that, while higher variance in a worker's productivity decreases the negotiated wage, there is evidence that experimental employers substitute hiring choice and wage contracts. More specifically, workers with higher productivity variance are *more* likely to be hired, but they receive lower wages. An alternative measure of productivity risk (i.e., the distributional support) significantly decreases the likelihood of being employed while not

---

Those employers most averse to the statistical characteristics attached to certain workers do not hire those workers, and the remaining employers require lesser wage discount to employ workers from the female or minority group. One might plausibly argue, however, that employers averse to minority or female workers (on statistical grounds) might choose to hire these workers if the market wage discount is large enough and employers view hiring choice and wage payments as substitutes.

significantly impacting the wage if hired. These results are intriguing and highly relevant to naturally occurring labor markets where hiring and pay decisions are often made over potential workers from heterogeneous statistical worker groups. Our evidence that experimental employers practice statistical wage discrimination and statistical employment reverse-discrimination indicates that a focus on wages alone may over-estimate the real incidence of statistical discrimination.

2. Experimental Design

The experimental environment is an oral double-auction market, with employer and worker subjects negotiating wage contracts in an open pit. There is no central auctioneer, and no actual labor task is involved. Rather, we use the context of a labor market so that it would be easier for subjects to comprehend the trading environment. We replicate the methods of Dickinson and Oaxaca (2009) to the extent possible, which facilitates comparison of our results. The design is a context-specific use of classic market experiment techniques discussed in Smith (1982). That is, supply and demand are induced upon subjects, and all decisions have monetary consequence.

Each experimental session consists of 15 subjects. Five of these subjects are randomly assigned to be "employer" subjects, and the rest are assigned as "worker" subjects. A worker can sell at most one unit of labor, and an employer can hire one unit of labor, during each round of the experiment. Workers have an induced reservation wage of \$.80, such that they are guaranteed this payment for a round in which they are not employed and this reservation wage is private information to workers. The expected productivity of a unit of labor to the employer is 3 units of output, which sell for a normalized \$1.00 per unit (the price per unit of output is private employer information). Thus, expected revenue to an employer from hiring a unit of labor is $3.00. Profits to a worker subject are either the reservation wage, W_R, or the negotiated wage, W. Employer profits are the realized productivity of the worker (times output price $1.00) minus the negotiated wage. The thicker supply side of the market guarantees equilibrium unemployment of 5 workers (50% unemployment) per round.[2] Figure 1 shows the simulated labor market for each round of the experiment.

An experiment session consists of 4 treatments of 4 decision rounds each, for a total of 16 decision rounds per experimental session. The labor pool in each treatment consists of workers belonging to one of two distinct worker productivity types. A worker's type or "group" for a given round is identified by an ID badge worn by the subject. Workers are randomly assigned to a productivity distribution group by randomly allocating the ten ID badges at the start of each round (i.e., 5 ID badges for each productivity distribution group). Importantly, this random assignment of workers each round also randomly distributes any negotiating power asymmetries across the two competing worker groups in each round.

We used a total of 6 different worker productivity distributions in all. The productivity distribution information of each worker group is shown in Table 1. As in Dickinson and Oaxaca (2009), the worker productivity distributions are intended to explore three distinct measures of "risk": the distributional variance, the support of the distribution, and the probability that earnings will be less than mean earnings ($3.00) for an employer. As can be seen in Table 1, hiring a worker identified as belonging to group #1 guarantees the employer a certain productivity of 3 units of output. Hiring a worker from any of the other groups involves risk of some sort. Upon hiring a worker from a risky productivity distribution group, a random draw

[2] Of course, we assume that all workers not employed were actually attempting to secure a wage contract, which is reasonable given that worker subjects were not allowed to simply disengage themselves completely from the pit negotiations. Of course, some subjects tried harder than others, but this is a feature of real world job search as well.

from the appropriate productivity distribution determines the worker productivity to the employer for that round. Productivity draws are independent each and every round, such that employers are aware that negotiating a wage contract with the same subject in two distinct rounds or with any subject from the same productivity group as in a previous round may not lead to the same productivity outcome.

As noted above, employer choice involves two dimensions: hiring workers from one group or the other, and the choice of wage. With six distinct worker productivity groups, there are fifteen possible binary group comparisons. An experiment session, however, involves only four treatments, and so we select treatments so that each session involves one treatment that pairs the certain productivity group, G1, with one of the other groups, and then three treatments with labor pools comprised of (G2,G5), (G2,G6), and (G3,G4) productivity group pairings (treatments randomly ordered within a session). These particular comparisons for three of the four treatments in each session were chosen such that the each pairing alters only one measure of the distributional risk across the two worker groups: the variance (G3,G4), support (G2,G6), and probability of earnings less than mean earning (G2,G5). The distributional information in Table 1 highlights how these binary comparisons vary only one measure of risk at a time. Table 2 shows the productivity comparisons used in each of the five experiment sessions we ran.

3. Theoretical Framework

In our environment, employers make a simultaneous choice of employment and wage rate. Thus, a simple choice framework for employers would be a traditional model of choice where employer utility, U, is a function of expected profits, π, and employment risk (i.e., productivity risk), r: $U=U(\pi,r)$, where $U_\pi^{'} > 0$, $U_r^{'} < 0$, $U_\pi^{''} < 0$, $U_r^{''} > 0$. Because expected productivity is fixed across all worker groups, π varies inversely with the wage rate. Assuming employers are risk averse, we borrow from optimal portfolio theory of Markowitz (1952, *J. Finance*) and formulate an employer's utility maximization decision. As seen in the Results section below (Table 3), our data indicate that expected profits are higher (i.e., wages lower) for the risky productivity groups relative to certain productivity. Thus, the labor market "portfolio" constraint describing combinations of expected profits and productivity risk available to employers appears as the upward sloping line in Fig. 2, as one would expect.

