A Game Theory Analysis of Dual Discrimination

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A series of experiments with undergraduate management students was conducted to examine the behavioral effects of situations with dual discrimination in an incentive compensation scheme. Subjects were randomly assigned to a disadvantaged or advantaged status and simultaneously were discriminated for or against, in a two-person tournament. A game theoretic model was used to predict the choices subjects in the two conditions of dual discrimination would make if they attempted to maximize monetary outcomes. Results indicated that while the theory of tournaments was capable of predicting the pattern of results, subjects tended to expend more effort than predicted. The implications of these results for the theory and for public policy are discussed.

INTRODUCTION

Individuals within organizations occasionally find themselves in situations where there is some form of discrimination. In such discriminatory situations, some individuals may have an advantage over others in their ability to obtain some outcome, such as being hired or receiving a promotion. To offset such discrimination in the workplace society has enacted various social policies such as affirmative action programs. These policies can create dual discrimination situations where individuals with an initial disadvantage are given preferential treatment, while those with an initial advantage are discriminated against. For example, individuals of a group that has suffered historical discrimination are given preferential treatment in selection and promotion decisions. An important research

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issue is the effects of dual discrimination for both individuals and organizations. When someone has an initial disadvantaged status, perhaps because of past discrimination, what happens to their effort levels when they are given preferential treatment? Conversely, what effect does this dual discrimination have on those individuals who initially began with an advantaged status and then must compete with those who receive the preferential treatment? And finally, what effect does this behavior have on firm performance?

The present research extends recent work on discrimination in a tournament compensation scheme (Weigelt, Dukerich, & Schotter, 1989). That study investigated the effects of one form of discrimination. Subjects were randomly assigned either an advantaged or disadvantaged status and competed against each other in a 20-trial two-person tournament. Results indicated that subjects exerted more effort (i.e., chose decision numbers with higher costs) than the theory of tournaments predicted, although there was no significant difference in the observed effort levels of advantaged and disadvantaged subjects (as predicted by the theory). The present research followed a similar format. In an attempt to replicate and extend the previous discrimination research, a series of experiments were conducted to determine the effects of combining two types of discrimination on subjects' behavior in an incentive compensation scheme.

Using a game theoretic model to study dual discrimination offered several advantages. First, it was possible to manipulate two distinct forms of discrimination to determine their independent and joint effects on behavior. Second, the game theoretic model provided precise behavioral predictions against which observed behavior could be compared. Thus, it was possible to determine the benefits (or costs) of dual discrimination to individuals (in a monetary sense), as well as to the tournament organizer (i.e., the firm). Also, since many researchers believe that game theory is solely normative in nature, the experiments provided a test of the theory's descriptive power. Some experiments on games suggest that subjects deviate from normative theory, and recent research has focused on whether such behavior is systematic (see Camerer, 1989). The results from this study and our previous discrimination study may provide insights into whether subjects do systematically deviate from normative theory and if so why.

In the following section, the theory of tournaments is discussed, and the derivation of subjects' optimal strategies is outlined. Next, a series of experiments are described, followed by a presentation of the results. Finally, research results are discussed in terms of theoretical and practical implications.
THE THEORY OF TOURNAMENTS

Tournaments differ from other incentive schemes in that an individual’s payment in a tournament depends only on his or her performance relative to others in the tournament, as opposed to some absolute level of performance (Green & Stokey, 1983; Lazaer & Rosen, 1981; Nalebuff & Stiglitz, 1983). In a two-person tournament, the performance of one individual is compared to the performance of another. On the basis of this comparison, the high-performance individual receives a higher payment relative to that of the low-performance individual. Tournaments can be either symmetric or asymmetric. In symmetric tournaments, both individuals are identical and have an equal probability of receiving the high payment. Asymmetrical tournaments can have two forms: uneven or unfair (O’Keefe, Viscusi, & Zeckhauser, 1984).

Tournaments are uneven if individuals are not identical, that is, some individuals have greater ability than others and thus must exert less effort to achieve a given level of output. In the theory of tournaments, ability is operationalized as the cost of effort. In an uneven tournament, one group of individuals has a lower cost-of-effort function than another group. Thus, the former group has an advantage since they can more cheaply supply a fixed amount of effort. Tournaments are unfair if individuals are identical (i.e., their cost of effort is the same), but the rules favor one of them. That is, in order to receive the high payment, an individual must not only achieve an output greater than that of the person receiving preferential treatment, his or her output must exceed the latter’s by some specified amount. In order to keep the two types of tournaments distinct, and for ease of presentation, the two groups in uneven tournaments will be referred to as cost advantaged or disadvantaged while the groups in unfair tournaments will be labeled rules advantaged or disadvantaged.

Equal opportunity laws address the issue of unfair tournaments. These laws attempt to force tournament organizers (i.e., the firm) to end discrimination against specified groups of individuals. Policies addressing uneven tournaments are more complex because society must attempt to redress historical discrimination by giving preferential treatment to individuals who have been artificially limited in their ability to obtain education or work experience. Programs like affirmative action sometimes create dual discrimination situations because they give preferential treatment to these disadvantaged individuals by using a type of unfair tournament.

