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Quitting

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Abstract

Many tournaments are played over time with repeated strategic interaction between the players. In such tournaments, quitting (or dropping out) is an important strategic option. The paper uses a field experiment to examine tournaments with different levels of rewards and different designs. Surprisingly, the results show a tradeoff between performance and quitting. Strong incentives (high rewards) induced players to exert more effort but, at the same time, to quit more often.

1. Introduction

Tournaments are games in which the players' payoffs depend on how their performance is ranked. Since the study of tournaments was first initiated by Lazear and Rosen (1981), extensive work has been done on the subject.[3] The main focus of the literature has been on static tournaments in which players choose effort levels that, together with their abilities, stochastically determine their relative performance. Many standard real-life tournaments, however, display a dynamic structure.[4] That is, tournaments are typically played over time, with effort decisions made at each period after players have observed (at least partially) their relative position in the game. Players may quit in the middle in such tournaments if, after observing their relative performance, they become discouraged and choose not to exert any further effort.

Quitting (or dropping out) is indeed a common phenomenon in tournament-like situations. Workers give up and quit competing for promotions, firms quit in the middle of R&D efforts, runners quit in the middle of a race and kids drop out of school. What makes players quit in the middle of a competitive task? Is it only the realization that they are not going to win or are there other considerations that affect the players' decision?

One can distinguish between two types of quitting: "no-participation" and "quitting in the middle." At the outset of a tournament, players consider the task to be performed, their incentives and their opponents, and may subsequently decide not to participate at all. But even when they choose to participate, they may decide to quit in the

[3] See for example Bull, Schotter and Weigelt (1987), Green and Stokey (1983), Nalebuff and Stiglitz (1983), O'Keeffe, Viscusi and Zeckhauser (1984) and Rosen (1986).

[4] Examples of such tournaments are patent races or R&D competition, competition for promotion in the workplace, election campaigns, sporting competitions, litigations, and competition for grades or school rank. For analysis of dynamic tournaments see for example Harris and Vickers (1985), Reinganum (1982) and Doraszelski (2003).

middle of the tournament as a response to new information or their assessment of their relative success.

Quitting is therefore a strategic decision and as such may be affected by the incentive schemes provided to the players. Intuition suggests that higher rewards reduce the likelihood of quitting. Our experiment indicated however that the relationship between incentives and quitting is not so simple. The relevant question, which is the focus of our experiment, can be phrased as: "What kinds of incentives trigger the different types of quitting and is it possible for incentives that elicit greater effort to elicit, at the very same time, more quitting?"[5]

Incentives in a tournament thus affect not just average performance but also the distribution of performance (of winners and losers) and the probability of quitting. The relative weight of these factors depends on the tournament designer's preferences. For example, in an R&D context, the designer probably cares more about superior performance than about quitting. In a tournament between a firm's workers the designer may focus on average performance while in a tournament among students, the designer may stresses the distribution of performance (in grades) as well as reduction of the number of quitters (drop outs).

Quitting can be a rational decision particularly when players face unfavorable conditions or are so far behind that the odds of winning are minimal.[6] But quitting often involves social stigmatization. We admire people who do not quit "against all odds". We

[5] The recent papers on optimal design of tournaments or contests (e.g. Moldevanu and Sela (2001) and Che and Gale (2003)) focus on the design of static tournaments. Extending the discussion to dynamic tournaments should also take into account the possible effect of incentives and reward structure on quitting.
[6] See Lippman and McCardle (1987) for an R&D race in which the follower drop out if the leaders gain a significant lead, and Muller and Schotter (2003) for an experiment in which players refuse to participate if the tournament is sufficiently asymmetric.

write books and make movies about them.[7] *"The Little Engine That Could"* is probably one of world's best-selling children's books; it is about persistence and about not quitting. We can therefore conclude that quitting in the middle of a tournament, will typically involve some social or psychological costs that players may try to avoid.[8]