In this framework, employers with a higher marginal disutility of productivity risk (bold indifference curves in Fig. 2) will choose to hire workers from groups considered a lower productivity risk, paying them higher wages (resulting in lower expected profits, π). Conversely, employers with lower marginal disutility of risk (dashed indifference curves) will hire from riskier worker groups and face higher expected profits. We reiterate here that higher expected profits is not due to higher levels of average productivity—average worker productivity is constant in our experimental design—but rather due to lower market wages for the same level of average productivity. The risk-reward trade-off is at the core of this framework.

This framework assumes a continuous risk choice dimension, but our experimental framework has employers choosing between hiring a worker from one group or another. Within this framework, choices of workers from one group or the other will generate the employment rates in our data. An underlying assumption is that there is a market wage for each worker group and employers take that wage as given. Though this is not true in our two-sided auction market, the simplification captures the idea that both empirical employment and wage models should be functions of worker groups as well as variables capturing the particular worker group pairing facing the employer in a given choice round. For example, consider two worker groups, G_x and G_y. A worker from G_x will be hired over G_y if the hire offers the employer higher utility. So, employment for the worker from G_x , E_{Gx}=1, if $U(\pi_{Gx}, r_{Gx}) - U(\pi_{Gy}, r_{Gy}) > 0$. Otherwise, E_{Gx}=0. Such a framework is basically a random utility model that lends itself to probit estimation techniques with regressors that capture the relevant worker group information. In Fig. 3 we see that the employer with indifference curves as shown, would prefer hiring a G_y worker over a G_x worker, but would employ a G_z worker over a G_y worker. The probability of employment for a worker from a given group depends on the alternative available to the employer.

4. Results

We consider a series of random effects models for wage and unemployment rate determination. For wage determination, we estimate wage equations based on contract pair (employer-worker) random effects, based on employer random effects, and based on worker random effects.[3] In any given experimental session there were 5 employers, 10 workers, 4 treatments, and 4 rounds per treatment. With a total of 5 sessions, we therefore have 25 employers and 50 worker subjects in the data set. In our design, 5 of the 10 workers are unemployed each round. Thus, our data include 400 total wage contracts and consequently 400 observations for contract pair random effects and 400 observations for employer random effects. On the other hand, there are a total of 800 observations for work random effects.

In the case of contract pairs, there were 161 distinct employer-worker pairings. The random effects wage determination model corresponding to contract pair random effects is an unbalanced design and is parsimoniously specified by

$$W_{\{ij\}t} = \beta_0 + G_{jt}\beta_G + T_t\beta_T + R_t\beta_R + C_{\{ij\}t}\beta_C + u_{\{ij\}} + \varepsilon_{\{ij\}t},\ \{ij\} = 1,\ldots,161$$

where {ij}denotes each unique employer(i)-worker(j) contract pair, G_{jt} is a vector of dummy variables for the group association of the jth worker, T_t is a vector of dummy variables for the

[3] For the wage determination models, we reject OLS in favor of random effects in all cases.

treatments (corresponding to which two worker groups are competing for wage contracts), R_t is a vector of dummy variables corresponding to the 4 rounds per treatment, $C_{\{ij\}t}$ is a vector of dummy variables for employer-worker gender pairings, the β's are conforming parameter vectors, $u_{\{ij\}}$ is a normally distributed mean zero, constant variance contract pair random effect, and $\varepsilon_{\{ij\}t}$ is a normally distributed mean zero, constant variance idiosyncratic error term.

When considering employer random effects, we have a balanced design. The wage determination model in this case is specified as

$$W_{it} = \beta_0 + G_{jt}\beta_G + T_t\beta_T + R_t\beta_R + C_{it}\beta_C + u_i + \varepsilon_{it}, \text{ i = 1,…,25, t = 1,…,16}$$

where variables are defined as above (*i* indexes employers, *j* indexes workers).

Since in any given period, half of the workers will be unemployed, we model the wage determination process for workers as a balanced design random effects Tobit:

$$W_{jt} = \beta_0 + G_{jt}\beta_G + T_t\beta_T + R_t\beta_R + X_{jt}\beta_X + u_j + \varepsilon_{jt} \text{ if } W_{jt} > 0, \text{ j=1,…,50, t=1,…16}$$

$$= 0 \text{ otherwise}$$

Here, X_{jt} is a vector of worker personal characteristics corresponding to gender, minority status, and citizenship. From the estimated Tobit model, we can examine unemployment rates. Specifically, we back out the probability of being employed

$$P(Employed=1)=\Phi(I/\sigma)$$

Where Φ is the standard normal cumulative distribution function, σ is the standard deviation of worker wages, and I is the index function defined above by $I = \beta_0 + G\beta_G + T\beta_T + R\beta_R + X\beta_X$.

Considering the wage effects coefficients of the random effects models for contract pairs and employers, all worker groups with some productivity risk exhibited negative wage effects compared with group G1 with the certain productivity outcome (see Table 4). These negative wage effects were statistically significant in two cases, Groups G3 and G4. When considering the random effects Tobit model for workers, we find that relative to G1 all of the other groups exhibit consistently negative wage effects. These were statistically significant in two cases, Groups G2 and G5.