As noted earlier, previous research (Weigelt et al., 1989) has examined the behavioral effects of discrimination in unfair tournaments. The present research attempted to extend these findings by creating dual discrimination situations (similar to situations of affirmative action) and
examined the resulting effects on behavior. Two experiments were conducted to examine the effects of dual discrimination. One group of subjects received an initial advantage by having a lower cost-of-effort function than the disadvantaged group. Dual discrimination was then created by changing the tournament rules: the cost-disadvantaged group was given a higher probability of winning the high payment than the former group. The results compared the amount of effort that individuals were willing to expend in order to win the tournament to that predicted by the theory.

THE NASH SOLUTION

The theory of tournament uses the Nash equilibrium concept (Nash, 1951) to generate precise behavioral predictions. Basically, a Nash equilibrium is composed of strategies such that no individual has an incentive to change his or her strategy given the belief that all others will choose their best corresponding strategy. It is a solution of mutual best response: one person's choice is optimal given that others choose their optimal choices. Solutions are stable because no individual can improve his or her payoff by unilaterally changing his or her strategic choice.

The earlier Weigelt et al. paper formally derived the Nash solution for asymmetric tournaments. We briefly sketch the solution here. In a two-person tournament, it is assumed that both individuals prefer (have greater utility for) the high payment. Thus, both individuals will expend effort in attempting to be the high performance person. The net reward from this effort is not simply the payment received, but the payment received minus the costs associated with the effort expended. This is represented as

$$U_i(p, e) = U_i(p, e) = u(p) - c(e),$$  (1)

where

$U_i = \text{utility function of person } i$

$U_j = \text{utility function of person } j$

$p = \text{a nonnegative payment to the person}$

$e = \text{a scalar representing a person's nonnegative effort level}$

$u(p) = \text{a person's utility for receiving payment } p$

$c(e) = \text{the cost to the person of expending effort } e.$

Effort levels of individuals are not easily observed but do generate an output that is observable. In the absence of perfect monitoring devices, the observed output depends upon the amount of effort expended, plus a random component which is a function of the precision of the monitoring device. Consider this random component as an extraneous uncontrolled
DUAL DISCRIMINATION

situational factor which affects observed individual performance. An individual’s output can thus be represented as

\[ y_i = f(e_i) + \mu_i, \]  

(2)

where

\( y_i = \) the observed output of individual \( i \)
\( f(e_i) = \) a production function with production conditional on the effort expended by individual \( i \)
\( \mu_i = \) a random component.

As previously explained, in a tournament, the person with the higher observed output (\( y \)) receives a high payment (\( M \)), while the person with the lower observed output receives a small payment (\( m \)). Given any pair of effort choices by individuals \( i \) and \( j \), person \( i \)'s probability of winning \( M \) is just equal to the probability that the difference between his or her random component and person \( j \)'s random component is greater than the difference between person \( j \)'s effort level and his or her effort level:

\[ (\mu_i - \mu_j) > f(e_j) - f(e_i). \]

UNEVEN TOURNAMENTS

Recall that an uneven tournament is one where one person has greater ability (i.e., lower cost of effort) relative to another. Using the above equations, the Nash solution for uneven tournaments is defined as:

\[ e_j^* = \frac{c(M - m)/4a\alpha}{1 + [(1 - \alpha)/4a^2](c(M - m)/2a)} \cdot \]  

(4)

where

\( e_i^* = \) the predicted effort level of individual \( i \)
\( e_j^* = \) the predicted effort level of individual \( j \)
\( M = \) the high payment monetary amount to the high performance individual
\( m = \) the low payment monetary amount to the low performance individual
\( c = \) the costs associated with expended effort
\( a = \) the range of the random component
\( \alpha > 1 \), and is a constant.

Intuitively, Eq. (4) states that individuals in a two-person uneven tournament will consider the prize spread (\( M - m \)), the cost of expended effort (\( c \)), the range of the random component (\( a \)), and the differential in their cost-of-effort functions (\( \alpha \)). The theory predicts that cost-
disadvantaged individuals will supply less effort than cost-advantaged individuals, because a given amount of effort is more costly to the former. The expected difference in effort between the two types of individuals will equal the differential in their cost-of-effort functions. For example, if the disadvantaged individual has a cost-of-effort function twice that of the advantaged individual, then his or her expected effort is one-half that of the advantaged individual.

**UNFAIR TOURNAMENTS**

In unfair tournaments, one individual is discriminated against. The degree of discrimination is measured in unit terms by a factor, \( k \). A \( k \) of 25 means that the rules disadvantaged individual's output must exceed that of the rules advantaged individual's output by 25 units or more for the former to receive the high payment \( M \).

The Nash solution for unfair tournaments is defined as

\[
e_i^* = e_j^* = \left[\frac{1}{2} - \frac{k}{4a^2}\right] \left(c(M - m)/2a\right),
\]

where

\[
k = \text{the level of discrimination}.
\]

This equation states that while individuals will consider three of the same factors they do in uneven tournaments (i.e., the spread of the fixed payments, the cost of effort, and the random component), they also consider the level of discrimination \( k \) in choosing effort levels. Note that the theory predicts that both rules-advantaged and -disadvantaged individuals will choose the same level of effort in unfair tournaments.\(^2\) Also, the greater the level of discrimination, the less effort both individuals are predicted to expend.

