Private Discrimination and Social Intervention in Competitive Labor Markets

By SHELLY J. LUNDBERG AND RICHARD STARTZ*

Do laws forbidding discrimination reduce allocative efficiency? A common thread in economists' discussions of equal opportunity laws has been a presumption that equal pay and/or quota constraints placed on firms act as transfer mechanisms which, as a rule, cause efficiency losses. The implicit model which commentators employ, however, is based on competitive markets with perfect information, so that it is unclear how discrimination could have arisen in the first place.[1] Our purpose in this paper is to consider the efficiency effects of equal opportunity type intervention in the context of a conventional model of discrimination; that is, one which does not depend upon differences in innate ability between groups of workers to produce differences in wages.

The economic analysis of labor market discrimination has produced two general types of models: "taste" discrimination and informational or "statistical" discrimination. Taste models, such as Gary Becker's prototype, produce wage differentials based on the preferences of majority employers, employees, and customers, but of a type which should not generally persist in competitive markets. Statistical models, on the other hand, demonstrate that treating two groups of workers differently may be the rational response of firms to uncertainty about an individual's productivity. In this case, persistent wage differentials may arise between workers with the same productivity who belong to different, identifiable groups, even in competitive markets.

We present a simple model of statistical discrimination and examine the effects of prohibiting group-specific treatment of workers on both net social product and the distribution of income. The agents are competitive firms who pay wages equal to the expected value of a worker's marginal product, conditional upon all information available to them, and income-maximizing workers who decide on the size of their human capital investments based on known wage schedules. Each worker is characterized by a level of innate ability, and by affiliation with one of two groups. Firms are able to assess the marginal product of members of one group more reliably than for the second group's members, and so offer different wage schedules. The main result is that the allocation achieved by rational agents in this labor market can be improved by prohibiting discrimination based on group membership.

I. Imperfect Information and Discrimination

Consider two groups of workers, defined according to race, sex, or some other easily observable, exogenous, characteristic. Each group contains individuals with varying levels of ability or skill which determine their marginal products in any employment. Risk-neutral firms, though they know the density functions which describe the distribution of ability for each type of worker, cannot observe directly the marginal product of an individual i, MP_i. They do, however, observe a test score T_i which is some function of the worker's marginal product and group membership, I_i.

The group index I_i will enter this relationship if the testing procedure differs across groups; that is, is biased or less reliable for one or the other. Since all firms are equally

*University of Pennsylvania and National Bureau of Economic Research; and the Wharton School, University of Pennsylvania, respectively. We acknowledge helpful comments from Charles Brown and an anonymous referee.

[1]For example, Finis Welch, in the course of an illuminating discussion of affirmative action enforcement (1981), constructs a simple model in which equal pay for workers who differ in ability does indeed distort occupational choices and cause efficiency losses.

effective in assessing MP_i via the test, a competitive equilibrium will involve paying each individual a wage, w_i, equal to the expected value of marginal product conditional on the test score and group membership; that is, $w_i = E(MP_i|T_i, I_i)$. The wage schedule $w(T_i)$ will generally be different for the two groups, though for each group the average wage will equal its average marginal product.[2]

Dennis Aigner and Glen Cain (1977) present a simple model of statistical discrimination, based on that of Edmund Phelps (1972), which illustrates the general characteristics of this approach. They assume that the exogenously given (normal) distributions of productivity in each of two groups of workers (black and white) are identical. The test scores which firms observe, however, are more reliable indicators of ability for whites than for blacks. Thus,

$$T_i^B = MP_i + \varepsilon_i^B; \qquad T_j^W = MP_j + \varepsilon_j^W,$$

where $\sigma^2_{\varepsilon^B} > \sigma^2_{\varepsilon^W}$.

It is straightforward to show that the equilibrium wage is a weighted average of mean productivity and the individual's test score, where the test score of a black worker is weighted more lightly than the test score of a white worker. The wage schedule $w^B(T_i^B)$ will have a smaller slope than the schedule $w^W(T_i^W)$, though mean wages will equal mean productivities, which are identical for the two groups. High-scoring blacks will thus be paid less than whites with the same test score; the reverse will be true for workers with low scores.