Table 5 reports the estimated treatment effects for isolated productivity risk variables: variance, support, and probability of productivity less than the mean. With respect to the contract pairs and employer random effects model, the results show that higher variances are associated with statistically significantly lower wage contracts. At the same time, there were no statistically significant wage contract effects of productivity distribution support or the probability of productivity less than the mean. On the other hand, the random effects Tobit model for workers shows no statistically significant coefficients associated with membership in higher variance groups or in groups with a higher probability of generating productivity less than the mean. Yet, there is a statistically significant negative coefficient for membership in groups with a higher support range.

We use the estimated probabilities of employment from the Tobit model evaluated at the overall sample mean to estimate the marginal effects of our risk measures on the probability of employment. We find no statistically significant employment effect of the higher variance of G4 against G3 but we do find statistically significant positive employment effects of the higher variances of G3 and G4 against G5. We find no statistically significant employment effect from a higher probability of drawing productivity less than the mean.

As already pointed out, while all three of the variance treatments had statistically significant negative impacts on wage contracts in the contract pairs and employer RE models, they had no direct wage impacts when taking account of worker random effects. Interestingly, two of the variance treatments (G4 vs G5 and G3 vs G5) had positive effects on employment. These positive employment effects were accompanied by negative wage contract effects for employers. The variance treatment for G4 vs G3 had no statistically significant employment effect to offset the employer/contract pair negative wage contract effect. In the case of the higher support range treatment, there was no contract pair/employer wage contract effect, but there was a negative wage and employment impact when taking account of worker random effects. When considering the probability of productivity draws less than the mean, we find no evidence of wage or employment effects.

The contract pair and employer based random effects estimations look at the data from the employer perspective, without considering the unemployment risk as is the case when looking at the worker random effects Tobit estimations. If we consider the workers' perspective, the expected wage is determined according to

$$W^e = E(W|X) = (W|W > 0) * (\pi) ,$$

where W^e is the worker's expected wage, $W \mid W > 0)$ is the wage conditional upon being employed, and π is the probability of being employed. This expected wage is simply a weighted average of W=0 when unemployed and W>0 when employed. The change in the expected wage associated with group "k" compared with group "j" can be calculated as follows:

$$\Delta W_{kj}^e = W_k^e - W_j^e$$

In the case of a Tobit model, the marginal effects of continuous variables are constrained to have the same sign for the conditional mean wage effects and the employment effects. This correspondence would generally carry over when looking at the marginal effects of binary variables.

Column 6 of Table 5 (Wage Effect | **X)** reports the expected wage effects using the predicted wages and probabilities evaluated at overall sample means. Three of the risk treatments show a negative effect on mean expected wages but only the negative Support treatment effect is statistically significant. In the case of employer and contract pair random effects, the support treatment does not produce a statistically significant wage effect. With the exception of the G4 – G3 comparison, the variance treatments show statistically significant positive effects on worker average wages (including 0 wages when unemployed). These same variance treatment comparisons show negative and statistically significant wage effects for employer and contract pair random effects. Thus, the expected or "average" wage results seem to conflict with the contract wage effects of the variance treatments when considering employer and contract pair random effects. It is clear that the employment probability effects are driving these results.

Our findings suggest that the variance treatments depress wage contracts for employers and contract pairs, but raise the probability of a worker being employed in 2 of the 3 variance treatments (see far-right column of Table 5). These wage contract effects are consistent with the theoretical framework outlined above, which stressed the risk-reward trade-off to an employer of wages and productivity risk of hiring certain workers. Regarding overall risk effects, the positive employment effects of two of the variance treatments in the worker RE Tobit model generate positive estimated effects on mean wages and conditional mean wages. While in some sense overcorrecting, our worker RE Tobit results demonstrate that the effects of risk on wage contracts alone does not reveal the full extent of statistical discrimination. Certainly, the negative risk effects of productivity variance on employer contract wages overstate the extent of statistical discrimination because the same measure of risk increases the probability of employment. In the case of the support treatment, the lack of wage contract effects actually understates the extent of statistical discrimination because the negative employment effects reduce the expected wages of these workers. The probability of productivity draws less than the mean had little effect on wage contracts, conditional wages, employment probabilities, and expected wages.

Among the control variables in our models, the round/period effects were never statistically significant. In the contract pairs and employer RE models (relative to contracts between male employers and male workers), the presence of a female in the contract is associated with higher wage contracts. The highest contract is associated with female employers and female workers (C_ff in Table 4), followed by contracts with male employers and female workers (C_mf), and finally by contracts between female employers and male workers (C_fm). However, the estimated wage contract effect for C_fm is not statistically different from a male employer male worker contract. In the RE Tobit wage model for workers, we controlled for gender, minority status, and noncitizen. For the most part these variables were not statistically significant though minority status exhibited a marginally significant negative effect on wages and by implication a small negative effect on the probability of employment. Because we exogenously control productivity and risk, this estimated negative wage effect is consistent with taste-based wage discrimination against minority subjects in our experiments.

