Dynamic Tournaments Under Different Mechanisms: Evidence From Experiment of Fishing Contests[1]

John A. List[2], Jan Stoop[3], Daan van Soest[4], Hong Chao[5], Chien-Yu (Jason) Lai[6]

Goal of this project

In this project, we focus on two issues related to tournaments. The first one is the dynamics of tournaments. For most tournaments, like fishing contest or racing, players could observe everyone's performance in the middle of the game. We want to know how such information affects player's decision on effort level for the rest of the tournament. In this project, we construct a model to predict the outcome from experiments.

The second issue is how different mechanisms affect efficiency in tournaments. We define that given the expected rewards are the same, if one mechanism (of assigning the reward) could make players exert higher effort, this mechanism is more efficient. In this project, we compare winner-takes-all, lottery, and piece rate. We want to know whether there are some conditions making one mechanism more efficient than the other two.

Model setup

We construct a two-stage game between two players. We assume that two players have the same cost function and the same joint distribution of random shocks. In each stage, each player generates his output. The sum of a player's outputs from two stages is his total output in the game. Total outputs decide how the reward is assigned. In this project, we only focus on the second stage, so we take first-stage outputs are exogenously decided (we did the same thing in the lab experiment). We denote E as the output from the first stage. The model is to analyze how these first-stage outputs affect players' effort levels in the second stage.

At second stage, each player needs to choose his effort (e) simultaneously, and his effort level generates the second-stage output as following:

Second-stage output=Effort (e) + Random shock (s)

When players decide effort levels, they also face a convex cost function, c(e). We

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[1] At this moment, we don't have the whole paper. This file is an abstract briefly summarizing the model and some pilot data for the project

[2] University of Chicago; email: jlist@uchicago.edu
[3] Erasmus University Rotterdam; email: stoop@ese.eur.nl
[4] Tilburg University; email: D.P.vanSoest@uvt.nl
[5] Shanghai Jiao Tong University; email: chaohong@sjtu.edu.cn
[6] University of Chicago; email: cylai@uchicago.edu

further assume players' utility function is quasilinear. Thus, their ex-post utility is:

U=r(total outputs)-c(e)

r(total ouputs) is a function for how rewards are assigned according to players' outputs.

Prediction for winner-takes-all

Under winner-takes-all, the winner (player with higher total output) gets the all reward (R). Player i wins if

$E_i+e_i+s_i>E_{-i}+e_{-i}+s_{-i}$

$s_i-s_{-i} >E_{-i}+e_{-i}-E_i-e_i$

This shows that players are competing over the density function of (s_i-s_{-i}). Therefore, the shape of the density function of (s_i-s_{-i}) affects the equilibrium for the second stage. If the density function of (s_i-s_{-i}) is bell-shaped, then if the gap in first-stage outputs is larger, both players will exert less effort in the second stage. If the density function of (s_i-s_{-i}) is uniform (this is what we use in the lab experiment), then players' effort levels doesn't depend on the first-stage outputs (given the equilibrium is interior solution).

Prediction for lottery

In lottery tournament, each player gets one lottery tickets for each unit of his total output. In the end, one lottery ticket will be drawn to decide the receiver of all the reward (R). The model predicts that if the winner of the first stage has more first-stage output (keep the other player's first-stage output the same), then in the second stage, both players exert less effort. On the other hand, if the loser of the first stage has more output (while he is still a loser of the first stage), then in the second stage, he will exert less effort but the winner of the first stage will exert higher effort.

Prediction for piece rate

Under piece rate, players could earn a fixed reward (p) for each unit of total output. Because we assume quasilinear utility function in the model, the equilibrium only depends on p and c'(e). The first-stage output and the density of shocks won't affect the equilibrium.