Does the equilibrium represented in Figure 1 constitute discriminatory treatment of black and white workers? A definition of economic discrimination is required to answer that question. The most literal meaning of "to discriminate" is "to differentiate,"

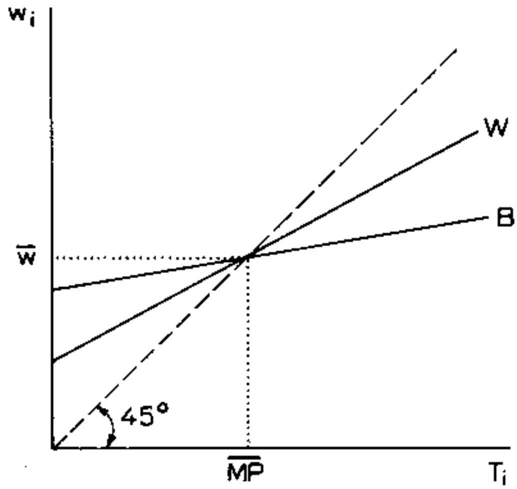

FIGURE 1

and differential treatment alone might be commonly accepted as evidence of discrimination. In this sense, the separate wage schedules faced by two groups of workers with identical distributions of productivity are discriminatory.

However, Aigner and Cain argue cogently that economists should not call this a discriminatory equilibrium, since groups with the same *average* productivity receive the same *average* compensation. Only a violation of this condition would be evidence of discrimination. In a perfectly competitive labor market, where firms pay each worker his expected marginal product according to an unbiased predictor, a nondiscriminatory equilibrium according to Aigner and Cain's definition is guaranteed.[3] Note that in a competitive market with perfect information, the absence of discrimination of the first sort is guaranteed as well. Only systematic differences in the quality of information available for the two groups of workers will cause

[2]We assume that firms are able to assess average group productivity accurately, but not the productivity of individual workers. Wage differentials between equally skilled workers, however, may be allowed to erode slowly as each firm acquires information about individual productivities without changing the essential character of the model.

[3]Aigner and Cain describe a model which relies upon employer risk aversion to produce different mean wages for blacks and whites. This is discriminatory according to the criterion that groups with equal average productivity be paid unequal average compensation. However, each group is still compensated according to its contribution to the value of the firm, which now depends on risk as well as expected productivity.

rational employers to set different wage schedules.

Part of the disagreement over what constitutes discrimination can be traced to the fact that two different questions are being asked. The legal system typically wants to know whether a particular employer is rewarding all employees according to a single standard. Economists are concerned with whether the structure and operation of the labor market is such that workers are compensated efficiently (and perhaps equitably).

What implications do existing informational models of discrimination have for the efficiency of labor market equilibria? Since the wage schedules have no real effects on resource allocation (i.e., on labor supply or on the sorting of workers among jobs in which their productivities differ) the sole effect of discrimination is a redistribution of income among workers with the same level of ability. A crucial assumption is stated by Aigner and Cain, "Our focus is on labor market discrimination, which means we will generally assume that the worker's pre-labor market investments and endowments are given" (p. 177). Figure 1 thus represents a partial equilibrium model in which wages are competitively determined, but the actions and characteristics of workers are taken to be exogenous.

We propose to depart from this framework, and in doing so offer a generalization of the standard definition of economic discrimination.

DEFINITION: *Economic discrimination exists when groups with equal average initial endowments of productive ability do not receive equal average compensation in equilibrium.*

In this paper we recognize that human capital investment decisions will be affected by the presence of labor market discrimination and model this dependence explicitly. If wages are based on the results of an imperfect test, the returns to an investment in skills which cannot be directly observed are reduced. The result is a suboptimal level of human capital which will vary over groups if the quality of testing varies. We show in what follows that equilibrium allocations under this type of imperfect information are discriminatory and can be improved by such simple forms of labor market intervention as enforcing group-blind compensation rules.[4]

II. Informationally Efficient Discriminatory Equilibria

We assume that workers have certain characteristics, both innate and acquired, which determine their productive abilities. These characteristics are distributed randomly in the population. Each worker knows his own characteristics exactly and invests in acquiring human capital to the point where the marginal cost of further investment just balances the increment to wages produced by the increased investment. It is important to note that human capital investments in our model do not consist merely of formal schooling, but of acquired abilities in the more general sense described by Kenneth Arrow: "Hence, the investments are not the usual types of education or experience, which are observable, but more subtle types of personal deprivation and deferment of gratification which lead to the habits of action and thought that favor good performance in skilled jobs..." (1973, p. 27).