A main result of this paper is that our estimations suggest that belonging to a risky productivity group has a negative effect on wage contracts while it may yet have a positive effect on the probability of being employed. Thus, our laboratory evidence suggests that employers may view hiring choices and wage contracts as substitute goods. That is, a higher productivity variance increases the likelihood that one will be employed, but conditional on employment there is a lower wage contract. Reverse statistical discrimination in hiring choices is perhaps used by employers to help leverage wage negotiations (i.e., those high-variance workers willing to accept lower wages increase their likelihood of being employed). It would therefore be an incomplete view of statistical discrimination if one were to focus simply on wage effects among the employed. In some cases, doing so in our data would upwardly bias one's estimate of the negative effects of productivity variance in the labor pool because it would fail to take into account any increased probability of employment. In other cases, there can be a downward bias in the estimate of statistical discrimination, such as when we find no significant wage effect among employed workers, but a decreased likelihood of employment.

5. Discussion

Our previous work (Dickinson and Oaxaca 2008) found a significant effect of loss probabilities on depressing wage contracts, a result we do not replicate in these data. However, the availability of more than one outlet for statistical discrimination in the present experiments implies the results we report here are not directly comparable to our previous research. The present experiments generate a richer data set for exploring how worker productivity risk impacts the dual choice faced by employers. The result is that this current work is more externally valid and applicable to field labor markets.

Our data are consistent with employer's exercising trade-offs between hiring choices and wage contracts in an environment where competing heterogeneous workers have identical expected labor productivity but differ with respect to the riskiness of their labor productivity. We implement a design where there is equilibrium unemployment such that employers may simply choose to not hire workers from less-preferred worker groups. For worker groups with a higher variance of labor productivity, we estimate lower wages from the contract-pair and employer random effects models, but we also find that these same workers often face an increased probability of being employed. Thus, our data overall show statistically-based discrimination in wages but reverse statistical discrimination in hiring choices. These offsetting effects can imply that expected wages of the worker may actually be higher as a result of belonging to a high risk worker pool, when defining risk as a higher variance of labor productivity. However, we also isolate distinct an alternative measure of risk, the support of the productivity distribution, and find that typical wage estimates may *under*estimate statistical discrimination as a result of that alternative risk measure. As a result, we cannot make a general claim as to the direction of the likely bias in typical wage discrimination estimates, but it is clear that ignoring hiring choices in one's analysis can generate significant wage effect biases.

Though there exists a body of literature on statistical discrimination, researchers have yet to examine environments where discrimination may be exercised on multiple dimensions. Our contribution is that we study such an environment in a controlled laboratory setting. This research highlights, however, that multiple avenues for potential discrimination does not necessarily imply discrimination on multiple fronts. Indeed, evidence suggests individuals may discriminate along one dimension but simultaneously reverse-discriminate along the other. This has important implications for our estimates of the extent of statistical discrimination, and highlights the likely bias that exists in such estimates when data analysis only examines one possible dimension for discrimination. Though our research examines non-prejudiced based discrimination, this is likely an important implication to consider in all types of discrimination research.

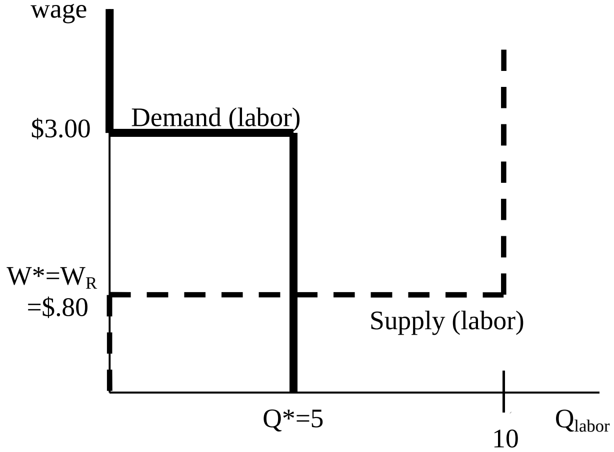

FIGURE 1: Simulated Labor Market

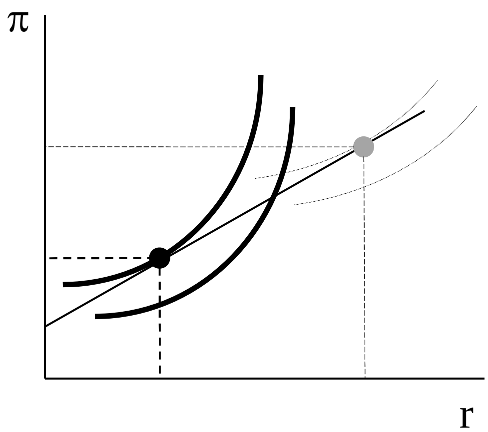

FIGURE 2: Employer Choice

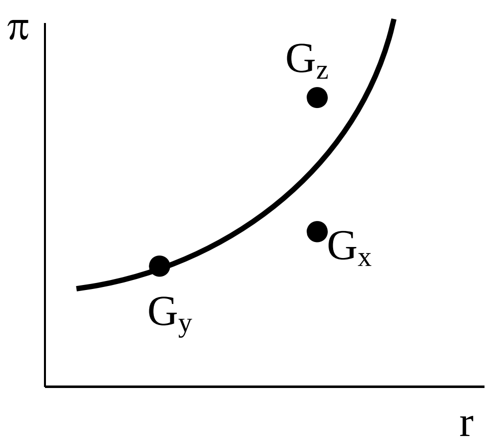

FIGURE 3: Employer Hiring Preference

Worker Group (G)	Productivity (probability)	Productivity Mean	Productivity Variance	Productivity Distribution Support	Likelihood of Productivity < mean productivity
G1	3 (1.00)	3	0	3	0
G2	1,2,3,4,5 (.1,.1,.6,.1,.1)	3	1	1-5	0.2
G3	1,2,3,4,5 (.2,.2,.2,.2,.2)	3	2	1-5	0.4
G4	1,3,5 (.4,.2,.4)	3	3.2	1-5	0.4
G5	1,2,3,4,5 (.01,.39,.27,.25,.08)	3	1	1-5	0.4
G6	1,2,3,4 (.15,.05,.45,.35)	3	1	1-4	0.2