**DUAL DISCRIMINATION TOURNAMENTS**

In situations of dual discrimination, individuals who have a cost disadvantage receive preferential treatment through the use of unfair tournaments. The Nash solution for dual discrimination situations is defined as

\[
e_j^* = \frac{\left[(1/2a) - (k/4a^2)\right] \left(c(M - m)/2a\right)}{1 + \left[(1 - \alpha)/4a^2\right] \left(c(M - m)/2a\right)}
\]

\[
e_i^* = \alpha e_j^*.
\]

Intuitively, the equation states that the two types of individuals will choose different effort levels, and that the effort differential will depend

\(^2\) The logic underlying this seemingly counterintuitive result is explained in Weigelt et al. (1989).
on the difference in their cost-of-effort functions, and the level of preferential treatment. Individuals with a lower cost-of-effort function are predicted to exert more effort than those at a cost disadvantage; but overall, both groups are expected to exert less effort than in the simple uneven tournament. Appendix A presents the derivation of the Nash equilibrium for the unfair, uneven, and dual discrimination tournaments.

OVERVIEW OF THE TASK

The predictions from the dual discrimination tournament were tested in two experiments. Prior to these experiments, four pilot studies were conducted in which the effects of each discrimination factor were isolated and examined. All experiments used the same parameters except for a ceterus paribus change in one parameter. The basic task involved subjects choosing a decision number which had an associated cost. The greater the decision number, the greater the cost. After selecting a decision number subjects drew a random number and totaled the two. This total represented their performance for that trial. Performance within subject pairs was then compared. The subject within a pair with the higher total number received the high payment $M$, while the other pair member received the low payment $m$. Uneven discrimination was operationalized by creating two different cost-of-effort functions. Unfair discrimination was created by requiring one group of subjects to exceed the performance of their pair member by a specified amount, $k$, in order to receive the high payment. The dual discrimination tournament involved crossing these two forms of discrimination. Subjects with a cost-of-effort disadvantage received preferential treatment and subjects with a cost-of-effort advantage were discriminated against.

PILOT STUDIES

Uneven and Unfair Tournaments

Method

Subjects. A total of 108 (56 male and 52 female) undergraduate students recruited from management and economic courses at a major northeastern university were paid for their participation. Subjects were randomly assigned seats and subject numbers and given written instructions. All of the tournament’s parameters were explained in the instructions, and thus were common knowledge.

Procedure. Subjects were informed that they were participating in a 20-trial decision task. They were instructed that their decisions would be compared to another subject who was randomly chosen as their “pair
member" for the experiment and that the amount of money they would earn was a function of their decisions, their pair member's decisions, and the effects of a random variable. Half the subjects received odd subject numbers and the other half received even numbers. A pair always consisted of one odd numbered subject and one even numbered subject. Subjects were always paired with the same person throughout the 20 trials, although the physical identity of each pair member was never revealed.

Upon entering the room, subjects selected 20 envelopes from a box containing hundreds of envelopes. Within each envelope was a random number ranging from $-60$ to $+60$. Subjects were then asked to select an integer from 0 to 100 (inclusive) as their "decision number." A table associated a cost with each decision number. The first two pilot studies tested predictions from uneven tournaments. The procedure for these two studies was identical; the only factor that changed was the differential between cost functions. Odd numbered (advantaged) subjects had a lower cost function than even numbered (disadvantaged) subjects. In the first pilot study ($\alpha = 2$), the costs of the decision number for the advantaged group were one-half the costs of the disadvantaged group. The second pilot study ($\alpha = 4$) increased the spread between the cost functions by a factor of 4:1. Subjects in the advantaged and disadvantaged groups received both cost tables so that they could see the cost of their pair member's decision, as well as their own.

The same procedure was used for the two pilot studies examining unfair tournaments. However, rather than having different cost functions, a discrimination factor ($k$) was introduced. Subjects were told that the even numbered pair member would only receive the fixed payment $M$ if their total number was 25 or greater (Study 3), or 45 or greater (Study 4), than their odd numbered pair member. All subjects were made aware that the odd-numbered subjects could have a lower total number than their even numbered pair member and still receive the fixed payment $M$.

After the subjects had chosen and recorded their decision numbers they opened one of the 20 envelopes and entered the random number on their worksheets. They then added this number to their selected decision number in order to arrive at their "total number" for that trial. This information was recorded on a slip of paper and collected by the experimenters. Following the collection of subjects' slips, odd numbered subjects' slips were compared to their respective even-numbered pair members' slips. The experimenter then announced which member from each comparison would receive fixed payment $M$ ($\$2.04$). The other pair member received the fixed payment $m$ ($\$0.86$) for that trial. Subjects calculated their payoff for the trial by subtracting the cost of their decision number from the fixed
payment. When trial 1 was completed and the payoffs recorded, the next trial began. All trials were identical.

Following the last trial, subjects calculated their payoff for the experiment by adding up their individual trial payoffs and subtracting a fixed cost. Subjects were then asked to complete a short questionnaire which measured their perceptions of the experiment. This manipulation check determined if subjects accurately perceived their advantaged/disadvantaged status. Subjects were asked on a 7-point scale whether they felt relatively advantaged or disadvantaged compared to their pair member. The experiments lasted approximately 90 min, and subjects earned, on average, $15.93.

