# Discrimination: Theory

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MIT 14.662

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# Classic topic, but still a very active area of research

- PNAS (2012): hiring for academic lab manager positions
  - Anecdotes about post-docs/parental leave, clerkships
- PNAS (2015): hiring for faculty positions
- Now-famous 2005 Larry Summers comment

1. Discrimination: Preliminaries
   - Empirical regularities in group differences
   - Sources of group differences
   - Defining discrimination
2. Taste-based discrimination
3. Statistical discrimination
4. Looking ahead

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# Preliminaries

We observe systematic and persistent differences in labor market outcomes across men and women, and across racial groups

- Wages, employment rates, non-wage compensation, job mobility...
- In theory, could be fully explained by other models that we have covered in 14.661/662
- But economists have long focused attention on the idea that discrimination may also be relevant
- Age, beauty, ethnicity, handicap, height, obesity, sexual orientation...

Two excellent review articles:

1. Altonji and Blank (1999) *Handbook of Labor Economics* chapter
2. Lang and Lehmann (2012) *JEL* review

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# Empirical regularities in group differences

Although models of discrimination can be applied in a variety of contexts, focus here on black/white labor market outcomes

- Goal is *not* to address whether observed group differences are explained by discrimination (that is the task of next lecture)
- Rather, goal is to review facts theories should try to explain

# Focus here is on men

- Lang and Lehmann argue that differences in the patterns of participation between black and white women make analysis difficult
  - Non-participation among prime-age males is concentrated among low-skill workers regardless of race
  - In contrast, same is not true for women

# Raw vs. conditional wage gaps

- We will see on the next slide that there is a large raw wage differential between black and white men
- As we will discuss more in the next lecture, much of this wage differential can be explained by differences in the skills these men bring to the labor market
  - By adolescence, on tests of cognitive ability, the differential between blacks and whites is typically on the order of one standard deviation
  - Potential influences on that test score gap discussed by Lang and Lehmann include residential segregation and school quality

# Brief note on wage gaps for women

- Lang and Lehmann argue we know much 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, and have at times been reversed
- However, this is thought to at least partially reflect 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 understatement of the black-white wage gap among women

# Neal (2004) on women

- Black-white wage gap smaller for women than for men
- LFPR similar for black-white women, but:
  - Non-working white women: high-education married mothers
  - Non-working black women: lower education single mothers