TABLE 1: Experiment Treatment Design

	Treatment pairings (T) of Worker groups (G)	Session 1	Session 2	Session 3	Session 4	Session 5
Risky choice options that identify unique risk factor	T1 = G2 & G5	X	X	X	X	X
	T2 = G2 & G6	X	X	X	X	X
	T3 = G3 & G4	X	X	X	X	X
Certain versus Risky choice employer options	T4 = G1 & G2	X				
	T5 = G1 & G3			X		
	T6 = G1 & G4					X
	T7 = G1 & G5				X	
	T8 = G1 & G6		X			
	Total treatments	4	4	4	4	4

TABLE 2: Pairings used in each Session
(note: the ordering of treatments was varied across Sessions)

Worker Group (G)	Wage	minWage	maxWage	Employment rate
G1	1.41	.79	10.00	.55
G2	1.08	.50	2.80	.46
G3	1.18	.75	2.50	.49
G4	1.07	.75	2.50	.52
G5	0.99	.50	3.00	.47
G6	0.99	.65	1.80	.56

TABLE 3: Summary wage and employment data (averaged across all treatments and sessions)

Variables	Contract Pair Random Effects (MLE) Wage Effect Coefficients (st. errors)	Employer Random Effects (MLE) Wage Effect Coefficients (st. errors)	Worker Random Effects (MLE) Wage Effect Coefficients (st. errors)
Constant	1.022*** (0.212)	1.023*** (.208)	0.561* (0.325)
G2	-0.086 (0.190)	-0.079 (.187)	-0.486* (0.283)
G3	-0.699*** (0.219)	-0.788*** (0.220)	-0.333 (0.337)
G4	-0.929*** (0.220)	-1.020*** (.220)	-0.336 (0.335)
G5	-0.084 (0.211)	-0.101 (0.205)	-0.514* (0.312)
G6	-0.186 (0.209)	-0.143 (0.198)	-0.149 (0.308)
T2	0.091 (0.129)	0.058 (0.130)	-0.165 (0.191)
T3	0.775*** (0.297)	0.878*** (0.296)	-0.135 (0.450)
T4	-0.003 (-0.199)	0.010 (0.199)	-0.256 (0.297)
T5	0.688** (0.279)	0.708*** (0.272)	-0.096 (0.417)
T6	1.452*** (0.279)	1.548*** (0.276)	0.287 (0.405)
T7	-0.177 (0.212)	-0.151 (0.216)	-0.323 (0.300)
T8	-0.069 (0.212)	-.051 (0.213)	-0.456 (0.315)
C_ff	0.527*** (0.164)	0.388*** (0.135)	--
C_mf	0.269** (0.109)	0.267*** (0.083)	--
C_fm	0.138 (0.126)	0.178 (0.114)	--
Female	--	--	0.166 (0.148)
Minority	--	--	-0.268* (0.156)
Noncitizen	--	--	0.027 (0.234)
Log Likelihood	-395.975	-398.730	-936.843
N	400	400	800

TABLE 4: Group Wage Effects
(round dummies—suppressed for space—were included but all statistically insignificant)

	Groups Compared	**Contract Pair Random Effects**	**Employer Random Effects**	**Worker Random Effects Tobit**		
Risk Measure	**Gx-Gy**	**(MLE) Wage Effect** Coefficients	**(MLE) Wage Effect** Coefficients	**(MLE) Wage Effect** Coefficients	**Wage Effect | X** (at sample means)	**Risk Effect on Employment Probability (marginal effects)** $\Phi(x'\beta/\sigma)_{Gx=1} - \Phi(x'\beta/\sigma)_{Gy=1}$ (at sample means)
Variance	**G4-G3**	-0.230** (0.126)	-0.232** (0.126)	-0.003 (0.194)	-0.001 (0.014)	-0.001 (0.009)
Variance	**G4-G5**	-0.846*** (0.301)	-0.919*** (0.301)	0.179 (0.450)	0.087*** (0.033)	0.058*** (0.022)
Variance	**G3-G5**	-0616** (0.309)	-0.684** (0.301)	0.181 (0.465)	0.088*** (0.035)	0.059*** (0.023)
Support	**G2-G6**	0.100 (0.125)	0.065 (0.127)	-0.337* (0.189)	-0.176*** (0.033)	-0.109*** (0.016)
Prod < avg	**G5-G2**	0.002 (0.124)	-0.022 (0.126)	-0.037 (0.187)	-0.013 (0.021)	-0.009 (0.016)
Log-L		-395.975	-398.730	-936.843	--	--
N		**400**	**400**	**800**	**800**	**800**

TABLE 5: Employment Models Risk Effect Identification

REFERENCES

Aigner, Dennis J., and Glen G. Cain. 1977. Statistical theories of discrimination in labor markets. *Industrial and Labor Relations Review* 30:175-87.