The experimenter made great efforts to deemphasize the "game" nature of the experiment. For example, subjects who had the higher total number for a particular trial were referred to as "high-number subjects" rather than "winners." Similarly, M and m were labeled, "fixed payments" rather than "prizes." This was done to encourage subjects to focus less on "winning" the game and more on the monetary payoffs associated with their decisions.

**Results**

**Manipulation check.** A t test was performed on the postexperimental questionnaire data to determine if subjects accurately perceived their advantaged or disadvantaged status. Even numbered subjects felt significantly more disadvantaged than odd-numbered subjects in Study 1 ($t(16) = 3.85; p < .01$), Study 2 ($t(29) = 5.28; p < .01$), Study 3 ($t(21) = 2.32; p < .05$), and Study 4 ($t(30) = 4.06; p < .01$); thus, the manipulations were successful.

**Predicted vs observed mean decision number choice.** Cost-advantaged subjects in the uneven tournaments were predicted to choose higher decision numbers than cost-disadvantaged subjects. Figures 1a and 1b present the pattern of per trial mean decision number choices for cost advantaged vs. disadvantaged subjects with respect to their predicted equilibrium.

To determine if the theory of tournaments could accurately predict subjects' behavior, a $1 \times 20$ repeated-measures analysis of variance was used to compare the mean decision choices of the cost-advantaged and -disadvantaged subjects to their respective equilibrium. Table 1a presents the results. As shown in Tables 1a and 1b both cost-advantaged and -disadvantaged subjects' decision choices were not significantly different from their equilibrium, in either Study 1 or 2. Thus, the theory of tournaments cannot be rejected for uneven tournaments. There was not a significant effect for trials nor a significant group by trials interaction in
the first pilot study. In the second, however, a significant group by trials interaction was found, $F(19,532) = 4.42; p < .001$. Figure 1b shows that cost-disadvantaged subjects initially chose decision numbers higher than the equilibrium but over time, reached the predicted decision number. Cost-advantaged subjects, on the other hand, chose lower numbers in the beginning and then increased their choices to converge on their equilibrium.

Figures 2a and 2b depict the pattern of per trial mean decision number choices for rules advantaged and disadvantaged subjects with respect to
the predicted equilibrium for Studies 3 and 4. The results of the $1 \times 20$ repeated-measures analysis of variance are presented in Table 1a. These studies indicated that mean observed choice for both groups was significantly different from predicted, as had been found in the previous discrimination research (Weigelt et al., 1989). There were no group effects, indicating that effort levels of both rules-advantaged and -disadvantaged groups were significantly greater than predicted. There also were no significant trial effects nor any interactions with the trial factor in either study.

**Advantaged vs disadvantaged mean decision number choice.** Observed decision choices for both subject groups were compared in separate $2 \times 20$ repeated measures ANOVAs to determine if the two groups chose significantly different decision numbers. The results are presented in Table 1b. As predicted, cost-advantaged subjects chose significantly higher decision numbers than disadvantaged subjects in the uneven tournam-

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**TABLE 1a**

**PREDICTED vs OBSERVED MEAN DECISION NUMBER CHOICES FOR THE FOUR PILOT STUDIES**

<table>
<thead>
<tr>
<th>Study</th>
<th>Predicted</th>
<th>Observed</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adv.</td>
<td>74.5</td>
<td>76.3</td>
<td>.36</td>
</tr>
<tr>
<td>$\alpha = 2$</td>
<td>Disadv.</td>
<td>37.3</td>
<td>39.4</td>
<td>(1,16)$^a$</td>
</tr>
<tr>
<td>2</td>
<td>Adv.</td>
<td>76.1</td>
<td>73.0</td>
<td>.03</td>
</tr>
<tr>
<td>$\alpha = 4$</td>
<td>Disadv.</td>
<td>19.0</td>
<td>23.0</td>
<td>(1.28)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>58.4</td>
<td>66.1</td>
<td>.22</td>
</tr>
<tr>
<td>$k = 25$</td>
<td></td>
<td>(29.8)$^b$</td>
<td>(1.24)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>46.1</td>
<td>55.9</td>
<td>8.21</td>
</tr>
<tr>
<td>$k = 45$</td>
<td></td>
<td>(28.4)</td>
<td>(1,32)</td>
<td></td>
</tr>
</tbody>
</table>

$a$ Degrees of freedom.

$b$ Standard deviation.

---

**TABLE 1b**

**ADVANTAGED vs DISADVANTAGED OBSERVED MEAN DECISION NUMBER CHOICES FOR THE FOUR PILOT STUDIES**

<table>
<thead>
<tr>
<th>Study</th>
<th>Advantaged</th>
<th>Disadvantaged</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76.3</td>
<td>39.4</td>
<td>33.06</td>
<td>.000</td>
</tr>
<tr>
<td>$\alpha = 2$</td>
<td>(23.9)</td>
<td>(30.7)</td>
<td>(1.16)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>73.0</td>
<td>23.0</td>
<td>83.0</td>
<td>.000</td>
</tr>
<tr>
<td>$\alpha = 4$</td>
<td>(24.3)</td>
<td>(21.0)</td>
<td>(1.28)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>65.9</td>
<td>66.2</td>
<td>0.00</td>
<td>n.s.</td>
</tr>
<tr>
<td>$k = 25$</td>
<td>(28.4)</td>
<td>(31.2)</td>
<td>(1.24)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>52.7</td>
<td>59.1</td>
<td>0.89</td>
<td>n.s.</td>
</tr>
<tr>
<td>$k = 45$</td>
<td>(24.5)</td>
<td>(32.4)</td>
<td>(1,32)</td>
<td></td>
</tr>
</tbody>
</table>
ments. There were no significant differences in the unfair tournaments, as the theory would predict. As had been seen in the earlier research, rules-disadvantaged subjects tended to choose higher decision numbers than those of rules-advantaged subjects but this difference was not significant. There were no significant trial effects, nor any significant interactions with the trial factor.