Employers know the density function describing the distribution of characteristics through the population and observe a "test score" for each worker that provides information about the worker's marginal product,[5] but do not observe endowed or acquired human capital directly. The employer then offers a wage equal to the conditional expectation of the worker's marginal product. We set out below a simple stochastic model of worker characteristics and calculate the unique linear rational expectations equilibrium.

[4]The idea that anticipated labor market discrimination may affect education decisions has a long history in this literature. For example, it is a major theme in Welch (1967).

[5]This test score need not result from a literal "test," but is simply a summary measure of all information the employer is able to acquire during the hiring process and on the job. It may include, for example, years of formal schooling and years of work experience.

Each worker produces a marginal product MP_i that depends on innate ability a_i and acquired ability X_i. The desired level of X_i can be purchased by each worker at increasing marginal cost, reflecting diminishing returns to time and money spent on training activities and increasing disutility of foregone leisure. Formulae for marginal product and the cost of acquired training are

$$(1)\qquad MP_i = a_i + bX_i;$$

$$(2)\qquad C(X_i) = .5cX_i^2, \quad C'(X_i) = cX_i.$$

In a full-information equilibrium, every worker purchases b/c units of education at a cost $.5b^2/c$. The per capita net social product of education is

$$(3)\quad MP(X_i) - MP(0) - C(X_i) = .5b^2/c.$$

Employers do not observe true productivity, but rather a test score, T_i, for each worker. The test measures the worker's marginal product with a random error:

$$(4)\qquad T_i = MP_i + \varepsilon_i.$$

The worker characteristics a_i and ε_i are drawn from a bivariate normal distribution with known parameters $\bar{a}, \bar{\varepsilon}, \sigma_a^2, \sigma_\varepsilon^2$. We assume that a_i and ε_i are uncorrelated, though this assumption is not crucial. Workers know their own individual characteristics and maximize wages net of education costs. Employers are competitive and maximize profits by setting wages equal to the expected value of marginal product, conditioning the expectation on all available information. The parameters of the joint density function, as well as b and c, are public knowledge.

There exists a unique linear rational expectations equilibrium for wages and human capital investments. In determining this equilibrium, workers look to the wage offer schedule to decide on the optimal level of human capital investment, and firms look to the joint distribution of test scores and marginal product to decide on the wage offer schedule. As a solution technique, we initially write optimal human capital investment as a linear function of worker characteristics with undetermined coefficients, as in (5) below. Properties of the equilibrium solution below allow us to fix unique values for the coefficients and thus completely characterize the equilibrium:

$$(5)\qquad X_i = \rho_0 + \rho_a a_i + \rho_\varepsilon \varepsilon_i.$$

The firm's problem is to establish a wage offer schedule as a function of test scores:

$$(6)\qquad w_i = E(MP_i|T_i) = E(T_i - \varepsilon_i|T_i)$$
$$= T_i - E(\varepsilon_i|T_i).$$

Since the test score is a linear function of normal random variables, the test score itself is normally distributed with mean $\bar{T} = b\rho_0 + (1 + b\rho_a)\bar{a} + (1 + b\rho_\varepsilon)\bar{\varepsilon}$ and variance $\sigma_T^2 = (1 + b\rho_a)^2\sigma_a^2 + (1 + b\rho_\varepsilon)^2\sigma_\varepsilon^2$. The test score T_i and test error ε_i have a bivariate normal distribution with correlation coefficient $(1 + b\rho_\varepsilon)\sigma_\varepsilon/\sigma_T$. The expectation of ε_i conditional on T_i follows immediately:

$$(7)\ E(\varepsilon_i|T_i) = \bar{\varepsilon} + \left[(1 + b\rho_\varepsilon)\sigma_\varepsilon^2/\sigma_T^2\right]\left[T_i - \bar{T}\,\right].$$

For convenience, we write the coefficient of the test score in (7) as $(1-\beta)$. Substituting (7) into (6), we write the wage schedule offered by employers as

$$(8)\qquad w_i = \overline{MP} + \beta(T_i - \bar{T}\,).$$

Note that if $\bar{\varepsilon} = 0$, the individual wage is a simple weighted average of the group mean and individual test scores.