Anderson, Donna M., and Michael J. Haupert. 1999. Employment and statistical discrimination: A hands-on experiment. *The Journal of Economics* 25:85-102.

Applebaum, Arthur Isak. 1996. Racial generalization, police discretion and bayesian contractualism. In *Handled with Discretion*, edited by John Kleinig. Lanham, MD: Rowman and Littlefield.

Ayers, Ian., and Peter Siegelman. 1995. Race and gender discrimination in bargaining for a new car. *The American Economic Review* 85:304-21.

Castillo, Marco, and Ragan Petrie. 2010. Discrimination in the lab: Does information trump appearance? *Games and Economic Behavior*, 68: 50-59.

Cornell, Bradford, and Ivo Welch. 1996. Culture, Information, and Screening Discrimination. *Journal of Political Economy* 104:542-71.

Davis, Douglas D. 1987. Maximal quality selection and discrimination in employment. *Journal of Economic Behavior and Organization* 8:97-112.

Dickinson, David L., and Ronald L. Oaxaca. 2009. Statistical discrimination in labor markets: An experimental analysis. *Southern Economic Journal*, 76(1): 16-31.

Fershtman, Chaim., and Uri Gneezy. 2001. Discrimination in a segmented society: An experimental approach. *The Quarterly Journal of Economics* 116:351-77.

Gneezy, Uri. and John A. List. 2006. Are the physically disabled discriminated against in product markets? Unpublished paper, University of Chicago.

Goldberg, Pinelopi Koujianou. 1996. Dealer price discrimination in new car purchases: Evidence from the Consumer Expenditure Survey. *Journal of Political Economy* 104:622-34.

Harless, David W., and George E. Hoffer. 2002. Do women pay more for new vehicles? Evidence from transaction price data. *American Economic Review* 92:270-79.

Ladd, Helen F. 1998. Evidence on discrimination in mortgage lending. *Journal of Economic Perspectives* 12:41-62.

Lang, Kevin. 1986. A language theory of discrimination. *Quarterly Journal of Economics* 101:363-81.

List, John A. 2004. The nature and extent of discrimination in the marketplace: Evidence from the field. *The Quarterly Journal of Economics* 119:49-89.

Lundberg, Shelly J., and Richard Startz. 1983. Private discrimination and social intervention in competitive labor markets. *American Economic Review* 73:340-47.

Markowitz, Harry. 1952. Portfolio Selection. *The Journal of Finance* 7(1): 77-91.

Oaxaca, Ronald L. and Iris Geisler. 2003. Fixed effects models with time invariant variables: a theoretical note. *Economics Letters*, 80(3): 373-77.

Phelps, Edmund S. 1972. The statistical theory of racism and sexism. *American Economic Review* 62:659-61.

APPENDIX: Experiment Instructions

INSTRUCTIONS: EMPLOYERS (GENERAL)

This is an experiment in economic decision-making. Please read and follow the instructions carefully. Your decisions as well as the decisions of others will help determine your total cash payment for participation in this experiment.

In this experiment, you are an **Employer**. Other individuals in the experiment will be workers. As an employer, you will have the ability to hire *one* unit of labor (at most) in each decision round from a pool of workers. You may wish to do this because a unit of labor will be assumed to produce a certain amount of output for you for that round. To keep things simple, whatever output a unit of labor produces, we will assume that you will then sell each unit of that output for a market price of $1 (one experimental dollar). You will have the ability to hire one unit of labor in each round for a series of decision-making rounds. In each decision round, your experimental earnings will be determined by your employer "profits". Profits are calculated as total revenues minus total costs. Your employer profits in each round are then simple to calculate—your total revenues are given by the quantity of output that the unit of labor will produce for you (multiplied by the $1 that you receive for each unit of output), and your total costs are just given by whatever you agree to pay for the worker for his/her unit of labor.

****You will receive specific and more detailed instructions on labor productivity shortly.****

You are *not* required to purchase a unit of labor in each round. Rather, if you do not purchase a unit of labor in a given round, your profits for that round are zero (since total revenue and total cost are zero). If you do hire a unit of labor in a given round, your profits for that round will depend on *both* the productivity of labor (i.e., how much output the unit of labor produces for you) and the wage that you pay for that unit of labor. For example, if a worker produces three units of output for you, and if you agree to pay that worker $2, then your profits for that decision round would be $1 (remember, three units of output are assumed to be sold by you for $1 each, and so total revenues are $3). If, on the other hand, you agree to pay that worker $4, then your profits for that round would be $-1. In other words, one dollar would be *subtracted* from you total experimental earnings in that case. As such, your experimental earnings would be higher if you did **not** hire a unit of labor in a given round, as opposed to hiring a unit of labor and earning negative profits. **The way in which you earn money in this experiment (through your profits) is private information to you and should not be discussed with other employers or with the workers.**

In this experiment, there are a total of ***5*** employers and ***10*** workers. Each worker in the experiment has the ability to sell one unit of his labor to only one employer in each decision round, and each employer can hire only one unit of labor per decision round. As an employer, you be allowed to freely "shop" around within the pool of workers in your attempt to hire one unit of labor for the round. Similarly, each worker will be allowed to freely shop among the employers in order to sell his/her unit of labor. Each round will last for a maximum of **2.5** minutes. The wages you and a worker mutually agree to and your per-round experimental profits will be calculated on the Decision Sheet that you have also been given. If you and a worker agree on a wage for given round, the Decision sheet also includes a space for you to **document the identification number** of the worker you purchased your unit of labor from for that round.