Dual Discrimination Tournaments
In order to examine the effects of dual discrimination, parameters from
the uneven and unfair tournaments were combined. Uneven status was created by varying the cost-of-effort function. One group of subjects (the cost-advantaged group) had a lower cost-of-effort function than the other group (cost-disadvantaged). Affirmative action was then simulated by introducing the discrimination factor \( k \). The cost-disadvantaged group was given an advantage by having a higher probability of winning the tournament than the cost-advantaged group. Thus, for one group (cost-disadvantaged/rules-advantaged), their effort was more costly, but they were favored by the organization (the tournament organizers). The other group (cost-advantaged/rules-disadvantaged) had a lower probability of winning the tournament, but their effort was not as costly, thus, if they so desired, they could exert more effort at less of a cost.

**Method**

*Subjects.* Fifty-two undergraduates (25 male, 27 female) at a major northeastern university were recruited from management and business economics courses and paid for their participation. The average earning across subjects was $15.93. Thirty subjects participated in Experiment 1 and 22 took part in Experiment 2. All subjects were randomly assigned seats and subject numbers.

*Procedure.* The same basic procedure as described for the pilot studies was followed: subjects were randomly assigned pair members and their total numbers were compared. Even numbered subjects had a cost function lower than that of odd numbered subjects; however, their total decision number had to be higher by a factor of \( k \) in order to receive \( M \). In Experiment 1, the cost-of-effort function was \( \alpha = 2 \) and the discrimination factor was \( k \) equal to 25. In Experiment 2, the \( k \) factor did not change but \( \alpha \) was increased to 4.

**Results**

*Manipulation check.* Even though the rules favored them, subjects at a cost disadvantage felt at a greater disadvantage in comparison to their pair member in Experiment 1 (\( t(27) = 2.04; p < .05 \)) and in Experiment 2 (\( t(28) = 2.48; p < .05 \)).

*Predicted vs observed mean decision number choice.* Figures 3a and 3b present the pattern of per trial mean decision number choices for both groups relative to their respective equilibrium. Separate \( 1 \times 20 \) repeated measures ANOVAs compared subjects' choices to their equilibrium and are presented in Table 2a.

As can be seen from the figure and the table, the results did not support the predictions from the theory of tournaments. Similar to the results of the unfair tournaments, subjects tended to oversupply effort, choosing higher decision numbers than predicted in both Experiments 1 and 2.
Dual Discrimination Tournament
\((\alpha = 2; k = 25)\)

- mean of CD/RA subjects
- mean of CA/RD subjects
- predicted CA/RA
- predicted CD/RA

**FIG. 3.** Pattern of per trial mean decision number choices for cost-advantaged/rules-disadvantaged and cost-disadvantaged/rules-advantaged subjects relative to their predicted equilibrium in the dual discrimination tournaments (experiments 1 and 2).

In addition, there was a significant trials main effect \((F(19,380) = 2.32; p < .01)\) and similar to the results of the second pilot study, a significant group by trials interaction \((F(19,380) = 3.59; p < .001)\) in Experiment 2. As before, cost-disadvantaged subjects tended to choose numbers above their equilibrium in the early trials while cost-advantaged selected numbers below their equilibrium. As the trials continued, the groups tended to converge although they both selected numbers significantly higher than either of their equilibria.

**Cost advantaged/rules disadvantaged vs cost disadvantaged/rules advantaged mean decision number choice.** The two groups were compared...
DUAL DISCRIMINATION

TABLE 2a
PREDICTED VS OBSERVED MEAN DECISION NUMBER CHOICES FOR THE DUAL DISCRIMINATION TOURNAMENTS

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Predicted</th>
<th>Observed</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CA/RD</td>
<td>59.0</td>
<td>67.4</td>
<td>8.38</td>
</tr>
<tr>
<td>$\alpha = 2; k = 25$</td>
<td>CD/RA</td>
<td>29.5</td>
<td>40.5</td>
<td>(1,28)*</td>
</tr>
<tr>
<td>2</td>
<td>CA/RD</td>
<td>60.2</td>
<td>73.5</td>
<td>24.08</td>
</tr>
<tr>
<td>$\alpha = 4; k = 25$</td>
<td>CD/RA</td>
<td>15.0</td>
<td>32.6</td>
<td>(1,20)</td>
</tr>
</tbody>
</table>

Note. CA/RI = cost advantaged, rules disadvantaged subjects. CD/RA = cost disadvantaged, rules advantaged subjects.

to each other using separate $2 \times 20$ repeated-measures ANOVAs. The results are presented in Table 2b. The groups choose significantly different decision numbers in both experiments as predicted. Therefore, although the specific predictions from the theory of tournaments were not supported, the pattern of data followed the theory with cost-advantaged/rules-disadvantaged subjects choosing decision numbers higher than those of cost-disadvantaged/rules-advantaged subjects.