Efficiency

Under winner-takes-all, equilibrium effort is decided by density of (s_i-s_{-i}). Under lottery, the equilibrium effort depends on the joint density of two shocks and probability of lottery. Under piece rate, the equilibrium effort doesn’t depend on all above. Therefore, even if we keep (expected) total reward the same, players could act differently under these three mechanisms. To simplify the discussion, we could reduce the game to a one-stage game by making first-stage outputs be 0. At this stage, we could think of two situations as following to compare efficiency.

First, if the density at s_i-s_{-i} =0 is higher (random shocks has less effect on deciding who generates total output), winner-takes-all could be more efficient than piece rate. Second, if we move up the distribution of s while keeping the density of s_i-s_{-i} the same, winner-takes-all could be more efficient than lottery and piece rate. Such discussion may be important if the tournament organizer cares about equilibrium effort levels or total outputs in the game.

Random shocks in the lab

In the lab experiment, we set the random shocks in the second stage as following:

s_i =x

s_{-i} =100-x

x~unifrom[0, 1, 2, …, 100]

In the model, if we take x as uniform[0, 100], we could easily to find closed solution for equilibrium. Therefore, we could compare the predicted number with the outcome from the lab. In addition, under such setting, winner-takes-all and lottery have very different comparative static. This helps us see different dynamics under these two mechanisms.

The Laboratory Experiment

In this section, we briefly present the experimental setup, experimental predictions, and experimental data of one pilot session.

Experimental setup

The first test of our theory consists of a laboratory experiment with student subjects. So far, we have only gathered data from one pilot session, in which we test the Lottery tournament. We conducted this session to get a feeling for what effort levels our subjects choose. Let us describe the setup of the experiment first.

Subjects were placed in groups of two, and play twelve rounds (after five non-incentivized practice rounds). In each period, subjects had to generate output.

Each unit of output yielded one lottery ticket to win a fixed prize of 4.5 points (the lozer prize is 2.4 points). In short, output in a round is generated as follows:

Total output = Random shock 1 + effort + Random shock 2.

Each subject first received a pre-programmed Random shock 1. For each subject, the draw was not greater than 40. By pre-programming these random draws, we can ensure that the most interesting outcomes are generated (the ones where subjects have draws that are far apart, or are the same).

After observing the outcomes for both players, subjects had to choose an effort level between 0 and 100. The cost of effort was determined as follows: $c(e) = e^2/10.000$. Subjects were not given this equation, but were given a table with costs for each possible integer effort level between 0 and 100.

Once both players had filled in their effort level, the computer randomly generated Random shock 2. The sum of these to shocks added to 100. After receiving feedback about the choice of both players, and realizations of Random shock 2 of both players, the next round was played. After the experiment, subjects were paid for all 12 rounds.

Subjects were recruited through Orsee (Greiner 2004). Subjects were students from Erasmus University Rotterdam and had backgrounds in economics, business and psychology. The software was programmed in Ztree (Fishbacher 2007). In total, 22 subjects participated, and they earned an average of 14.45 euro in a session that lasted one hour and 15 minutes.

Experimental predictions

The theory of the lottery incentive scheme yields three testable predictions:

Prediction 1: In the lottery tournament, a player that leads after stage 1 (Random shock 1) exerts less effort than the player that is trailing. The bigger the gap in output, the less effort the leading subject will exert.

Prediction 2: In case of a draw after stage 1 (Random shock 1), both players will exert as much effort. The higher the realization of stage 1, the lower the effort level for both players.

Experimental data

Figure 1 below gives the average effort levels of all subjects, as a function of their relative standing after stage 1.

Result 1: We find a weak negative and insignificant correlation between effort and difference in stage 1 scoring. The greater the difference in score, the less effort the leading subject exerts.

Support for Result 1: We take the least conservative approach first, by using all observations as independent observations (given the small amount of data we have). A pair consists of the effort level and the difference in stage 1 shocks. Still, the Pearson correlation coefficient is insignificant with a value of -0.06 (p-value = 0.36, N = 262).