*You are **not** allowed to communicate with other employers in this experiment.

FOR TODAY'S EXPERIMENT, YOUR CASH EARNING ARE RELATED TO YOUR EXPERIMENTAL EARNINGS BY THE FOLLOWING EXCHANGE RATE:

$1 EXPERIMENTAL=$ _1_U.S.

INSTRUCTIONS: EMPLOYERS (SAMPLE TREATMENT)

For the next few rounds, different workers may have different productivities, and you will **not** know the productivity of any given worker until after you have hired a unit of labor from that worker for that round. You will, however, be given some general information on the workers' productivity for this set of rounds.

Specifically, a worker will either belong to Group G2 or Group G5 for the next few rounds. Five of the workers (i.e., half) will have productivity determined by Group G2 characteristics, and the other five workers will have productivity determined by Group G5 characteristics. The characteristics of these two groups of workers are as follows, and productivity is ultimately determined by drawing a random number between 0 and 99 (the information below includes information on which numbers drawn would lead to which productivity outcome):

Group	**Productivity characteristics**	**Random # determines productivity**
Group G2 characteristics	10% chance that a worker has productivity of 1	(random # 00-09)
	10% chance that a worker has productivity of 2	(random # 10-19)
	60% chance that a worker has productivity of 3	(random # 20-79)
	10% chance that a worker has productivity of 4	(random # 80-89)
	10% chance that a worker has productivity of 5	(random # 90-99)
Group G5 characteristics	1% chance that a worker has productivity of 1	(random # 00)
	39% chance that a worker has productivity of 2	(random # 01-39)
	27% chance that a worker has productivity of 3	(random # 40-66)
	25% chance that a worker has productivity of 4	(random # 67-91)
	8% chance that a worker has productivity of 5	(random # 92-99)

A worker will be wearing an ID badge indicating his/her Group affiliation for that round. Workers are randomly assigned to a group in each round, and so a worker may or may not belong to the same Group from one round to the next. Remember, you are **not** allowed to communicate with other employers in any way, or you may be disqualified from today's experiment.

So, neither you nor the workers know exactly how productive a worker will be **until after** the unit of labor is hired. You may seek to mutually agree upon a wage with any worker. However, the only thing you will know at the time of making a wage agreement with any worker is the group to which he/she belongs for that round. **Typically, the workers do not know how productive their labor will be for an employer either (they only know the group to which they belong for that round).** Workers see the same general worker characteristics that you see above.

Once the round is over, for all employers who hired a unit of labor, a random number between 0 and 99 will be drawn by two rolls of a 10-sided die. The first roll will determine the first digit, and the second roll will determine the second digit (so, 0 is accomplished by 0 twice). A separate and private number will be drawn for each employer. Profits for each employer can then be calculated using the random draw of productivity to determine the total revenue that is generated by that unit of output. Your total costs are still just the agreed-upon wage for the unit of labor that you hired.

Finally, it is important for you to realize that each new round under this set of instructions will be conducted similarly. You may have made a wage agreement with a particular individual in a previous round which resulted in a productivity of 1, 2, 3, 4, or 5. However, that does **not** affect in any way the probabilities for productivity for a future round, **even if you re-hire the same person**. In other words, if you make an agreement with Jane Doe in round one, and the random productivity draw says that the productivity for that unit of labor is 3, that does **not** imply that you can make an agreement with the same Jane Doe in the next round and be guaranteed a productivity of 3. The productivity that Jane Doe's unit of labor provides for you or any other employer in any round will always be determined by a new random number draw and the group to which the worker belongs. Each round should be treated as independent from any other round in terms of determining worker productivity after agreements have been made—even though the overall pool of workers is still physically composed of the same individuals. Please raise your hand if this is confusing in any way!

Each decision round is ***2.5*** minutes long, and the experiment will continue in this fashion until you are given different instructions. If you and a worker agree on a wage for a given round, the Decision sheet also includes a space for you to **document both the identification number and the Group affiliation** of the worker you purchased your unit of labor from for that round.

Your decision sheet for these rounds is attached to these instructions. Please raise your hand if at any point you have questions about how each round will proceed and/or how to correctly fill out your decision sheet.

Decision Sheet for S1-T1 **Employer ID#_____**

Employer Decision Sheet						
Round #	**Productivity of Worker**	**Output price**	**Mutually agreed-upon wage**	**Worker group**	**Worker ID#**	**Profits =(productivity times output price, minus the wage)**
1		**$1**				
2		**$1**				
3		**$1**				
4		**$1**				

TOTAL PROFITS FOR THIS DECISION SHEET______________

INSTRUCTIONS: WORKERS (General)

This is an experiment in economic decision-making. Please read and follow the instructions carefully. Your decisions as well as the decisions of others will help determine your total cash payment for participation in this experiment.

In this experiment, you are a **Worker**. Other individuals in the experiment will be employers. As a worker, you will have the ability to sell *one* unit of labor (at most) in each decision round to only one employer. You may wish to do this because selling a unit of labor will provide you with a wage for that round. You will have the ability to sell a unit of labor in each round for a series of decision-making rounds. In each decision round, your experimental earnings will be determined by the wage you can obtain from selling your unit of labor. Employers may be interested in paying you a wage for your unit of labor because your labor produces output for the employer, which we will assume the employer can sell for profit.

You will receive specific and more detailed instructions on labor productivity shortly.