**The Measured Black-White Wage Gap among Women Is Too Small**

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Derek Neal

*University of Chicago*

# Time trends in earnings gap

- Large "raw" earnings gap for men

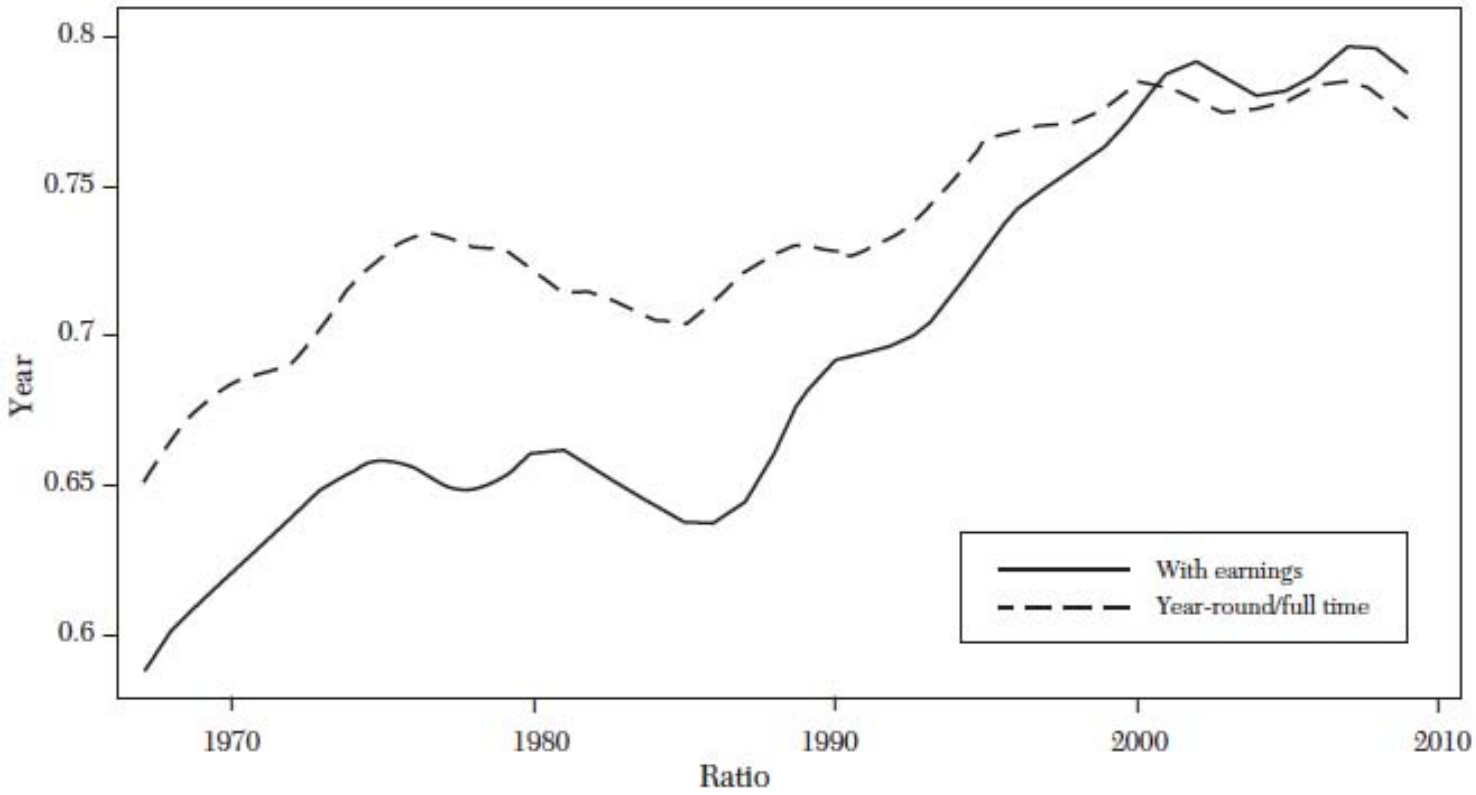



*Figure* 1. Ratio of Median Earnings: Black Men/White Men, 1967–2009

# Time trends in earnings gap

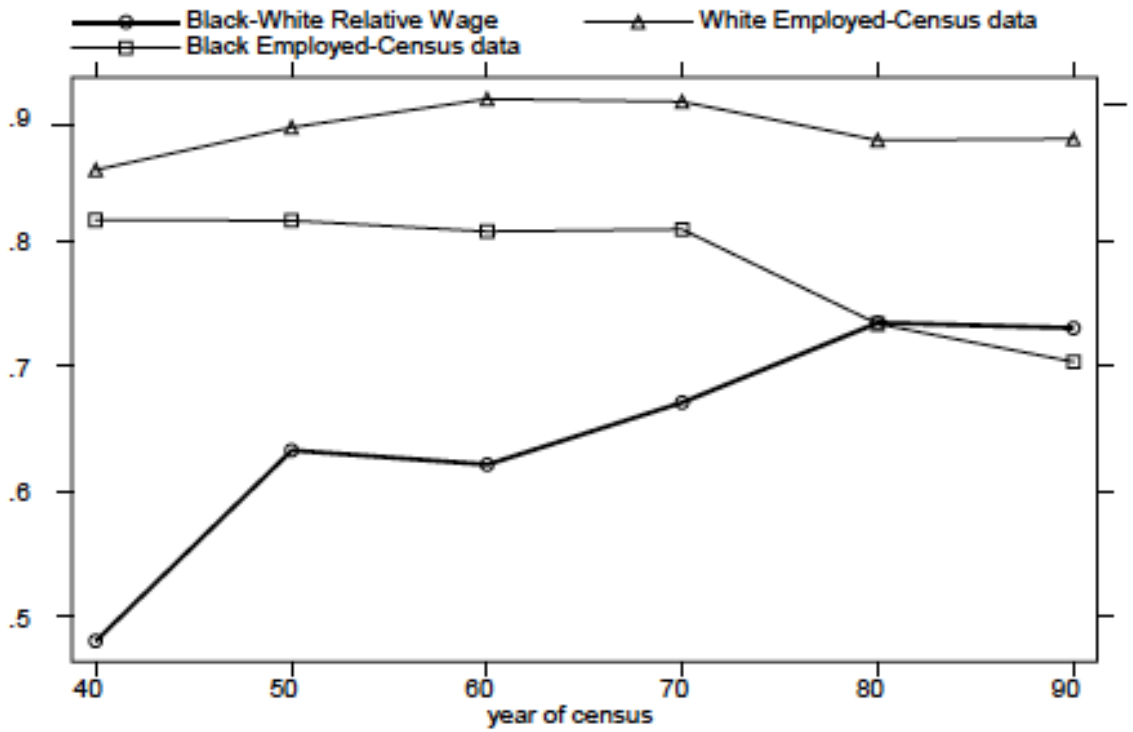
- Relative earnings of black men in these groups rose sharply from the late 1960s until the mid-to-late 1970s, and then fell somewhat until the mid-1980s, after which they rose again until roughly 2000; they have since remained flat
- Lang and Lehmann stress these patterns should not solely be ascribed to changes in labor market discrimination. Other important factors:
  - Changes in labor force participation of black men
  - Changes in relative quantity/quality of education