We present in this paper a field experiment designed to examine some of these issues. Participants were 10th grade high school students who were asked to run a 60-meter race during their physical education class. The students participating in the experiment were told to run the course twice, with the teacher measuring their speed. The first run was an individual event with no rewards and no competition. In the second run, participants were matched into pairs and told to compete in a race. We varied three parameters. The first was the matching scheme. We either matched participants at random while ignoring their abilities, or matched them by their times in the first race. The second parameter was the level of incentives (no incentives, low incentives and high incentives to win). Finally, in some treatments we let the runners run side by side (hereinafter the "direct tournament") while in others each pair ran on the same track but separately, with their performance announced only at the race's end (hereinafter the "indirect tournament"). In the latter procedure there was no strategic interaction between the players throughout the race as they were unable to condition their effort on their relative positions.[9]

[7] The social stigma may vary between societies and cultures. Even within a society people may assign different importance to such stigmatization.

[8] Clearly not every case of quitting is socially stigmatized. When firms drop from an R&D race there are usually no social consequences whereas when athletes drop out in the middle of a race or a competition, some social disapproval is typically generated.

[9] In the language of dynamic games, the two procedures represent the closed loop and the open loop strategies.

We found that players indeed reacted to large rewards: In all treatments, average performance was better when we provided large rewards. But the type of matching was also found to be important: Average performance was higher when we matched runners according to their ability rather than randomly.

With respect to quitting, we found that quitting in the middle of the race was far from common. In many tournaments, even though it was clear by the middle of the race which runner was going to win, the second runner continued to compete without giving up.[10] Surprisingly no quitting was common in tournaments with no (or small) rewards, suggesting that some stigma was associated with quitting as players preferred not to quit despite it being "rational" to do so.

An alternative explanation of the no quitting phenomenon is the "sunk cost" or "escalation" effect, often discussed in the literature (see Arkes and Blumer (1985), Staw (1997), Thaler (1999) and Arkes and Ayton (1999)), which is defined as "the irrational tendency to choose to continue to invest money, time, or effort following unsuccessful investments." The existence of social rewards or, alternatively, social stigma has been recognized in the psychological literature as one explanation for the escalation effect: "Social rewards may pressure individuals and groups into persisting in a course of action in the face of negative feedback" (Street and Anthony, 1997, p. 275).

But we also found that the probability of quitting was affected by the rewards given. Surprisingly, high competitive rewards, while inducing better average performance, also led to more quitting in the middle. In our experiment, most of the quitting in the middle occurred in tournaments offering high rewards, with almost no

[10] Clearly, the odds of winning in such a race are subjective estimates only. We do not know how the runners made their estimates, what thought processes were involved. The only observation we can make is that relatively few quit.

such behavior observed during tournaments offering small or no rewards. On the other hand, "no participation" behavior was observed only in tournaments with small or no rewards. Large rewards always induced participation by all the players. Furthermore, it is interesting to note, quitting in the middle occurred only when players ran side by side. In the indirect tournament, in which players ran separately, this type of behavior was not observed.

In many tournaments, like those in the classroom, we are concerned about the performance of losers as well as of winners. The design of a tournament indeed affects not just the average performance but also the distribution of performance among winners and losers. For example, while average performance in high-reward direct tournaments differed little from that in high-reward indirect tournaments, winners in the indirect tournament exhibited significantly better performance than in the direct tournament while losers exhibited significantly better performance in the direct tournament.

Our experimental results have interesting implications for the design of tournaments. For instance, in cases where we care only about the best performance — an R&D tournament or a running race — we are better off using a high-reward indirect design. With respect to incentive structures, such as those applied in schools, greater competitive incentives may indeed induce better average performance of students but at a cost of more students quitting.

As far as we know, only one experimental study on quitting has been conducted. Muller and Schotter (2003) used a laboratory experiment to study static tournaments in which players were required to choose (once) an effort level. Their main result indicated

that when there is sufficient asymmetry between the players' abilities, the low-ability player might give up and drop out of the race (no participation).

The remainder of the paper is organized as follows: In the next section we describe the experimental design. In section 3 we present our results while in section 4 we use a dynamic game presentation to explain our main results.