Each worker faces the wage schedule (8) with certainty and invests in human capital to the point where the marginal cost of acquiring more training equals the marginal increase in wages. An additional unit of X increases the worker's marginal product and test score by b, so that wages rise by βb. The equilibrium level of acquired human capital is

$$(9)\qquad X_i = \beta b/c$$

for all workers.

Since the marginal cost of and marginal returns to each unit of X are identical across workers, X is nonstochastic in equilibrium—ρ_a and ρ_ε in (5) are identically zero. The equilibrium value of β is

$$(10) \qquad \beta = \sigma_a^2/\sigma_T^2$$

so that β, which is also the ratio of marginal private to marginal social returns to acquired human capital, is between zero and one and depends only upon the relative sizes of the variances of innate ability and testing error. Since $MP_i = a_i + \beta b^2/c$ and $w_i = \overline{MP} + \beta[(a_i - \bar{a}) + (\varepsilon_i - \bar{\varepsilon})]$, it is easy to show that $\bar{w} = \overline{MP}$ and that $\sigma_w^2 = \beta\sigma_{MP}^2 = \beta\sigma_a^2$.

The net social product of education is

$$(11) \quad MP(X_i) - MP(0) - C(X_i) = \beta(b^2/c)(1 - \beta/_2)$$

so social welfare increases monotonically with β. Private markets result in an underinvestment in education.[6]

We now consider discriminatory equilibria. Suppose that workers are drawn from two subpopulations, the star group (*) and the dagger group (†). We assume the groups have identical mean innate characteristics $\bar{a}$ and $\bar{\varepsilon}$ and the same test variance σ_T^2. The only innate difference between the two groups is that the star group has relatively heterogenous innate ability and relatively homogeneous testing ability as compared to the dagger group.[7] Algebraically, $\sigma_a^2(*) > \sigma_a^2(\dagger)$ and $\sigma_\varepsilon^2(*) < \sigma_\varepsilon^2(\dagger)$. Using (10) we have $\beta^* > \beta^\dagger$.

Employers rationally discriminate between the star group and the dagger group by offering separate wage schedules. Workers in each group respond to their available opportunities and separate equilibria are calculated as above. The star group, whose test scores are more reliable indicators of productivity, becomes the high-wage/high-training group. Every member of the star group acquires $(\beta^* - \beta^\dagger)b/c$ more training than every member of the dagger group, since the marginal return to each unit of X is higher. The average wage for each group, however, is equal to the group average marginal product.

Suppose the star group makes up α percent of the population and the dagger group the remaining $1 - \alpha$ percent. Total training is $(\alpha\beta^* + (1 - \alpha)\beta^\dagger)b/c$ and the net social product of training is

$$(12) \quad \left[\alpha\beta^*(1 - \beta^*/2) + (1 - \alpha)\beta^\dagger(1 - \beta^\dagger/2)\right]b^2/c.$$

Wage schedules for the star and dagger groups are reproduced in Figure 2. Does this situation constitute labor market discrimination? Regression tests of wages against test scores would reveal that the two groups are paid according to different schedules with star workers receiving larger raises for increased test scores, and higher average wages, than dagger workers. As Figure 2 shows, the average wage differential is more than can be explained by the difference in training using either the star or dagger schedule to calculate the wages due to increased training. In fact, for two workers with identical test scores, the star worker will generally receive the higher wage, the situation reversing only at very low test scores.

The legal system would almost certainly consider this equilibrium to be one of illegal discrimination, since dagger workers are generally paid less than star workers even after accounting for all observable individual characteristics. An economist, however, might disagree, since each worker is paid a wage equal to expected marginal product, and the average wage for each group is equal to that group's average marginal product. In our model, however, this is not an adequate test for discrimination, since productivities are

[6] Note that there is a first best policy the government could use to achieve social efficiency. It could order employers to use wage offer schedules with a coefficient of unity on test scores or subsidize wages at a rate of $(1-\beta)$ per unit test score. However, the implementation of such a policy is not likely to be straightforward. We have assumed for simplicity that the test score and marginal product are measured in the same cardinal units, but this need not be true for the purposes of the model. To relax the restriction would require, for a first best solution, that the government know the relationship between test score and marginal product for each employer.