# Time trends in racial wage and employment gaps

- Large emp-to-pop gap $\Rightarrow$ complicates interpreting wage gap
- Could also be changing selection in addition to aggregate gap

**Figure 1: Black-White Relative Wages and Employment Population Ratios, for Men aged 25-55**

**Panel A: All Schooling Groups**




Courtesy of Amitabh Chandra. Used with permission.

# Time trends in racial wage and employment gaps

- Lang and Lehmann argue that much less attention has been paid to racial employment and unemployment differentials than to wage differentials, even thought the former are in many ways more dramatic
- Unlike the black-white wage gap, very little of the unemployment differential can be accounted for by education or other characteristics

# Time trends in racial attitudes

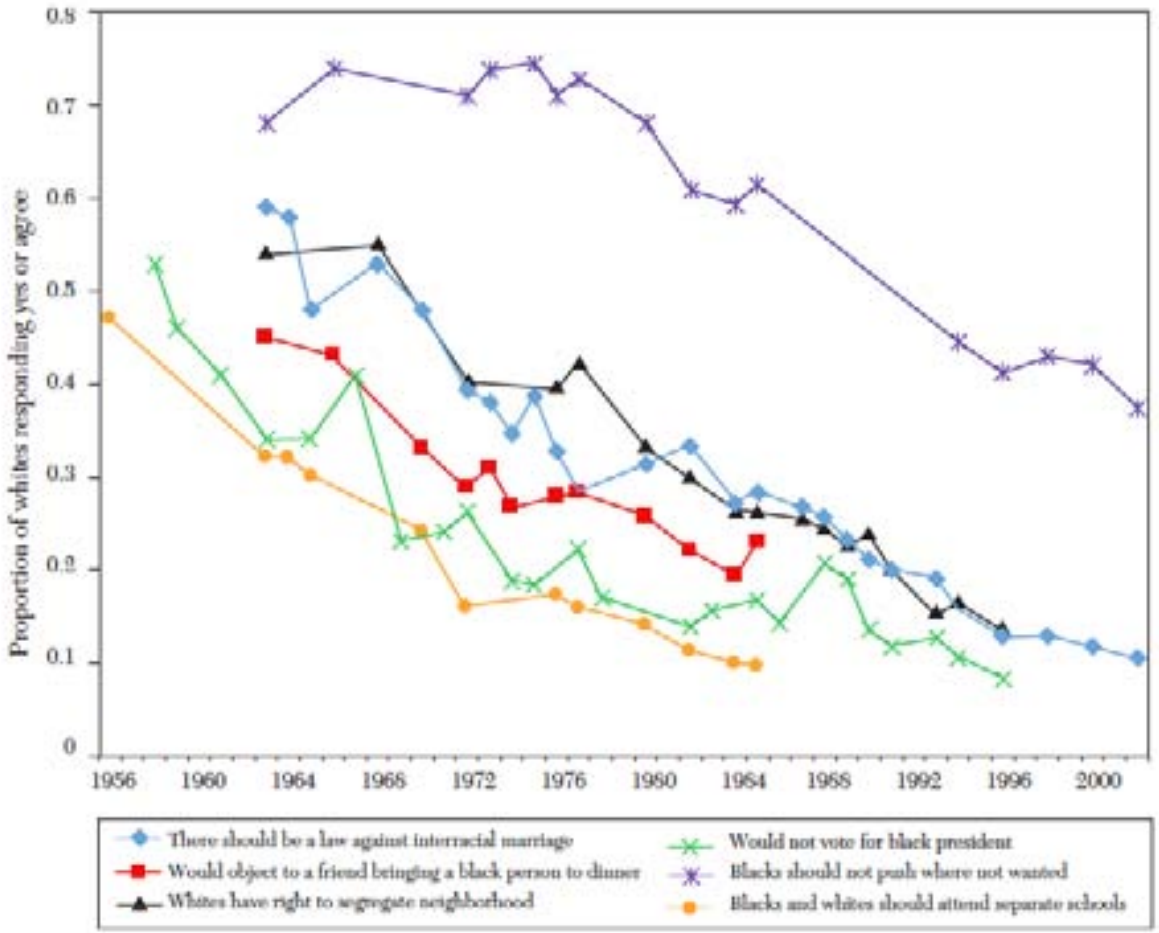



*Figure* 3. Trends in Prejudice Measures, 1956–2003.