2. Experiment Design

The study was conducted in schools in Tel Aviv. Participants were 10th grade boys.[11] The youngsters participated in 60-meter running races that were conducted during physical education classes and that followed closely standard class practice: The boys run twice along a track 60 meters long, with the teacher measuring their speed. The first race was an individual run with no rewards and no competition.

The procedure was manipulated in several ways.[12] In all the treatments, each player ran alone the first time; in the control treatment, they ran alone the second time as well. This setup was used to control for unobservable factors that may cause differences between the two outcomes. In all other experimental treatments, the teacher matched the boys in pairs. There were two possible matching procedures:

- Random matching: The teacher simply matched two players at random, ignoring their speed in the first round.

[11] We used only boys because competition may affect boys and girls differently, see Gneezy and Rustichini (2004).
[12] But in each class that participated in the experiment there was only one manipulation knew only about one possible procedure of the tournament.

- Matching by time: The teacher began the matching with the two fastest runners; moving down the list, the next two fastest runners were matched.[13] In this way, the members of a pair had speeds resembling one another as closely as possible.

In standard races, where runners run side by side, participants can observe their relative position at each moment in the race; they can observe which runner is ahead and the distance remaining. The runners' efforts may be conditioned on these observations. In contrast, we can design a race where players compete but not directly. In our setup, each competitor runs separately on the same track and for the same distance; hence, they cannot observe one another. After the two complete their runs, their performance is compared; the player who achieves the best time wins. In the indirect race, players are unable to observe their relative positions while running. We thus have two treatments, based on how the tournament is conducted:

- Direct Race: Each pair runs on the same track, side by side.
- Indirect Race: Each pair runs on the same track but separately, without observing each other.

The players had been informed about the race procedure and their performance in the first round was clearly announced before the entire class. Therefore, they knew their relative performance from the pairing procedure.

[13] When more than two youngsters had achieved the same time in the first round, the match was random.

Finally, one of three possible incentive schemes was applied in the second period:

- No monetary incentives: In this treatment, no extrinsic monetary incentive was awarded but everyone could observe the tournament's winner.
- Small monetary incentive: The winner was announced and received a small prize of three colored pens worth NIS 10 (about $2 at the time).
- Large monetary incentive: In this treatment the prize was NIS 50 (more than $10 at the time).

The number of participants in each tournament is summarized in Table 1.

	Indirect-Time Matched	Direct-Time Matched	Direct-Random Matched
No reward	28	72	42
Small reward	40	58	64
Large reward	68	34	24