You are *not* required to sell a unit of labor in each round. Rather, if you do not sell a unit of labor in a given round, you will still earn a minimal $.80 for that round. If you do sell your one unit of labor in a given round, then your experimental earnings for that round will be the wage you mutually agree upon with the employer. For example, if you agree with an employer to sell your unit of labor for $1.50, then your earnings for that round would be $1.50 (one experimental dollar). If you agree with an employer to sell your labor for $.25, then your earning for that round would be $.25. If you do not sell your unit of labor to any employer, then your earnings for that round are $.80. As such, your experimental earnings would be higher if you did **not** sell your unit of labor in a given round, as opposed to selling it for less than $.80. **The way in which you earn money in this experiment (through wages) is private information to you and should not be discussed with other workers or with the employers**

In this experiment, there are a total of ***5*** employers and ***10*** workers. Each worker in the experiment has the ability to sell one unit of his labor to only one employer in each decision round, and each employer can hire only one unit of labor per decision round. As a worker, you will be allowed to freely “shop” around among the employers in your attempt to sell one unit of labor for the round. Similarly, each employer will be allowed to freely shop among the pool of workers in order to hire his/her unit of labor. Each round will last for a maximum of ***2.5*** minutes. The wages you and an employer mutually agree to and your per-round experimental profits will be calculated on the Decision Sheet that you have also been given. If you and an employer agree upon a wage for given round, the Decision sheet also includes a space for you to **document the identification number** of the employer you sold your unit of labor to for that round. You are **not** allowed to communicate with other workers in this experiment.

FOR TODAY’S EXPERIMENT, YOUR CASH EARNING ARE RELATED TO YOUR EXPERIMENTAL EARNINGS BY THE FOLLOWING EXCHANGE RATE:

$1 EXPERIMENTAL=$ _1_U.S.

INSTRUCTIONS: WORKERS (SAMPLE TREATMENT)

For the next few rounds, different workers may have different productivities, and the productivity of any given worker will **not** be known until after a wage agreement has been made with that worker for that round. Everyone will, however, be given some general information on the workers' productivity for this set of rounds.

Specifically, you as a worker will be randomly assigned as belonging either to Group G2 or Group G5 for the next few rounds, and your productivity for a potential employer will be determined by the characteristics of the group to which you are assigned. The characteristics of these two groups of workers are as follows, and productivity is ultimately determined by drawing a random number between 0 and 99:

Group	**Productivity characteristics**	**Random # determines productivity**
Group G2 characteristics	10% chance that a worker has productivity of 1	(random # 00-09)
	10% chance that a worker has productivity of 2	(random # 10-19)
	60% chance that a worker has productivity of 3	(random # 20-79)
	10% chance that a worker has productivity of 4	(random # 80-89)
	10% chance that a worker has productivity of 5	(random # 90-99)
Group G5 characteristics	1% chance that a worker has productivity of 1	(random # 00)
	39% chance that a worker has productivity of 2	(random # 01-39)
	27% chance that a worker has productivity of 3	(random # 40-66)
	25% chance that a worker has productivity of 4	(random # 67-91)
	8% chance that a worker has productivity of 5	(random # 92-99)

Neither you nor the employers know exactly how productive a worker will be until after the unit of labor is hired. **You are required to display your current Group ID badge in each round, which will be randomly drawn at the beginning of each round.** You may seek to mutually agree upon a wage with any employer, but the employer will not know your productivity for that round until after you have made your wage agreement with the employer (he/she will only know the group to which you belong). Please recall that you are **not** allowed to communicate with other workers in this experiment, and doing so will result in you being disqualified from the experiment.

Once the round is over, for all employers who hired a unit of labor, a random draw will be made to determine the productivity of the unit of labor (for the purposes of the employer's calculation of profits). A separate draw will be made for each employer. As a worker, your experimental earnings for each round are still determined by the wage agreed upon with the employer (or $.80 in a round when you do not sell your unit of labor to any employer).

Finally, it is important for you to realize that each new round under this set of instructions will be conducted similarly. An employer may have made a wage agreement with you in a previous round which resulted in a productivity of 1, 2, 3, 4, or 5. However, that does **not** affect in any way the probabilities for your productivity for a future round. In other words, if you make an agreement with an employer in round one, and the random productivity draw says that the productivity for your unit of labor is 3, that does **not** imply that your productivity is guaranteed to be 3 in the next round. The productivity that your unit of labor provides to any employer (even then same one) in any round will always be determined by a new random draw. Each round should be treated as independent from any other round in terms of determining worker productivity after agreements have been made—even though the overall pool of workers is still physically made of the same individuals. Please raise your hand if this is confusing in any way!

Each decision round is ***2.5*** minutes long, and the experiment will continue in this fashion until you are given different instructions. If you and an employer agree upon a wage for given round, the Decision sheet also includes a space for you to **document the identification number** of the employer you sold your unit of labor to for that round, as well as document your own Group affiliation for that round.

Your decision sheet for these rounds is attached to these instructions. Please raise your hand if at any point you have questions about how each round will proceed and/or how to correctly fill out your decision sheet.

Decision Sheet for S1-T1 **WORKER ID#_____**

Worker Decision Sheet				
Round #	**My worker Group #**	**Mutually agreed-upon wage**	**Employer ID#**	**Earnings =(agreed-upon wage *or* $.80 if your unit of labor was not sold)**
1				
2				
3				
4				

TOTAL PROFITS FOR THIS DECISION SHEET______________