[7] Suppose, for example, that personnel managers are all members of the star group, and are more effective at assessing workers who are members of their own group.

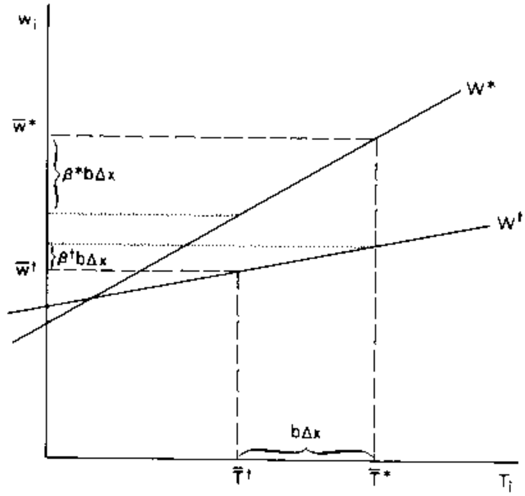

FIGURE 2

endogenous. Differences in group average productivities are a direct result of the incentives provided by employers and embodied in the wage schedule. Since different average wages are paid to groups whose average levels of "premarket" (in this case innate) abilities are the same, the labor market equilibrium depicted above is an example of economic discrimination as defined in Section I.

III. Socially Preferable Nondiscriminatory Equilibrium

We demonstrate that a policy forbidding separate wage schedules for star workers and dagger workers results in an increase in allocative efficiency. Consider the consequences of the following policy restriction: employers may offer wages equal to the expectation of a worker's marginal product conditioned on his test score, but may not consider group membership.

We now derive the linear rational expectations equilibrium by arguments analogous to those in Section II. The key step is the derivation of $E(\varepsilon_i|T_i)$. A few intermediate calculations are required because the joint density function of ε_i and T_i is no longer bivariate normal. Let $f(\cdot)$ represent the density function of the mixture and $f^*(\cdot)$ and $f^\dagger(\cdot)$ represent the densities for the star and dagger groups. The density function of the mixture is

(13)
$$f(\varepsilon_i, T_i) = \alpha f^*(\varepsilon_i, T_i) + (1-\alpha) f^\dagger(\varepsilon_i, T_i).$$

Suppose, as we shall demonstrate, that there exists a linear rational expectations equilibrium. Let β be the (as yet undetermined) coefficient of the test score in the wage offer equation. Every worker, star and dagger, will choose $\beta b/c$ units of education, so that X_i is nonstochastic. The density functions $f^*(\cdot)$ and $f^\dagger(\cdot)$ are therefore bivariate normal as in Section II, except that star and dagger functions share a common mean test score which may differ from the mean test score of either group in the discriminatory equilibrium.

To find the conditional expectation, we need to find the conditional density function $f(\varepsilon_i|T_i) = f(\varepsilon_i, T_i)/f_T(T_i)$, where $f_T(T_i)$ is the marginal density function with respect to T. This marginal is a weighted sum of the star and dagger marginal densities, which are identical by construction, so

(14)
$$\begin{aligned} f_T(T_i) &= \int f(\varepsilon_i, T_i)\, d\varepsilon_i \\ &= \alpha \int f^*(\varepsilon_i, T_i)\, d\varepsilon_i + (1-\alpha)\int f^\dagger(\varepsilon_i, T_i)\, d\varepsilon_i \\ &= \alpha f_T^*(T_i) + (1-\alpha) f_T^\dagger(T_i) \\ &= f_T^*(T_i) = f_T^\dagger(T_i). \end{aligned}$$

The marginal distributions with respect to T are $N(\overline{T}, \sigma_T^2)$ for both the star and dagger group, and therefore for the mixture as well. The conditional density for the mixture is a weighted sum of the individual conditionals, given (13) and (14).