Table 1: Number of participants in each tournament

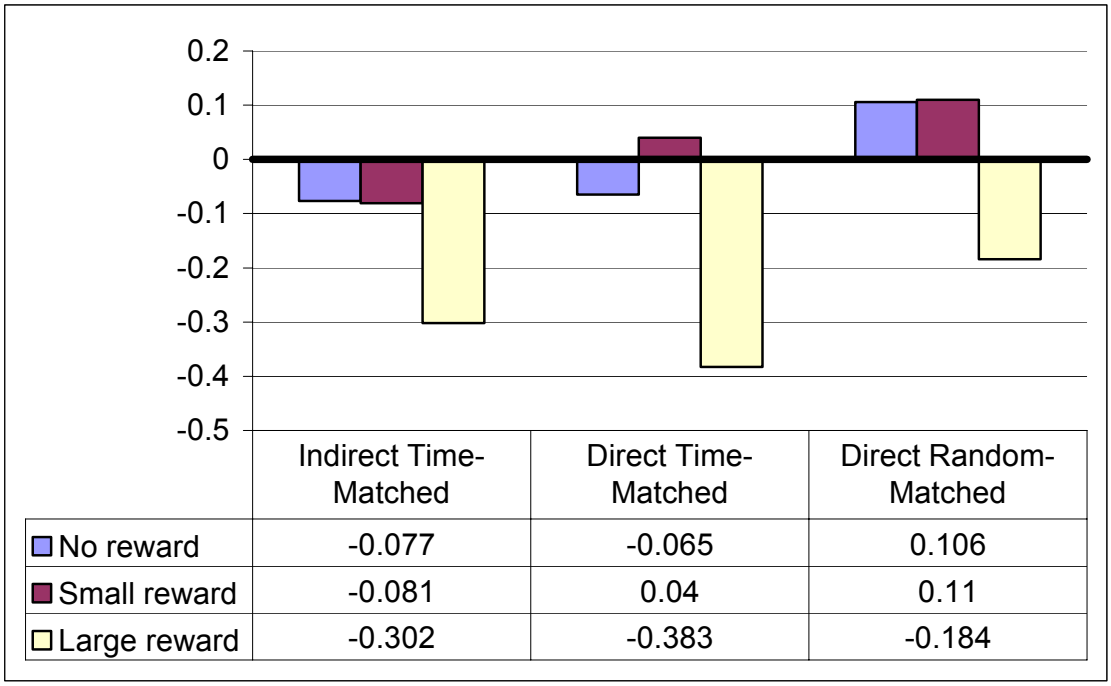
3. Results

The first issue of interest is the effect of incentives or rewards on the players' performance. To explore this issue, we ignore players who quit and focus exclusively on the performance of the players who completed the race. We then examine the relationship between incentives and quitting and discuss the overall effect of rewards on tournaments.

The variable examined is the difference in the player's performance between the first and second round of running. As our benchmark we use the performance observed in the treatment where all runners run twice with no competition and no rewards (see Figure A1). The basic statistics of all the runs is provided in Table A1 in the Appendix.[14]

3.1 Incentives and Performance

We first focus on the relationship between incentives and performance. Figure 1 presents the average time differences between the runs (time for round 2 minus time for round 1) under each of the treatments. Hence, a negative number means faster (better) performance in the second round.



	Indirect Time-Matched	Direct Time-Matched	Direct Random-Matched
No reward	-0.077	-0.065	0.106
Small reward	-0.081	0.04	0.11
Large reward	-0.302	-0.383	-0.184

Figure 1: Average time in round 2 minus time in round 1 in the different treatments

[14] Refusing to participate or quitting the race in the middle were options available to the players. There was no monetary penalty for quitting. The statistics that we provide in Table A1 regarding the average performance relate only to players who actually finished the race.

As Figure 1 indicates, large rewards have a very strong effect on performance. In all treatments, average running time was significantly ($p<.05$, Mann-Whitney *U*-test) faster with high incentives than with the other two incentives schemes.[15]

Observation 1: Participants react to large incentives: in all tournaments, large rewards produced the best performance.

While the above result is not surprising, it is also not straightforward. Camerer and Hogarth (1999), for example, reviewed the experimental literature on the effect of incentives on performance and concluded that in some cases, such as judgment tasks that are responsive to greater effort, increasing incentives improves performance. However, they emphasized that a "narrow-minded focus on incentives alone is misguided" as in most cases incentives did not improve performance.

The second finding, also shown in Figure 1, is that Time-Matched tournaments yielded significantly (at the .05 level) better performance than did Random-Matched tournaments for the no reward as well as for the large reward case.

Observation 2: Symmetry is important; Time Matched tournaments yielded better performance than did Random Matched tournaments.[16]

[15]It is interesting to note that in two of the treatments (Indirect-Time Matched and Direct-Random Matched), the performance in the "no payment" and "small payment" treatments are not statistically significant. Moreover, in the Direct Time-Matched case, the "low payment" treatment yielded worse performance than did the "no payment" treatment. This result relates to the literature on the counter-productivity of small incentives that claims that sometimes it is better not to pay at all than to pay small amounts of money (e.g., Frey and Jargen, 2001, Gneezy and Rustichini, 2000). This literature points to the difference between intrinsic motivation and monetary incentives and claims that small monetary incentives may have a negative effect on performance as it may diminish intrinsic motivation. For a theoretical discussion of this issue see Benabou and Tirole (2003).

