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The Evolution Of Labor Market Discrimination In Duopsony Contests

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I. Introduction

The standard treatment of labor market discrimination by Becker (1974) assumes that firm owners have a "distaste" for blacks. In equilibrium firms tradeoff the disutility of black employment for profits, resulting in wage differential between equally qualified black and white workers. In this paper, whether or not a whiteowned firm discriminates against black labor is determined by a genetically programmed behavioral phenotype. It is maintained that such a genetic embedding is plausible if fitness maximization is an objective of the human species. Tastes for discrimination are cast in an evolutionary context, where individual firms desire to maximize their fitness. Given that genetic inheritance processes evolve slowly, one could in principle object to using a genetic model of the firm to evaluate discrimination. However, following Ursprung (1988), one can argue that the greatest part of human history to date, has been characterized by situations in which man has lived under the permanent threat of death. It it reasonable therefore to view preferences as having evolved through the process of natural selection.

II. A Model of Duopsonistic Competition

The market consists of a large and finite population of whiteowned sole proprietorships that produce an identical output. The firms compete in random pairwise duopsony contests. Both firms compete against each other for two units of homogeneous of black labor. The competition is stylized as a "fitness" contest in the sense that each firm needs at least one unit of black labor to produce a good that enhances fitness. In particular, the two firms are concerned with maximizing Darwinian fitness, defined as the conditionally expected number of offspring. It is assumed that each firm owner breeds true, all offspring are male, and have the identical behavioral phenotype of the parent. Each unit of produced output sells for a constant price of one, which is equal to the marginal cost of production. It is assumed that the expected number of offspring for the firm owner is proportional to firm profit, and that in the absence of profit, Darwinian fitness is zero. Each unit of black labor has a constant marginal product, and the firm's have a production function given by $q = L^r$, where q is output, L is labor input, and $r > 0$ is a parameter measuring the elasticity of output with respect to black labor input. The wage that firms pay black labor is determined by a behavioral phenotype that is genetically programmed. Two phenotypes are possible. A firm can either have a phenotype that makes it not discriminate against black labor by paying a wage equal to its marginal product, or a firm can have a phenotype that makes it discriminate against black labor by paying a wage of one half of its marginal product. It is assumed that each unit of black labor has no opportunities for firm ownership, and that their fitness depends upon obtaining employment with one of the whiteowned duopsonists. Given that a firm discriminates and the rival does not, the rival firm bids away all the labor in the market, and the discriminating firm is unable to achieve fitness. This is a "loss of fitness" cost, and it captures the essence of strategic interactions in the labor market that may characterize duopsony.

Given the two possible behavioral phenotypes, two types of strategists are possible in the population of firms. Firms that are genetically programmed to pay black labor one half of its marginal product are "Illiberal" strategists, and firms that are genetically programmed to pay black labor its marginal product are "Liberal" strategists. An equilibrium in this model will be characterized by each firm offering a wage to black labor that maximizes fitness. In principle, there are four possible outcomes, and the equilibrium that emerges requires a solution concept. The approach adopted below will allow the equilibrium to depend upon genetic behavioral phenotypes the owners of the firms have.

III. Equilibrium and Invadability with Asexual Reproduction

For random pairwise contests between firms, the gains to Darwinian fitness are a function of the behavioral phenotype and returns to scale. What are plausible equilibrium outcomes of this fitness contest? If we appeal to rationality on the part of each firm, gametheoretic solution concepts are not helpful. Under rationality, an environment characterized by perfect information will not permit a stable equilibrium in random fitness contests in the sense that no best response or undominated strategies will emerge in the absence of some evolutionary mechanism. Thus, a genetic embedding of behavioral phenotypes permits coherent equilibrium outcomes in the sense that pairwise strategies in the population of firms will be stable or unstable according to the gains to Darwinian fitness realized by each strategy.