Courtesy of Kevin Lang, Jee-Yeon K. Lehmann, and the American Economic Association. Used with permission.

# Time trends in racial attitudes

- Large declines over time in expressions of prejudiced views on issues such as school segregation, social interaction, and blacks in politics
- Caveat: whites may be more cautious in expressing what are now socially unacceptable views, but note that behavioral evidence supports some degree of real change
- Example: share of Americans reporting disapproval of marriage between a white and a black declined from 94% in 1958 to 17% in 2007; the frequency of black-white marriages increased over eight-fold over the same time period, albeit from a very low level
- Whether more subtle or subconscious forms of prejudice have also declined is an ongoing topic of current research

# Lang-Lehmann summary

Lang and Lehmann argue that a theory of discrimination should 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.
2. There is a notable employment gap between blacks and whites that is somewhat smaller among high-skill than among low-skill workers. Black have both longer unemployment duration and a higher rate of entry into unemployment.
3. The black-white earnings gap has fallen, albeit sporadically, over the last five decades, 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.

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# Sources of group differences

Altonji and Black distinguish two sources of group differences:

1. Group differences in preferences, comparative advantage, skill
2. Labor market discrimination

Our focus (and Altonji and Blank's focus) is on (2), not (1)

- Where do differences in preferences come from?
- Importance of comparative advantage likely declining
- Endogeneity of skill investments

Altonji and Blank conclude (1) may complement (2)

- See also Bertrand (2011) *Handbook* chapter on gender

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# Defining discrimination

Arrow (1973) motivates his definition of discrimination as follows: *"The fact that different groups of workers, be they skilled or unskilled, black or white, male or female, receive different wages, invites the explanation that the different groups must differ according to some characteristic valued on the market. In standard economic theory, we think first of differences in productivity. The notion of discrimination involves the additional concept that personal characteristics of the worker unrelated to productivity are also valued on the market."*

- Altonji and Blank adopt a similar definition

# Defining discrimination

- $Y_i$: log wage
- $X_i$: exogenous vector of productivity determinants
- $Z_i$: indicator for membership in a group
- Minority group is discriminated against if $\alpha < 0$:

$$Y_i = \beta X_i + \alpha Z_i + e_i$$

# Defining discrimination

Three problems:

1. How to define "equal productivity"?
   - Becker: *"...discrimination and prejudice are not usually said to occur when someone prefers looking at a glamorous Hollywood actress rather than at some other woman..."*
   - Related to literature on "beauty premium"
2. Technology determining $\beta$ may not be exogenous
   - Example: fire-fighting
3. Investments in $X_i$ may be a function of pre-market discrimination or expectations of labor market discrimination

# Theories of discrimination

- Economic models of discrimination can be divided into two classes:
  - Taste-based: Becker (1957) *The Economics of Discrimination*
  - Statistical: Phelps (1972), Arrow (1973), Aigner-Cain (1977)
- Initially applied to race and gender
  - Later applied to beauty, obesity, ethnicity...

# Taste-based discrimination

- Becker model: "taste for discrimination"
  - *As if* willing to pay to associate with some persons, not others
  - *E.g.* act as if blacks more expensive to hire than they are
- Strange feature (Becker, Arrow): prejudiced employers will be driven out of the market in a long run competitive setting
  - Doesn't predict equilibrium wage differentials
  - Arrow: Becker's employer discrimination model "predicts the absence of the phenomenon it was designed to explain"
- Modifications that can generate equilibrium wage differentials
  - Nepotism: Goldberg (1982)
  - Search and adjustment costs: Black (1995), Lang *et al.* (2005)
  - Employer-employee transitions: Charles-Guryan (2008)

# Taste-based discrimination

- Classic reference:
  Becker's 1957 book
- Focus on employer model
  (not employee, consumer)
  - Models are very similar
  - Some interesting contrasts:
    Borjas-Bronars (1989) on
    consumer discrimination and
    self-employment