This observation stresses that when designing tournaments, attention should be paid not only to the compensation scheme but also to how the competitors are matched (or grouped). Considerable differences between competitors yield poorer performance than in tournaments between players displaying relatively similar abilities. This observation implies, for example, that better performance can be obtained in a class composed of students with similar intellectual capacities than from a class of students with diverse capacities.

A direct race, where runners run side by side, enables players to observe their relative positions in the race at every moment. Effort is clearly conditioned on these observations. In contrast, in the indirect tournament, each player runs separately; only after the two players complete their runs do they learn who won. In such races players do not observe their relative positions while running. Yet, the comparison between the direct and the indirect races yields weaker results than the comparison between the Time Matched and Random - Matched tournaments. Moreover, none of the differences between the respective incentive levels for the direct and indirect tournaments were significant at the .05 level.

Observation 3: No difference in average performance between the direct and indirect tournaments.

The above observations tell only part of the story, i.e., it conveys solely the players' average performance. Average performance may be the major criterion for some

[16] Better performance was also obtained with the "small reward" treatment in the Time-Matched tournament but the difference was not significant.

tournaments but in others, such as classroom situations, two other salient issues may be at work. The first is the percentage of quitters; the second the distribution of performance (that is, the losers' performance).

3.2 Quitting

Two forms of quitting interested us: (i) Runners who refuse to participate in the second run; (ii) Runners who start running only to quit in the middle of the race. There was no monetary penalty for quitting other than the fact that such behavior became common knowledge. The number of participants who chose to quit in the different treatments is presented in Table 2.

			No Participation	Quit in the Middle
Time Matched	Direct	No reward	3 (.041)	1 (.013)
		Small reward	2 (.034)	1 (.017)
		Large reward	0	6 (.176)
	Indirect	No reward	0	0
		Small reward	2 (.05)	0
		Large reward	0	0
Random - Matched	Direct	No reward	1 (.024)	0
		Small reward	3 (.047)	0
		Large reward	0	5 (.208)

Table 2: Number of participants who quit by treatment. The figure in the parenthesis represents the fraction of players in the treatment among the total number of players.

Interestingly, most of the quitting in the middle occurred in tournaments with high rewards while most of the no participation behavior occurred in tournaments with no or small rewards. Specifically,

Observation 4 (quitting in the middle):

(i) In tournaments with no or small rewards quitting in the middle of a race was a relatively rare event.

(ii) In tournaments with large rewards, there was significantly more quitting in the middle than in races with small or no rewards.

(iii) In direct tournaments with high rewards, in which players run together, there is significantly more quitting than in indirect tournaments, in which players run separately.

The fact that quitting in the middle was a relatively rare event is somewhat puzzling. In most cases the race was not neck to-neck until the last second. The general impression was that in many of the races, the winner was not determined until the last moment. When the chance of winning became slim, one option the runners had was to quit. Yet, our findings indicate that even when it was obvious to the second runner that he was not going to win, he continued to run. This observation suggests that the final prize is not necessarily what motivates runners to complete a race. Quitting may be associated with a social stigma or negative feelings that prevent players from quitting even when they know that their chance of winning is almost nil.

The second part of the observation indicates that quitting in the middle occurs mainly in tournaments with large prizes. This is a surprising result; it implies that by providing strong incentives, it is possible to induce more effort and better performance but at a possible cost of more cases of quitting. On the other hand, when the environment is less competitive, with either no or small monetary rewards, hardly any cases of quitting are observed.[17]

Not having quitting in an indirect race is probably not surprising and indicates that quitting in the middle, the behavior observed in direct tournaments, is an outcome of the runners' capacity to observe their relative position throughout the race. In the indirect race, runners are unaware of their relative performance — winning or relatively behind — in the course of the race. They therefore cannot be "disappointed" until the race is over.

Moving to no participation, Table 1 shows us that large rewards induce participation. The few cases of no participation occurred when the winners received small (or no) rewards. Specifically,

Observation 5 (no-participation): No participation occur **only** in tournaments with no or small rewards. Large rewards always induce participation by all the runners.