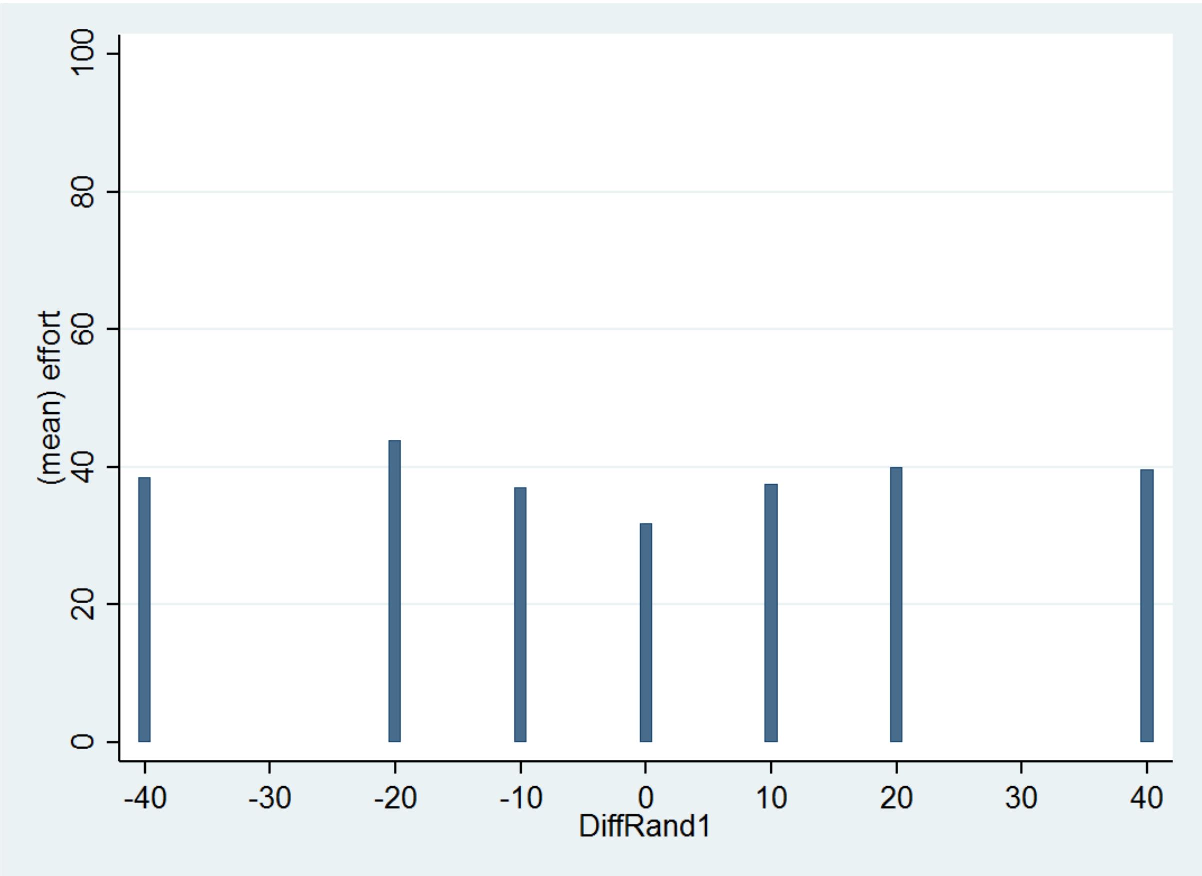

Figure 1: average effort as a function of the difference in score after stage 1.

Result 2: When the score is tied after stage 1, subjects exert less effort when the outcome of the score is higher. However, this difference is not statistically significant.

Support for Result 2: Averaged over all 22 subjects, when the score after stage 1 is 0,0, subjects effort is 35.52. When the score after stage 1 is 40,40, average effort is 28.09. A Wilcoxon test, at the individual level yields a p-value of 0.63 ($N_1 = N_2 = 22$).