# Model

- Two groups: $a$ is majority, $b$ is minority
  - Perfect substitutes in production
- Some employers are prejudiced against group $b$
- $d$: "coefficient of discrimination" (firm taste parameter)
- Employers maximize utility (not profits):

$$U = pF(N_b + N_a) - w_a N_a - w_b N_b - dN_b$$

where $p$ is price, $F$ is production function, $N_g$ is employment of members of group $g$, and $w_g$ is wage paid to members of group $g$

# Prejudiced employers

- Prejudiced employers:
  - $d > 0$
  - Act as if price of hiring $b$ worker is $w_b + d$
- Employer will hire $b$ workers only if $w_a - w_b \geq d$
- $G(d)$: CDF of prejudice parameter $d$ in population of firms

# Hiring

Firms choose $N_a$ and $N_b$ according to:

$$\begin{aligned} \frac{dU}{dN_a} &= 0 \\ \Rightarrow pF'(N_b + N_a) &= w_a \end{aligned}$$

for firms that hire $a$ workers, and:

$$\begin{aligned} \frac{dU}{dN_b} &= 0 \\ \Rightarrow pF'(N_b + N_a) &= w_b + d \end{aligned}$$

for firms that hire $b$ workers

# Equilibrium

- Treat price $p$ as fixed
- Market demand: $N_b^d(w_a, w_b; G(d))$, $N_a^d(w_a, w_b; G(d))$
- Market supply: $N_a^s(w_a)$, $N_b^s(w_b)$
- Wages for the two groups determined by:

$$\begin{aligned} N_a^d(w_a, w_b; G(d)) &= N_a^s(w_a) \\ N_b^d(w_a, w_b; G(d)) &= N_b^s(w_b) \end{aligned}$$

# Equilibrium: Intuition

- Wage differential ($w_b < w_a$) will arise if share of employers who are prejudiced is sufficiently high that demand for $b$ workers when $w_b = w_a$ is less than supply
- That is, segregation could "solve" if few prejudiced $\Rightarrow$ no wage gap
- But if prejudicial employers are a large share of the market, then as in a Rosen-style model:
  - Sorting. $b$ workers are employed by the least prejudiced firms; only marginal firms hire both groups
  - Marginal preferences. Price of $d$ determined by preference of least prejudiced employer who hires $b$ workers, *not* by average prejudice

# Becker (1957): Implications and revisions

- Discriminating employers earn lower profits
  ($d = 0$ firms will pay less for their labor by hiring $b$ workers)
- Free entry or CRS: "competed out of the market" in long run
- Three subsequent proposed modifications to the Becker framework that can generate equilibrium wage gaps:
  1. Nepotism: Goldberg (1982)
  2. Search and adjustment costs: Black (1995), Lang *et al.* (2005)
  3. Employer-employee transitions: Charles-Guryan (2008)

# Nepotism: Goldberg (1982)

- Reformulates model in terms of "nepotism" towards whites instead of "discrimination" towards blacks
  - Re-writes $d$: firm acts as if white wage is lower than it is (firm earns non-monetary utility from hiring white workers)
- Sellout price of the firm is utility level, not money profit level
  - Becker: discriminating employers should be willing to sell their firm to non-discriminators (who can earn higher profits)
  - Goldberg: nepotistic employers earn a non-pecuniary return from staying in the market
- Goldberg model can generate long-run wage differentials

# Search costs: Black (1995), Lang *et al.* (2005)

- Two types of search models have been exposited:
  1. Random search models (Black 1995)
  2. Directed search models (Lang *et al.* 2005)
- Both generate long-run wage differentials
- Employee discrimination with search: Sasaki (1999)
- Customer discrimination with search: Borjas-Bronars (1989)

# Employer-employee transitions: Charles-Guryan (2008)

- NBER working paper version of Charles-Guryan (2008)
- In the long run prejudiced employers have two options:
  1. Be unprofitable
  2. Shut down, transition to be a worker at another firm
- If prejudiced employers consider outside option of co-worker interactions they will have if they shut down the firm, prejudiced employers may not shut down in long run

# Empirical test

Conditional on being hired, discriminated group should be better qualified

More on this next lecture

# Statistical discrimination: Overview

Two main strands of literature on statistical discrimination:

1. Group differences in precision of information employers have about individual productivity: Aigner-Cain (1977)
   - Relevant if race, gender correlated with productivity
2. Employers have prior beliefs (stereotypes) about productivity of group members: Phelps (1972), Arrow (1973)
   - Key issue in second strand of literature: biased employer beliefs may be self confirming if payoff for hard-to-observe worker investments depends on employer beliefs
   - Discrimination lecture #3: Coate and Loury (1993)

# Model

- Employers base hiring decisions on an indicator of skill $y$ (say, a test) that measures a worker's true skill level $q$
- Measurement equation: $y = q + u$
  - $u \sim N(0, \sigma_u^2)$
  - $u$ is independent of $q$
  - $q \sim N(\alpha, \sigma_q^2)$.
- Employers observe $y$ but not $q$:
  use $y$ to extract information about $q$
- Want to derive employer's predicted value of true skill $q$ given observed indicator of skill $y$: $\hat{q} = E[q|y]$

# Deriving $\hat{q}$

1. $u$ is independent of $q \Rightarrow$
   - $cov(u, q) = 0$
   - $q$, $u$ joint normally distributed: $\binom{q}{u} \sim N\left(\binom{\alpha}{0}, \begin{pmatrix} \sigma_q^2 & 0 \\ 0 & \sigma_u^2 \end{pmatrix}\right)$
2. $y$ is a linear combination of two $\sim N$ random variables $\Rightarrow$
   - $y \sim N(\alpha, \sigma_q^2 + \sigma_u^2)$
3. Recall: a property of the bivariate normal distribution is that if $X$ and $Y$ are jointly normally distributed with means $\mu_x$ and $\mu_y$, variances $\sigma_x^2$ and $\sigma_y^2$, and correlation $\rho_{X,Y}$, then the conditional distribution of $Y$ given $X = x$ is normally distributed $\sim N\left(\mu_y + \rho_{X,Y}(\frac{\sigma_y}{\sigma_x})(x - \mu_x), \sigma_y^2(1 - \rho_{X,Y}^2)\right)$ where $\rho_{X,Y} = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$

# Deriving $\hat{q}$

$$\begin{aligned}
\hat{q} &= E(q|y) \\
&= \mu_q + \rho_{y,q}\frac{\sigma_q}{\sigma_y}(y - \mu_y) \\
&= \mu_q + \frac{cov(y,q)}{\sigma_y\sigma_q}\frac{\sigma_q}{\sigma_y}(y - \mu_y) \\
&= \mu_q + \frac{cov(y,q)}{\sigma_y^2}(y - \mu_y)
\end{aligned}$$

Substituting $\mu_q = \mu_y = \alpha$, we have:

$$\begin{aligned}
\hat{q} &= \alpha + \frac{cov(y,q)}{\sigma_y^2}(y - \alpha) \\
&= \alpha - \alpha\frac{cov(y,q)}{\sigma_y^2} + y\frac{cov(y,q)}{\sigma_y^2} \\
&= \alpha\left(1 - \frac{cov(y,q)}{\sigma_y^2}\right) + y\frac{cov(y,q)}{\sigma_y^2}
\end{aligned}$$

# Deriving $\hat{q}$

Letting $\gamma$ denote $\frac{cov(y,q)}{\sigma_y^2}$, we thus have:

$$\hat{q} = (1-\gamma)\alpha + \gamma y$$

This is a signal extraction problem: the expectation of a worker's productivity is a weighted average of her test score $y$ and the group average $\alpha$, where weights are determined by $\gamma$

# Re-writing / interpreting $\gamma$

$$
\begin{aligned}
\gamma &= \frac{cov(y,q)}{\sigma_y^2} \\
&= \frac{cov(q+u,q)}{var(q+u)} \\
&= \frac{cov(q,q)+cov(u,q)}{var(q)+var(u)+2cov(q,u)} \\
&= \frac{var(q)+0}{var(q)+var(u)+2\cdot 0} \\
&= \frac{var(q)}{var(q)+var(u)}
\end{aligned}
$$

If the test is less informative (higher $var(u)$) gamma will be smaller, employers put more weight on group average $\alpha$ in $\hat{q}$

# Two groups: whites and blacks

Now consider two groups of workers: whites and blacks, possibly different means ($\alpha_w$ and $\alpha_b$) and variances of $q$ and $u$

Employers assumed to pay workers based on data available for each group:

$$\begin{aligned} \hat{q}^w &= (1-\gamma^w)\alpha^w + \gamma^w y \\ \hat{q}^b &= (1-\gamma^b)\alpha^b + \gamma^b y \end{aligned}$$

In general, $\gamma^w \neq \gamma^b$ if variances of $q$, $u$ differ.