[17] A one-tailed test of the equality of proportions, using normal approximation to the binomial distribution, indicates that the fraction of participants who quit in the middle of the direct Time Matched and the direct Random Matched tournaments is not statistically different, and that the fraction in these two tournaments is significantly (at the .01 level) higher than in all other treatments.

3.3 Performance of Winners and Losers

So far we have evaluated average performance in different types of tournaments. But what happens when we consider separately the performance of winners and losers? Figure 2 presents this comparison in the different dynamic treatments.

<Insert figure 2>

The most interesting of the comparisons undertaken is that between the indirect and the direct Time Matched races. In the tournaments with no rewards, no differences are found in average performance or in the winners' and the losers' performance between the two types of race. When there are small rewards, the indirect race elicits better performance on the average. This phenomenon may be due to the winners' better performance, which may more than compensate for the losers' poor performance. The interesting difference is in tournaments with large rewards.

Observation 6:

(i) The indirect race setup created a significant behavioral difference. While the average performance in the high-reward direct tournament was not significantly different from the average performance in the high-reward indirect tournament, winners in the indirect tournament performed better than did winners in the direct tournament, while the losers in the direct tournament performed better than losers in the indirect tournament.

(ii) The best performance in our experiment was exhibited by the winners in the indirect race with high rewards.

The implication of the above observation is straightforward. If a tournament's designers care mainly about the performance of winners (like in an R&D race), indirect tournaments with large rewards yield the best outcome. On the other hand, if the designers also care about the performance of the losers (or the performance gap between players) the designer is better off with a direct tournament. That is, it appears that neck-to-neck competition, in which players can constantly measure their relative performance, reduces the performance gap between winners and losers but, as shown previously, at a cost of having more quitters.

4. Discussion: Quitting in tournaments

Our experimental results point out a number of puzzling phenomena. Runners quit only when large rewards were provided, yet almost no runner quit a tournament when no (or small) rewards were provided.[18] These observations do not necessarily contradict rational behavior. In order to better understand our experimental outcomes, we will discuss them within the framework of a continuous time dynamic tournament. Note, however, that a closed-form analytical solution for dynamic race games is unknown (see Doraszelski (2003) for a numerical solution approach to dynamic tournament games). We therefore limit ourselves to the terminology of dynamic games to convey a better intuition of our result.

[18] It is interesting to note that in static tournaments, increasing the reward induces greater effort from the participants; however, quitting in the middle is not part of this game.

Consider a two-player dynamic race. The race is for a given distance; the winner receives prize P. We assume a direct tournament such that at each time *t,* a runner's position, denoted by (x_1^t, x_2^t), is perfectly observable to both players. In order to advance in the race, the runners need to exert (costly) effort to (stochastically) improve their positions in the race. Markov strategies in such a race are the functions $e_i(x_i^t, x_{-i}^t, t, P)$, *i*=1,2, that is, specify effort as a function of the players' positions in the race, time and the reward given to the winner. A Markov Perfect Equilibrium of this game is the strategy specification $e_i^*(x_i^t, x_{-i}^t, t)$, and the value function $V_i^*(x_i^t, x_{-i}^t, t, P)$, which provides the value of the game for player *i* given (x_i^t, x_{-i}^t, t, P), such that strategies are optimal given the value function and the value function represent the value of the game when the players play the equilibrium strategies.[19]

When quitting yields zero payoffs then it would be rational to quit whenever $V_i^*(x_i^t, x_{-i}^t, t, P) < 0$. That is, players will quit whenever the value of continuing the race is negative.

In a tournament with no rewards, the monetary value of the race is always negative and if players care only about their monetary rewards, we expect them not to participate in the race; if they do, we expect them to quit in the middle. The fact that in our experiment players participated in races with no monetary rewards without quitting implies that there might be some non-monetary rewards (such as the joy of winning) that are sufficient to motivate such behavior. Hence, the reward P should take into account monetary and non-monetary rewards.

[19] See Maskin and Tirole (2001) for a definition of MPE in dynamic games.