(15)
$$f(\varepsilon_i|T_i) = \alpha f^*(\varepsilon_i|T_i) + (1-\alpha) f^\dagger(\varepsilon_i|T_i).$$

Since expectation is a linear operator,

(16)
$$E(\varepsilon_i|T_i) = \alpha E^*(\varepsilon_i|T_i) + (1-\alpha) E^\dagger(\varepsilon_i|T_i).$$

Using the properties of bivariate normal distributions once again we have

$$(17)\quad E(\varepsilon_i|T_i)=\alpha\left[\bar{\varepsilon}+(1-\beta^*)\left[T_i-\bar{T}\,\right]\right] + (1-\alpha)\left[\bar{\varepsilon}+(1-\beta^\dagger)\left[T_i-\bar{T}\,\right]\right].$$

Notice that the conditional expectation of marginal product will be linear in the test score, even though the conditional distribution is nonnormal.

Conveniently, we can define

$$(18)\qquad \beta=\alpha\beta^*+(1-\alpha)\beta^\dagger,$$

and by setting the wage equal to expected marginal product, we can reproduce the linear wage schedule

$$(19)\qquad w_i=\overline{MP}+\beta(T_i-\bar{T}\,).$$

As a result of the policy restriction on wage schedules, all workers choose the same level of training. Average wages are the same for both groups and individuals with identical characteristics receive identical wages regardless of group membership. While the average marginal products of both groups are now equal, the variability in marginal product is greater for the star group. This implies that an individual employer faced with the equilibrium mixture still has an incentive to discriminate. The privately rational (but illegal) wage schedule pays each group the same on average, but, at high test scores, pays star workers more than dagger workers, and at low test scores, pays dagger workers more than star workers.

How does social welfare in the nondiscriminatory equilibrium compare with social welfare in the discriminatory equilibrium? By substituting (18) into (11) and comparing it with (12), we can see that total training is the same in both cases, but *net social product is higher in the restricted, nondiscriminatory equilibrium*. The improvement in social efficiency occurs because some high cost units of training have been shifted from star workers to dagger workers, for whom marginal training costs are lower. The ratio of nondiscriminatory to discriminatory costs is

$$(20)\qquad \frac{\left(\alpha\beta^*+(1-\alpha)\beta^\dagger\right)^2}{\alpha\beta^{*2}+(1-\alpha)\beta^{\dagger 2}}<1.$$

As an example, consider the case of maximum private discrimination, where $\beta^*=1$, $\beta^\dagger=0$, and the ratio of nondiscriminatory to discriminatory costs is α.

IV. Summary and Conclusions

The model constructed above provides a sparse representation of labor market discrimination. It produces differentials in average wages and rates of return to observable training between groups without appealing to differences in innate ability, risk aversion, or testing bias. We have shown that a competitive equilibrium under certain types of imperfect information can be improved by enforcing equal wage schedules for different groups of workers.

Our specific model can only give specific results. What more general lessons ought we draw about social policy toward discrimination? At a general level, the results of our paper are an example of the theory of the second best. In a first best world, economic agents would use all available information. In a second best world, there is no reason to assume that approaching the first best—using more information—is welfare improving. Since the problem of incomplete information is endemic in situations of discrimination, considerations of the second best are a general concomitant to policy questions in this area.

Specifically, our results arise because social marginal conditions diverge from private marginal conditions. Moving from the discriminatory to the nondiscriminatory equilibrium, we see that one group (the dagger workers) had its private incentives pushed closer to socially correct incentives, while the other group had its private incentives pushed even farther from the socially desirable level. The loss to society from the divergence between private and social incentives varies directly with the distance between the social and private incentives. The gain to society from discrimination, which reduces the small loss for the advantaged workers, is smaller than the loss to society from discrimination, which increases the large loss to the disadvantaged workers. While this result is not invariant with respect to specifications of cost and production functions, neither is it a peculiar case or the result of some special trick.

Our arguments have been intentionally and openly one-sided. We recognize the omission of social costs of antidiscrimination policy which might arise from production losses due to mismatches of workers and jobs, and from the costs to the government of maintaining any sort of social policy which must work against the private incentive structure. However, we believe we have demonstrated the need to be cautious in assessing the allocational consequences of equal opportunity type policies.

The appropriate social response to rational discrimination must be determined by analysis of specific problems. It is not an appropriate response, even for those of us who generally believe in the efficacy of private markets, to dismiss discrimination as something "the market will handle."

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