Suppose the initial population of firms consists of Illiberals, and a rare mutant Liberal phenotype appears. Under constant returns to scale can these Liberals successfully invade the population? Let the number of these mutant Liberals in the population be $p\ \varepsilon\ (0, 1)$. In random contests between two firms, the probability that an opponent will be a Liberal (Illiberal) strategist is $p\ (1\ \ p\ )$. Two propositions for this game follow below.

Proposition 1: Under perfect competition where $r = 1$, the population of Illiberal strategists is stable against invasion by mutant Liberal strategists.

If the population of Illiberals is to be stable against invasion, the Darwinian fitness of Illiberals must be greater than that of Liberals. Let the Darwinian fitness of Illiberals and Liberals be F(I) and F(L) respectively, then under constant returns to scale, evolutionary stability of the population of Illiberals requires that $F(I) > F(L)$ where:

$$F(I) = p \times 0 + (1\ \ p\ )(1^r\ .50r)$$

$$F(L) = p\ (1^r\ \ 1) + (1\ \ p\ )(2^r\ \ r2^r\ )$$

If $r = 1$, $\pi\ (I,L) = \pi\ (L,L)$, thus evolutionary stability requires $(1\ \ p\ )\pi\ (I,I) > (1\ \ p\ )\pi\ (L,I)$, or:

$$(1\ \ p\ ).50 > 0$$

Thus, for $p < 1$, the population of Illiberal strategists is stable against invasion by Liberal strategists. The Illiberal strategy is also an evolutionary stable strategy (ESS), defined as a strategy such that if, all members of the population adopt it, no mutant strategy could invade the population under the influence of natural selection [Maynard Smith, 1982]. Thus, a market environment characterized by constant returns to scale in production does not provide conditions favorable for invasion by Liberal firms.

Proposition 2: If r is approximately.1988, the population of Illiberal strategists is not stable against invasion by mutant Liberal strategists.

When $r < 1$, the fitness functions for Illiberals and Liberals are respectively:

$$F(I) = (1\ \ p\ )(1^r\ .50)$$

$$F(L) = p \times (1^r\ \ 1) + (1\ \ p\ )(2^r\ \ r2^r\ ) = (1p)(2^r\ \ r2^r\ )$$

Invadability by Liberals requires:

$$(1\ \ r)2^r > 1\ .50r$$

Taking the natural log of both sides, the difference F(L) F(I) is:

$D = ln(1 \quad r) \quad r ln(2) \quad ln(1 \quad .50r)$ Differentiating D with respect to r and solving will yield the value of r that maximizes the difference between F(L) and F(I) for $r \neq 1$.:

$D'_r - \; - \frac{1}{1 \quad r} + ln2 + \frac{.50}{1 \quad .50r}$ simplifying results in the approximate quadratic equation:

$$D'_r \quad .3465r^2 - 1.0396r + .1931$$

with positive roots of approximately .1988 and 2.8014. The second order condition is negative with respect to r =.1988, which establishes that the maximum positive distance between F(L) and F(I) occurs when there are decreasing returns to scale. Thus, Liberal mutant firms can invade the population of Illiberals when there are decreasing returns to scale in the sense that any existing population of Illiberal firms, when r =.1988, is not evolutionary stable. In general, there is a range of values for r < 1, such that F(L) > F(I). Proposition 2 merely establishes the existence of an r that permits Liberal firms to invade.

IV. Natural Selection and Replicator Dynamics

The ESS emphasizes the role of mutation, indicating the conditons under which rare phenotypes can invade a population. If a rare phenotype is favored by natural selection, than the next generation will include such phenotypes. To characterize replicator dynamics, it is assumed that reproduction is continuous. It is also assumed that background fitness is zero, and that the profit of each firm results in a gain to fitness that exceeds the constant date rate of δ in the population of firm owners. The difference between profit and the death rate δ, determines the birth rate of firms. For a given state of the population, the payoff to a pure strategy, and hence the gain to fitness is simply π (i,j). Two propositions characterizing natural selection follow below.