But non-monetary rewards for winners are insufficient to explain why we rarely observed quitting in the middle in such races. In many of the races the winner's identity was clear before the end of the race.[20] Yet almost all runners continued on to finish the race. One possible, intuitive explanation is that a social stigma is associated with quitting. The stigma of quitting, denoted by S_i; S_i<0, can be a function of the two players' positions, the prize, the runners' relative abilities and the outcomes of other races in the treatment. For example, if many players quit, this behavior would become more acceptable, implying reduced social stigma. We ignore these issues here and continue our discussion assuming, for convenience, a constant stigma S_i.

In considering the stigma associated with quitting, the first question to be asked is how quitting is defined in a dynamic tournament. Ceasing to exert effort is clearly an instance of quitting, but so is a drastic reduction in effort. That is, quitting in a race can be defined as stopping to run or continuing to run but at a noticeably slower pace. In a different context, youngsters can continue to go to school but they can devote noticeably less effort to studying. Where exactly does the cutoff point lie below which we can say that someone quits? There is no obvious answer to this question. It seems that the characterization depends on the type of tournament and the observability of effort, among other factors. Interestingly, in our experiment, quitting the race was characterized by stopping to run. This seems to be rational behavior as if a runner gives up the chance of winning and is ready to bear the stigma of quitting; there are no benefits from continuing to exert even a minimal level of effort.

[20] We clearly could not ask the runners in the middle of the race if they were sure who was going to win the race. But in a 60-meter run, any significant gap (particularly in equal-ability races) provides an excellent predictor of the winner's identity. However, given the stochastic element in any such race, nothing is "obvious" with certainty.

In a dynamic tournament, the decision whether to quit is made every minute (or period) and affected by the players' realized relative performance. The players compare the value of continuing the tournament, given their past performance and the social stigma associated with quitting, and decide whether to continue. Following our previous notations we let $V_i^*(x_i^t, x_{-i}^t, t; P, S)$ be the equilibrium value of the tournament given the relative position of the players and the reward structure *(P,S)*. Players will quit the tournament whenever $V_i^*(x_i^t, x_{-i}^t, t; P, S) < S_i$. That is, quitting will occur whenever the value of continuing the race is below the value of the social stigma associated with quitting. A larger social stigma therefore induces less quitting.

So, why do we have more quitting in the large-reward tournament? One possible answer is that the social stigma from quitting the race depends on the incentives themselves. Quitting may be considered more legitimate when stress is placed on monetary rewards, like the case of races with large prizes. On the other hand, in races with no or small rewards, the runners' state of mind is that competition is for the sake of competition and not for monetary gains and consequently quitting is less acceptable.

But the explanation of this phenomenon may also be linked to the performance effect of large rewards. In the race with large prizes, the players ran much faster than in the race with small or no prizes. When runners exert great effort or when they are in a middle of a fast race, the cost of continuing the race without quitting — i.e., any substantial decrease in speed — is high. Now consider a player in a losing position; assume that the asymmetry is such that the possibility of winning is negligible. When the race is faster, the cost of continuing the race can be sufficiently high to overcome the social stigma associated with quitting. On the other hand, in races with small prizes, the

equilibrium effort levels are moderate and thus the cost of finishing the race, even when the possibility of winning is slim, may still be below the cost of the social stigma associated with quitting.

Concluding Remarks

Whenever players are in direct competition with one another, social preferences may be an important determinant in their behavior. Winning has value in itself, with or without monetary rewards. It affects how people view themselves, their self-esteem and often how others evaluate them. Social preferences are subjective and difficult to measure. Moreover, social rewards may be sensitive to the specific scenario, history of the interaction, or even the framing of the competitive tournament. In tournament-like situations similar to our experiment, players compete directly with each other while all their friends were watching. There can be little doubt that in such a tournament, non-monetary rewards influence the players' performance. Non-monetary rewards are, furthermore, affected by the tournament's design: whether it is a direct tournament, what information becomes public, and so forth. It appears that an important part of designing a tournament is to try to incorporate the social rewards and pressures that will produce favorable outcomes.