Discussion

The results of the dual discrimination experiments indicated that aspects of both uneven and unfair tournaments had an effect on subjects’ choice behavior. Similar to what had been found in the uneven tournaments, cost-advantaged subjects tended to choose higher decision numbers (exert more effort) than cost-disadvantaged subjects, which could be expected since their “effort” cost them less. In addition, cost-advantaged versus -disadvantaged subjects appeared to have different strategies with respect to their equilibria in the beginning trials in Experiment 2 ($\alpha = 4; k = 25$). Cost-disadvantaged subjects tended to choose very high num-

TABLE 2b
COST ADVANTAGED/RULES DISADVANTAGED VS. COST DISADVANTAGED/RULES ADVANTAGED MEAN DECISION NUMBER CHOICES

<table>
<thead>
<tr>
<th>Experiment</th>
<th>CA/RD</th>
<th>CD/RA</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67.4</td>
<td>40.5</td>
<td>16.17</td>
<td>.001</td>
</tr>
<tr>
<td>$\alpha = 2; k = 25$</td>
<td>(30.7)*</td>
<td>(26.9)</td>
<td>(1,28)</td>
<td>.001</td>
</tr>
<tr>
<td>2</td>
<td>73.5</td>
<td>32.6</td>
<td>42.30</td>
<td>.001</td>
</tr>
<tr>
<td>$\alpha = 4; k = 25$</td>
<td>(25.6)</td>
<td>(26.6)</td>
<td>(1,20)</td>
<td>.001</td>
</tr>
</tbody>
</table>

Note. CA/RD = cost advantaged, rules disadvantaged subjects. CD/RA = cost disadvantaged, rules advantaged subjects.

* Degrees of freedom.

b Standard deviation.
bers while cost-advantaged subjects chose numbers well below their equilibrium. This same pattern was observed in the second pilot study where $\alpha = 4$.

The results of these two experiments did differ from the first two pilot studies in that subjects overall tended to choose numbers higher than their equilibrium. This overexertion of effort may have been due to the discrimination factor ($k$). As had been seen in previous research and in the unfair tournaments, both rules-advantaged and -disadvantaged subjects tended to choose higher numbers than predicted. It would appear then that subjects' behavior in these types of tournaments is sensitive to both the cost-of-effort and discrimination parameters.

**CONCLUSIONS AND IMPLICATIONS**

The intent of this research was to determine if subjects exhibited systematic behavior in asymmetric tournaments and whether the theory could predict this behavior. Because the theory of tournaments makes different predictions depending upon which parameters are manipulated, we will discuss them separately.

The theory predicts that the behavioral reaction to various types of asymmetry will differ and the results clearly confirm this prediction. In unfair tournaments, rules-disadvantaged and -advantaged subjects were expected to choose approximately the same decision number and this pattern of results was observed. Similarly, in uneven tournaments, cost-disadvantaged subjects were predicted to choose lower decision numbers than their advantaged counterparts and the results demonstrated that the differential between cost-advantaged and -disadvantaged mean decision numbers was roughly equal to that predicted. Observed mean decision numbers of subjects in dual discrimination tournaments also differed as predicted, although the magnitude of the decision numbers was greater than predicted.

Although the pattern of results roughly approximated the predictions, the theory was not so successful in predicting the actual decision numbers chosen in the unfair and dual discrimination tournaments. In unfair tournaments, the theory always underestimated the choices of subjects. While advantaged and disadvantaged subjects chose decision numbers that were not significantly different from each other, their mean choices were always significantly higher than predicted, thus replicating the results of Weigelt et al. The mean choices of advantaged and disadvantaged subjects in uneven tournaments were not significantly different from those predicted by the theory. However, in dual discrimination tournaments, the mean decision numbers chosen by subjects were significantly different from those predicted. As in unfair tournaments, the theory consistently underestimated the choices of subjects.
Across all experiments, as the asymmetry between advantaged and disadvantaged groups increased, the total tournament output (i.e., the combined mean decision numbers of both advantaged and disadvantaged subjects) was predicted to decrease. That is, the greater the discrimination (in any form), the less total effort subjects were expected to exert. This finding held true even in the unfair tournaments where subjects exerted more effort than predicted. As can be seen in Table 1, subjects in uneven tournaments chose lower decision numbers (i.e., exerted less effort) as $\alpha$ increased (57.85 versus 53.95). This same pattern was exhibited in the unfair tournaments (66.1 versus 55.9) and in the dual-discrimination tournaments (53.95 versus 53.05). Thus, the predictions derived from the theory of tournaments appear to account for much of the behavior exhibited by subjects in asymmetric tournaments but fall short of accounting for the oversupply of effort seen in unfair and dual-discrimination tournaments.