If test is more informative for whites ($var(u_b) > var(u_w)$) then $\gamma_w > \gamma_b \Rightarrow$ employers put more weight on individual test scores for whites than blacks

# Special cases

Two special cases of this model are frequently exposited:

1. Mean differences, equal variances:
   $\alpha_b < \alpha_w$, $var(u_b) = var(u_w)$, and $var(q_b) = var(q_w)$
2. Equal means, different variances:
   $\alpha_b = \alpha_w$, $var(u_b) > var(u_w)$, and $var(q_b) = var(q_w)$

# Mean differences, equal variances

- Assume $\alpha_b < \alpha_w$, $var(u_b) = var(u_w)$, and $var(q_b) = var(q_w)$
- Phelps (1972): employers view blacks as having lower skill level on average but test is equally informative for blacks and whites
- Recall our expression for $\hat{q}^g$ for group $g$:
  $\hat{q}^g = (1 - \gamma^g)\alpha^g + \gamma^g y$
- Aigner and Cain's Figure 5 illustrates this case graphically, plotting test score $y$ on $x$-axis and predicted skill $\hat{q}$ on $y$-axis

# Mean differences, equal variances

- Because of differences in means ($\alpha_b < \alpha_w$), predicted $\hat{q}$ lower for blacks relative to whites for a given test score $y$
  - Even though test score is unbiased signal for both workers, expected productivity of blacks is lower than of whites
- Lines for whites and blacks have equal slopes because of the assumption of equal variances for $q$ and $u$ (and hence for $y$)

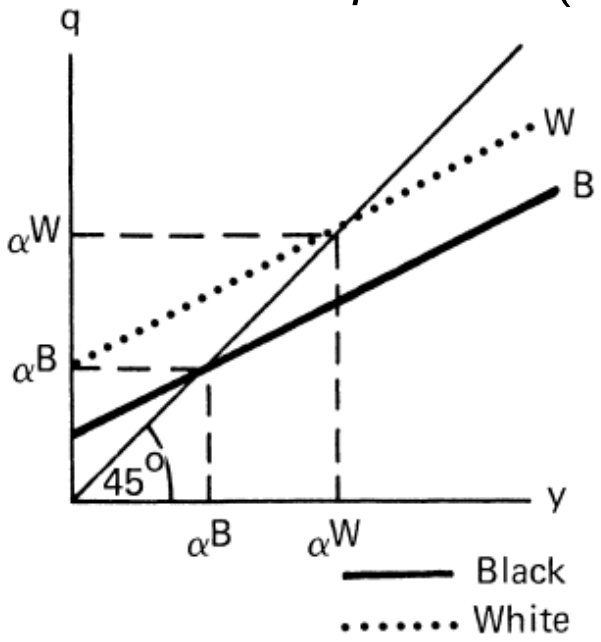


*Figure 5.* Prediction of Productivity (q), by Race and Test Score (y), Assuming the Slopes Are Equal.

# Mean differences, equal variances

When $y_i = \alpha^g$, expectation of $q_i$ conditional on $y_i$ will equal $\alpha^g$:

$$\begin{aligned} \hat{q}^g &= (1-\gamma^g)\alpha^g + \gamma^g y \\ &= \alpha^g - \gamma^g\alpha^g + \gamma^g\alpha^g \\ &= \alpha^g \end{aligned}$$

This clarifies why black line ($B$) intersects 45 degree line at $\alpha_B$, and why white line ($W$) intersects 45 degree line at $\alpha_W$

# Mean differences, equal variances

- Because $u$ is mean zero, the expectation of the test score $y_i$ conditional on $q_i$ is equal to $q_i$ for each group
  - $E(y_i|q_i, g) = E(q_i + u_i|q_i, g) = q_i + E(u_i|q_i, g) = q_i$ since $E(u_i|q_i, g) = 0$ given that $u$ is independent of $q$
  - That is, the expectation of the productivity signal ($y_i$) is equal to true productivity ($q_i$): the signal is unbiased
- However, in general it will not be true that $E(q_i|y_i, g) = q_i$
  - True in some special cases, e.g. $\sigma_u^2 = 0$, in which case $\gamma = 1$ and $E(q_i|y_i, g) = y_i = q_i$
- The expectation of the productivity signal ($y_i$) is equal to true productivity ($q_i$), but the expectation of productivity given the signal is - in general - not equal to actual productivity
- Said differently: there is not equal pay for equal productivity, but there is equal pay for equal expected productivity