Designing a tournament depends very much on the designer's objectives. In some tournaments, that objective is to produce a winner with the best possible result. This objective probably characterizes R&D tournaments or running competitions. In such tournaments, the possibility of quitting is of less importance. In other situations, the designer's objective may be to achieve a desired average result or average effort (for

example, in firms where higher average effort implies higher overall output). In yet other situations (such as in schools) it is the distribution of performance that is important; stress here is placed on the lower tail of the distribution with its associated probability of quitters. Our result may therefore also contribute somewhat to the debate about which type of incentives we would like to introduce into schools. Many advocate stronger incentives. However, as long as students are evaluated relatively, such incentives may enhance performance but at the cost of more dropouts.

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Appendix:

We start by analyzing the benchmark treatment in which the youngsters ran alone in both stages. The purpose of this treatment is to measure the difference between the first run and the second run, without the competition effect. The distribution of changes in times (time of round 2 minus time of round 1) is presented in Figure A1.

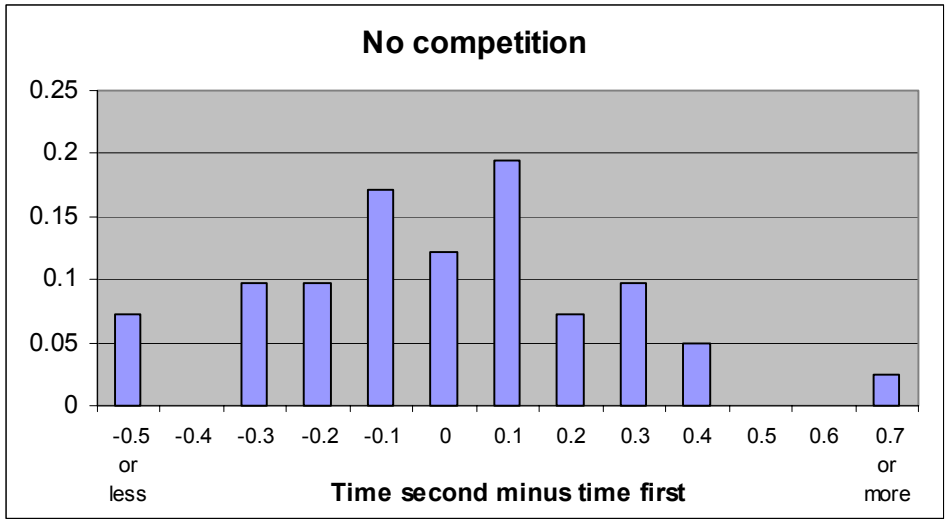

Figure A1: Distribution of changes in times (time of round 2 minus time of round 1) in the no-competition treatment.

Table A1: Basic Statistics

			All Participants			Winners			Losers		
		N =	Avg.	Median	S.D.	Avg.	Median	S.D.	Avg.	Median	S.D.
	No competition	41	-.056	-.02	.327	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Random	No Reward	42	.106	.13	.565	.105	.16	.438	.107	-.02	.680
	Small Reward	64	.110	0	.594	.065	.03	.338	.154	-.03	.774
	Large Reward	24	-.184	-.235	553.	-.098	.005	.536	-.270	-.275	.580
By Time	No Reward	72	-.065	-.03	.424	-.200	-.135	.333	.070	.06	.466
	Small Reward	58	.004	0	.312	-.092	-.1	.320	.010	.1	.278
	Large Reward	34	-.383	-.185	.657	-.497	-.42	.622	-.269	-.12	.690
Indirect	No Reward	28	-.077	-.05	.399	-.226	-.135	.291	.073	.06	.445
	Small Reward	40	-.081	-.1	.315	-.233	-.305	.284	.071	.05	.274
	Large Reward	68	-.302	-.09	.753	-.568	-.28	.881	-.036	.05	.479

Note: The statistics refer to time in round 2 minus time in round 1 (Quitting is ignored).

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Figure 2: Comparison of improvement between the winners and the losers in the different dynamic treatments.