Proposition 3: In a duopsonistic labor market with incumbent Illiberals, if there are constant returns to scale in production the market cannot be populated in the longrun by Liberals.

For an initial population of Illiberal strategists with constant returns to scale, the number of Illiberals (n_I) and Liberals (n_L) will grow over time according to:

$$\dot{n}_I = \frac{dn_I}{dt} = [\pi(I,I) \quad \delta]n_I = [.50 \quad \delta]n_I$$

$$\dot{n}_L = \frac{dn_L}{dt} = [\pi(L,I) \quad \delta]n_L = \quad \delta n_L$$

Given the solutions for n^*_I and n^*_L, the limit of the ratio n^*_L / n^*_I is:

$$\lim_{t \quad >\infty} \frac{n^o_L e^{-\delta t}}{n^o_I e^{(.50-\delta)t}} - \lim_{t \quad >\infty} \frac{n^o_L}{n^o_I} \times \frac{1}{e^{.50t}} - 0$$

where n^o_L and n^o_I are defined at t = 0.

Proposition 4: In a duopsonistic labor market with incumbent Illiberals, if r =.1988 (decreasing returns to scale) the market cannot be populated in the longrun by Illiberals.

Under decreasing returns to scale, Darwinian fitness for Liberal firms is positive. If r =.1988, the number of Illberals and Liberals will grow over time according to:

$$\dot{n}_I = \frac{dn_I}{dt} = [\pi(I,I) - \delta]n_I = [.9006 - \delta]n_I$$

$$\dot{n}_L = \frac{dn_L}{dt} = [\pi(L,I) - \delta]n_L = [.91 - \delta]n_L$$

The limit of the ratio n^*_L / n^*_I is:

$$\lim_{t \to \infty} \frac{n_L^0 e^{(.91 - \delta)t}}{n_I^0 e^{(.9006 - \delta)t}} = \lim_{t \to \infty} \frac{n_L^0}{n_I^0} e^{.0094t} = \infty$$

V. Conclusion

The approach adopted here is neither new or novel, per se. It does however cast further theoretical insight upon how evolutionary processes can alter the traditional neoclassical outcomes where agents are presumed to be rational actors. As Lane, Malerba, et. al (1995) argue, rationality imposes stringent conditions upon the agents involved in a choice situation. In particular, neoclassical models usually offer a representation of context as a choice situation without any consideration as to where the representation comes from. To model discrimination as a taste is in a sense a representation without representation. If however, Darwinian fitness is a relevant context for the human species, then to paraphase Mitchell (1995), evolution is a representation of context that provides a method of searching among an enormous number of possibilities for maximizing fitness. By embedding tastes in behavioral phenotypes that evolve through natural selection, a more coherent context is provided for explaining the choices and behaviors that agents make in the marketplace.

By modelling wage discrimination in an evolutionary framework, at least two insights about the nature of such behavior are revealed. First, discrimination need not be pathological, or based on pure bigotry. The results here suggest that discrimination by white firm owners against black labor represents a favorable adaptation that promotes Darwinian fitness, in a given technological environment. Finally, the results show that wage discrimination need not be based on rationality, where firm owners efficiently tradeoff black employment for profit. In evolution, the efficiency promoting mechanism is not rational utility maximization per se, instead it is natural selection.

References

Becker, G. (1973) The Economics of Discrimination, University of Chicago Pres, 2d ed.

Land, D., Malerba, F., Maxfield, R., and Orsenigo, L. (1995) "Choice and Action", Working Paper #9501-004, Santa Fe Institute.

Maynard, Smith, J. (1982) Evolution and the Theory of Games, New York, Cambridge University Press.

Mitchell, M. (1995) "Genetic Algorithms: An Overview", Complexity, vol. 1, 3139

Ursprung, H.W. (1988) "Evolution and The Economic Approach To Human Behavior", Journal of Social and Biological Structures, vol 11, 257279