A Field Experimental Comparison of Races & Tournaments

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# Executive Summary

In this paper we report the results of a field experiment conducted to compare actions and outcomes of individuals randomly assigned to a contest under different competition regimes. The plan of the experiment was to sort participants into groups homogenous by distribution of skills, group size, experimental task and the same expected rewards and assign the groups to three experimental conditions or treatments. Specifically, in each group participants pit against each other to develop solutions to a given problem, the same across groups. They can submit as many solutions as thy wish and at any point in time within a 2-week submission period. Solutions get automatically scored and winners are determined by the time of the submission and the score. The only difference across groups lies in the criterion used to identify the winners and therefore in how to distribute the prize money in each group.

* In one treatment we award 2 prizes to the first 2 agents to develop a solution scoring higher than a given level Q>0. If no participant attains a score higher or equal to Q, the prizes are not awarded.
* In a second treatment, we award 2 prizes to the 2 agents with the highest score of the group.
* In a third treatment, we award 2 prizes to the 2 agents with the highest score of the group—as in the second treatment—but we condition the awards upon attaining a score higher than Q—as in the first treatment. If no participant attains a score higher or equal to Q, the prizes are not awarded.

These situations are interesting because they match some of the theoretical conditions of a *race (competition to be first)*, a *tournament (competition to be best)* and a *tournament with a minimum-effort requirement*.

Races and tournaments are very versatile kinds of contests and have been used extensively in economics to model a broad class of real-world competitions, that also includes patent races, political elections, lawsuits, and job promotions. For instance, Loury (1979), Dixit (xxxx), Dasgupta & Stiglitz (XXXX), Harris & Vickers (XXXX) and Grossman & Shapiro (xxxx) have developed game-theoretic models of races to study the incentives of firms to be first to applying for patent protection or to commercializing a given product. Taylor (XXX), Moldovanu & Sela (XXXX) and Che & Gale (XXXX) have developed game-theoretic models to understand individual agents competing to be the best in *tournaments*.

Overall, economic theory offers a number of predictions on how agents will behave in these prize-based competition settings. This kind of behavioral predictions could help form the right expectation regarding the outcomes of a contest with a particular competition setting and might inform the design of new competitions. For instance, one sponsor of an open-innovation competition may want to know under what circumstances a race would lead to more innovative outcomes compared to a tournament. Supposing he would go for a tournament, should she add a minimum quality requirement or not?

To address these questions, economic theory suggests that agents exert effort insomuch the additional cost of raising the level of their performance is compensated by a corresponding increase in the chances of winning a reward. Broadly speaking, when the probability of winning is very ``responsive`` to effort, a competition to be best (a tournament) could lead to better outcomes than a competition to be first (a race), all else being equal. By contrast, when the intensity of competition is relatively low or the winner is pretty much settled, one concern is that the solutions of a tournament would be of low quality and therefore it might be better to consider ways to ``force`` contestants to achieve a minimum level of quality, as for example by adding a participation constraint. Similarly a race offers a better guarantee on paying solutions of certain quality, at least compared to a tournament, but in addition to that forces competitors to self-select on the xxx.

Clearly, there are many other issues to consider to may somewhat justify one or the other approach. However, there is poor empirical evidence on the developed theoretical predictions.

# Old Notes

Motivations to study races & tournaments are well summarized by the following picture:



FIGURE: Equilibrium bids from the Moldovanu & Sela (2001) model for a Tournament (black, solid) & a Race (red, dashed).

The picture shows the realized equilibrium bidding function of an extended version of Moldovanu and Sela (2001) model of tournaments competition.

As opposed to the original model, we consider that participants have to make 2 decisions: a costly bid *q* and some costly effort *t*to accelerate the time to submit.

It turns out that the solution of the extended model is very simple. In particular, conditional on exerting positive effort in the competition, bidding q=Q is a dominant strategy in any MS-race (likewise choosing t=0 is a dominant strategy in the MS-tournament). As a result, the bidding function is a step function in a race (red, dashed) and a continuous function in a tournament (black, solid).