This oversupply of effort found in tournaments where the discrimination factor is introduced, but not in uneven tournaments, has been demonstrated in previous studies which used this same basic methodology (Bull, Schotter & Weigelt, 1987, 1988; Weigelt et al., 1989). We may speculate as to why subjects react differently to unfair versus uneven tournaments. It may be argued that cost-advantaged subjects in the uneven tournaments are analogous to members of a majority who have had the benefit of better opportunities all their life. These members, by virtue of their higher education levels or more varied and richer experiences, may not have to try as hard in order to perform well and succeed. Thus, their effort may not be as costly to them relative to minority group members. Disadvantaged members (members of a minority group, for example) may find the effort needed to succeed to be quite costly since they might have less experience due to their restricted opportunities (analogous to the subjects who were at a cost disadvantage).

As a result of various experiences in school or work situations, individuals may be familiar with inequality in such factors as ability or effort, and thus, may not react negatively to it. Explicit discrimination on the part of an organization or tournament organizer may not be encountered as often and thus, may arouse negative feelings. Rules-disadvantaged subjects (in the unfair and dual discrimination tournaments) may have been motivated to "beat" the system and their oversupply of effort may have led to advantaged subjects to do the same, thus leading to a type of "rat race" (Teger, 1980). Of course, this line of reasoning is purely speculative and needs to be investigated.

Though the game theoretic tournament model did not perfectly predict subjects' behavior, it does apparently capture some aspects of their decision processes. It is our contention that such models are not just clever
Although subjects may not consciously calculate the Nash solution during the experiment, they act as if they recognize the intuitive ideas underlying the Nash solution. It is our belief that the theory underestimates the choices of subjects in unfair tournaments because it assumes that subjects have a single attribute preference function—monetary return. In discussions with subjects after the experiments, they often expressed a positive taste for “winning.” Aside from a preference for the money received from winning, subjects apparently received utility from the act of winning itself. Hence, they seemed willing to sacrifice some monetary return to increase the probability of winning the tournament. This taste for winning apparently increases when the rules discriminate against them. New research is presently testing this idea, and preliminary evidence is supportive.

**Affirmative Action Programs: Individuals and the Firm**

Although affirmative action programs are widely used in corporate settings, little research has examined the effects of such programs on either firm or individual performance. If we assume that the structure of the dual discrimination tournaments sufficiently mimics that of affirmative action programs then the present research may help answer the following questions. First, do affirmative action programs benefit the disadvantaged? Our results indicate that affirmative action programs (at least in a laboratory setting) do provide a benefit. When the net earnings of cost-disadvantaged subjects in the dual discrimination tournaments are compared to cost-disadvantaged subjects in uneven tournaments, the results indicate that the former subjects earn more ($21.40 versus $18.50). Second, what are the costs of affirmative action programs? When the magnitude of the cost-of-effort differential was low between high and low ability subjects (\(\alpha = 2\)) then the affirmative action program tended to reduce the mean decision number choices of all subjects (relative to the comparable uneven tournament), and hence total tournament output was reduced. That is, total tournament output (adding the mean decision number choices for advantaged and disadvantaged subjects) was greater in the first pilot study than in Experiment 1 (115.7 versus 107.9, respectively). Thus, while the programs do benefit the disadvantaged, the tournament organizer (i.e., the firm) bears the costs of such programs. However, when the degree of cost disadvantageousness is high (\(\alpha = 4\)), then the laboratory affirmative action program tended to increase the mean decision numbers chosen by subjects, and hence the tournament’s total output increases (Pilot Study 2 total output = 97; Experiment 2 total output = 106.1). This result suggests that under certain conditions (i.e., a large
differential in workers' ability), affirmative action programs can actually improve a firm's performance.

The logic underlying this result is as follows. In the second pilot study ($\alpha = 4$), roughly half of the cost-disadvantaged subjects "dropped out" and supplied zero effort, thus guaranteeing themselves a per trial earning of $0.86. They apparently felt they could never overcome the high cost differential. It appeared as though their counterparts soon realized what was happening and reduced their effort levels. This allowed the cost-advantaged subjects to increase their total earnings (i.e., the payment minus the decision number cost). Thus, total tournament output was reduced. When the affirmative action program was implemented in Experiment 2 ($\alpha = 4; k = 25$), no cost-disadvantaged subject dropped out. With the program's preferential treatment, these subjects realized that they had more of an equal chance and they produced positive effort. This induced their counterparts to work harder, thus all subjects chose higher decision numbers, and total tournament output increased.

The research presented here is only suggestive of various effects of discrimination and affirmative action programs. Obviously, field work must be conducted to determine the behavioral consequences of such programs. The implications of the present research might provide a starting place for behavioral research on discrimination and affirmative action programs in the work place.

APPENDIX

Consider the following two-person tournament. Two identical agents $i$ and $j$ have the following utility functions that are separable in the payment received and the effort exerted.

\[ u_i(p,e) = u(p) - c(e) \]
\[ u_j(p,e) = u(p) - c(e), \] (1)

where $p$ denotes a nonnegative payment to the agent, and $e$, a scalar, is the agent's nonnegative effort. The positive and increasing functions $u(\cdot)$ and $c(\cdot)$ are, respectively, concave and convex. Agent $i$ provides a level of effort that is not observable and which generates an output $y_i$ according to

\[ y_i = f(e_i) + \mu_i, \] (2)

where the production function $f(\cdot)$ is concave and $\mu_i$ is a random shock. Agent $j$ has a similar technology and simultaneously makes a similar decision. The payment to agent $i$ is $M > 0$, if $y_i > y_j + k$, and $m < M$ if $y_i < y_j + k$, where $k$ is a constant. A positive $k$ indicates that $j$ is favored
in the tournament, while a negative $k$ indicates that $i$ is favored. Agent $j$
faces the same payment scheme.