# Equal means, different variances

- Assume $\alpha_b = \alpha_w$ and $var(u_b) > var(u_w)$; $var(q_b) = var(q_w)$
- Aigner-Cain (1977): blacks and whites have the same skills on average but test is more informative for whites than blacks
  - For example, differences in cultural characteristics such as language may make it more difficult for employers to understand blacks than whites (Lang 1986)
- Aigner and Cain's Figure 1B illustrates this case graphically, plotting test score $y$ on $x$-axis and predicted skill $\hat{q}$ on $y$-axis

# Equal means, different variances

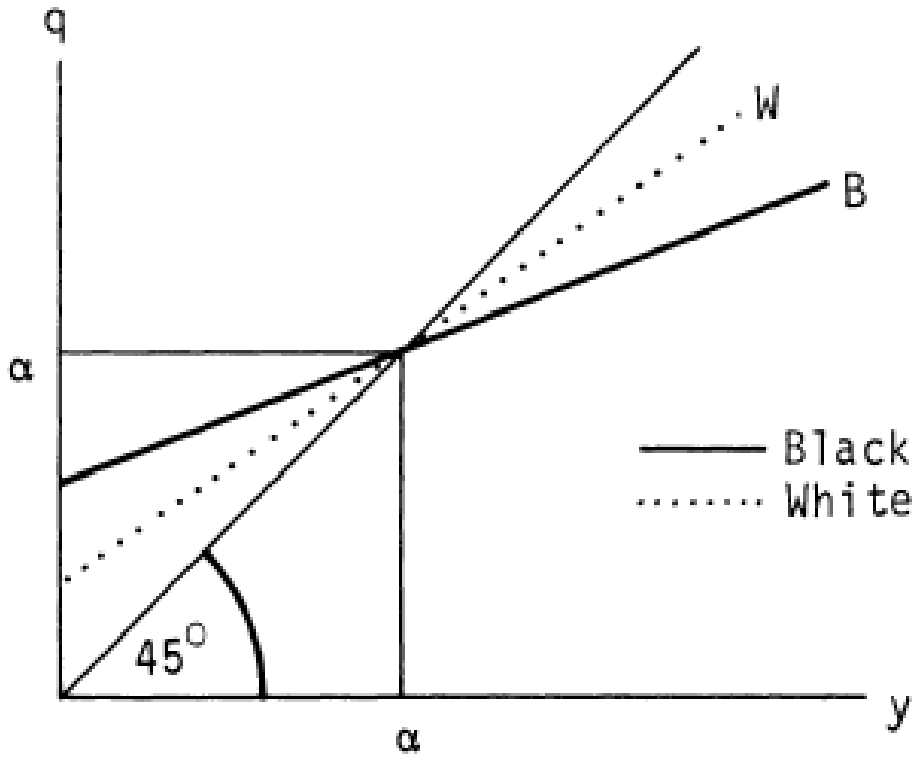


*Figure 1B.* Predictions of Productivity (q) by Race and Test Score (y), Assuming a Steeper Slope for Whites.

# Equal means, different variances

- Each worker is paid according to her expected productivity
  - $\Rightarrow$ equal average wages for the two groups (given the assumption of equal mean skill levels across groups)
- The line for whites is steeper than the line for blacks
  - Because $var(u_b) > var(u_w)$, the $\gamma$ term is smaller for blacks than for whites, implying that for blacks more weight is placed on the group average relative to the individual test score
  - $\Rightarrow \hat{q}$ is less sensitive to $y$ for blacks relative to whites
  - Rotation implies whites with scores $y$ above the mean receive higher wages than blacks, and the reverse is true for $y$ scores below the mean (blacks receive higher wages than whites)
- There is discrimination in the sense that there is different pay granted to individuals with the same test score

# Defining discrimination

- If there is equal pay for equal expected productivity, does that constitute discrimination?
- Depends on definition of discrimination
- Lundberg-Startz (1983) propose an alternative definition:
  - When groups with equal average initial endowments of productive ability do not receive equal average compensation in equilibrium
  - Extend Aigner-Cain framework to accommodate endogenous human capital investments in the presence of labor market discrimination
  - Pset #4

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# Looking ahead

Two more lectures on discrimination

- Discrimination: Empirics
- Discrimination and learning

Please read Goldin-Rouse paper by Friday night

# 14.662 Labor Economics II

Spring 2015