The key observation is that no setting seems to dominate the other in terms of the quality of the final outcomes. In fact, suppose that the x-axis denotes the ability of the best participant registered to the competition. Then, there is an interval of values in the middle of the x-axis in which the race would do better, while for higher values the tournament would do better.

Thus, if we knew who registered to the competition we would also have known which setting to choose. But what competition format is best from an ex-ante perspective? The answer would depend on the distribution of abilities. This would require some computations, but if top-coders are relatively scarce, then a race may be a better option to consider.



FIGURE: distribution of abilities used to plot the bids in the previous figure

In sum, according to our extended MS model, it seems that outcomes in a race can be higher when the (expected) “intensity of competition” is somewhat low. Otherwise the tournament seems a better option.

Note, no prior works comparing races with tournaments—see lit. section at the end of this document—(Why?)

## Limitations

One obvious limitation of this setting is that MS may explain well a tournament setting, but not a race. In fact, a race is more a dynamic type of contest where participants could benefit a lot form feedback generated during the competition by others (e.g., stop exerting effort, waiting, etc.). On the other hand, we can use individual data to see if there is a good fit.

Overall, these economic models may fall in the category of works studying ``decisions under uncertainty`` where uncertainty is mainly determined by the actions of the other agents and concerns either the order of arrivals, i.e., who is going to be the first to achieve a certain performance, or the intensity of competition, i.e., how high the performance of others would be.

## Unit of analysis

The unit of analysis should be the group. We need many groups.

# Details of the Experiment on TopCoder

|  |  |  |  |
| --- | --- | --- | --- |
|  | Tournament | Race | Open issues: |
| Pre-contest | - | We need to set a quality threshold  Invite TopCoder experts to provide feedback on a reasonable quality threshold (“bootstrap”). | Can we set hard & easy thresholds?  **Pro**: more robust if we misspecify the threshold. **Contra**: can we extend the model? |
| Advertising | - |  |  |
| Submission Period | Two weeks. | Two weeks.  The submission period stops as soon as 2 members hit the quality threshold. |  |
| Prizes | Top 2 ranked solutions by quality. | First 2 solutions to hit the quality threshold. | Should #2 prize be the same of #1 prize?  Should we add a general prize across groups? No! |
| Provisional Score | The leaderboard shows the provisional score. | The leaderboard shows the provisional score.  In the background we compute the final score.  If someone hits the threshold we send notification to all participants in that group. |  |
| On each submission | Pop-up asking how many hours worked. | Pop-up asking how many hours worked. |  |
| Group size | If enough sample:  Groups of different size: 7 and 30 | If enough sample:  Groups of different size: 7 and 30 |  |
|  |  |  |  |
| Prevent cheating | Ex-post we control winning submissions | Ex-post we control winning submissions |  |

# Literature Review

## Theory

* Moldovanu & Sela (2001)
  + We extend to incorporate a race.
* Harris & Vickers (ReStud, 1985) “Racing with uncertainty”
  + Interplay of *uncertainty* in the outcomes of effort and *strategic interaction* between competitors.
  + Leaders make greater efforts as the gap with the followers widens.
* Fudenberg, Gilbert, Stiglitz, Tirole (EER, 1983)
  + When races are neck-to-neck and when degenerate into monopoly?
* Zizzo (IJIO, 2002)
  + lab. experiment on H&V predictions.
  + Not as predicted!
* Baye & Hoppe (GEB, 2003)
  + Tullock contest function races are equivalent to tournaments.

## Surveys

* Konrad (book)
* Decheneaux, Kovenock, Sheremeta (2012)
  + Dynamic contest: one paragraph on races. Mainly Zizzo’s results.

## Something to read

* Hoppe & Lehman-Grube (JET, 2005), “Innovation timing games: a general framework with applications“