Testing the theory of tournaments requires the specification of the utility function, the production function, the distribution of $(\mu_i - \mu_j)$ and the
prizes $M$ and $m$. One simple specification is the following.

$$U_i(p_i,e_i) = p_i - \frac{e_i}{c}$$

$$U_j(p_j,e_j) = p_j - \frac{e_j}{c}$$

(1')

$$y_l = e_l + \mu_l, \text{ where } l = i,j,$$

(2')

where $c > 0$ and $\mu$ is distributed uniformly over the interval $[-a,a]$, $a > 0$, and independently across the agents. $e_i$ and $e_j$ are restricted to lie in
$[0,100]$. If a pure strategy Nash equilibrium exists and is in the interior of
$[0,100]$, each agent’s first order condition must be fulfilled,

$$\frac{\partial E_i}{\partial e_i} = \frac{\partial \pi(e_i^*, e_j^*, k)}{\partial e_i} [M - m] - 2e_i^*/c = 0$$

$$\frac{\partial E_j}{\partial e_j} = \frac{\partial \pi(e_i^*, e_j^*, k)}{\partial e_j} [M - m] - \alpha 2e_j^*/c = 0.$$  

(3)

The concavity of the agent’s payoff function ensures that Eq. (3) is suf-
ficient for a maximum.

Given the distributional assumptions on $\mu_i$ and $\mu_j$, the probability of win-
ing function with $k > 0$ can be shown to be

$$\pi^i(e_i,e_j,k) = \begin{cases} 
\frac{1}{2} - \frac{(e_i - k - e_j)/2a + (e_i - k - e_j)^2/8a^2}{(e_i + k - e_j)/2a + (e_i + k - e_j)^2/8a^2} & \text{if } e_i - k > e_j \\
1 - \frac{(1/2 - (e_i - e_j - k)/2a - (e_i - e_j - k)^2/8a^2)}{(1/2 - (e_i - e_j - k)/2a - (e_i - e_j - k)^2/8a^2)} & \text{otherwise.} 
\end{cases}$$

$$\pi^j(e_i,e_j,k) = \begin{cases} 
\frac{1}{2} - \frac{(e_j - e_i - k)/2a + (e_j - e_i - k)^2/8a^2}{(e_i + k - e_j)/2a + (e_i + k - e_j)^2/8a^2} & \text{if } e_j + k > e_i \\
1 - \frac{(1/2 - (e_i - e_j - k)/2a - (e_i - e_j - k)^2/8a^2)}{(1/2 - (e_i - e_j - k)/2a - (e_i - e_j - k)^2/8a^2)} & \text{otherwise.} 
\end{cases}$$

(5)

with

$$\frac{\partial \pi^i(\cdot)}{\partial e_j} = \frac{1}{2a} - \frac{(e_j - e_i + k)}{4a^2} \quad \text{if } e_j + k > e_i,$$

$$\frac{\partial \pi^i(\cdot)}{\partial e_j} = \frac{1}{2a} - \frac{(e_i - e_j - k)}{4a^2} \quad \text{if } e_j + k < e_i,$$

and

$$\frac{\partial \pi^i(\cdot)}{\partial e_i} = \frac{1}{2a} - \frac{(e_i - e_j - k)}{4a^2} \quad \text{if } e_i - k > e_j,$$
DUAL DISCRIMINATION

\[
\frac{\partial \pi^i(\cdot)}{\partial e_i} = \frac{1}{2a} - \frac{(e_j - e_i - k)}{4a^2} \quad \text{if } e_i - k < e_j.
\] (6)

Plugging Eqs. (5) and (6) into Eq. (3) and solving for \(e_i^*\) and \(e_j^*\), we get

\[
e_j^* = \frac{\left(1/2a\right) - (k/4a^2)}{1 + \left(1 - \alpha/4a^2\right) (c(M - m)/2a)} \left(\frac{c(M - m) - c(1 - \alpha)}{2a}\right)
\]

\[
e_i^* = \alpha e_j.
\] (7)

When \(k > 0\), and \(\alpha = 1\), Eq. (7) defines the equilibrium of an unfair tournament as

\[
e_i^* = e_j^* = \frac{(1/2a) - (k/4a^2)}{1 + \left(1 - \alpha/4a^2\right) (c(M - m)/2a)} \left(\frac{c(M - m) - c(1 - \alpha)}{2a}\right).
\] (8)

When \(k = 0\), and \(\alpha > 1\), Eq. (7) defines the equilibrium of an uneven tournament as

\[
e_j^* = \frac{c(M - m)/4a\alpha}{1 + \left(1 - \alpha/4a^2\right) (c(M - m)/2a)}
\]

\[
e_i^* = \alpha e_j.
\] (9)

To define the equilibrium of a dual discrimination tournament we simply compare the equilibrium of an uneven tournament (9) to that of an appropriately defined dual discrimination tournament (7).

REFERENCES


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