Dipartimento Economia e Statistica Cognetti de Martiis

Working Paper Series

19/15

COMPETING FOR PROMOTION: ARE "THE BEST" ALWAYS THE BEST?

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Matteo Migheli*

Abstract

Several selection processes use multistage tournaments to choose the best candidates. The theoretical models predict that tournaments are efficient in selecting the best candidates, as they stimulate the best to perform relatively better than their opponents. Empirical tests are difficult, as data on the agents involved in these selections are scarce. Exploiting data from a field natural experiment, the World Swimming Championships, I show that two- and three-stage tournaments are effective for stimulating performance, selecting the best contestants and the winners are the players who are the most able to increase their relative performance from one stage to the next.

Keywords: tournament; competition; selection; natural experiment

JEL Codes: C70, D03, J33, M50

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1. Introduction

"Rewards" are allocated to workers, students, athletes, political leaders, etc. following comparative evaluations of their performances in the relevant domains. These comparative procedures select the winners of promotions, medals, elections, prizes, scholarships, and admission to prestigious colleges, and are crucial in the formation of leadership in almost all the spheres of social life (politics, business, etc.). Sequential tournaments are the most commonly used process of selection. In particular, elimination contests are widely used in the labour market, in political competitions, in science contests, for choosing CEOs, for determining their remuneration, and, of course, in sports competitions (Main, O'Reilly, and Wade 1993; Moldovanu and Sela 2006; Kale, Reis, and Venkateswaran 2009; Zhang and Wang 2009; Connelly et al. 2013; Waldman 2013). According to Hvide (2002), and following Holmstrom (1979), "The main theoretical rationale for rewarding relative performance [… is that] an optimal compensation contract conditions rewards on any variable that is (incrementally) informative about work intensity (effort)."[1] Indeed, in the real world, tournaments allow the observation of the relative performance of the contestants, in order to select the best: they promote the survival of the fittest and save sampling costs by early elimination of weaker contenders (Rosen 1986). In particular, firms generally award promotions to employees based on their relative performance in the workplace. Indeed, the maximum effort that an individual is able to exert is generally his private information and is hardly observable: winning a competition means overtaking the other contestants, which does not necessarily require the exertion of the maximum effort. Because of this, Lazear and Rosen (1981) note that relative performances are more informative than absolute results. The extant theoretical and empirical literature on tournaments[2] suggests that players' effort depends on the presence of multiple prizes, on how their value is differentiated, on the degree of homogeneity between the

[1] Hvide (2002), pp. 877–878.

[2] For a review of this literature, see section 2.

contestants, and on the information disclosed in the intermediate stages of the tournament. In tournaments involving elimination, in which prizes are awarded only in the last stage, high performances in intermediate stages are necessary to pass the stage and compete in the next. On the one hand, since effort is energy consuming, the subjects have an incentive to save their energy for the last stage (when prizes are awarded); on the other hand, if they save too much energy (i.e. do not exert enough effort) in a stage and do not access the last one, all the effort is wasted. In principle, the contestants should aim just to pass from one stage to the next, and then to use all their remaining energy to win the tournament. In other words, it is unclear how people allocate their energy between the different stages of a tournament. The intermediate results, anyway, represent a signal of the contestants' ability to both the competitors and the principal; the latter, in particular, bases the decision on whether to promote an agent to the next stage on this information. Therefore, the question is: how reliable are these intermediate signals in representing the subject's ability? In other words: are they good predictors of the real ability of the subject (i.e. of the ability to win the competition in the last stage)? The answer to this question is important in terms of the efficiency of sequential tournaments in selecting the best competitors. Indeed, if this scheme were not able to incentivise the best to make enough effort to pass the intermediate stages, it would fail in individuating and promoting the best. This paper aims to answer this question, examining the data of a real sports tournament in two and three stages. The paper uses data from three- and two-stage tournaments to understand whether these are effective in selecting (awarding prizes to) the best participants. The results show that this is the case.

2. Sequential tournaments in the literature

Since the pioneering paper by Lazear and Rosen (1981), the theoretical literature has elaborated several models of sequential tournaments. In particular, the early works point out that, in order to maximise the effort exerted by participants in sequential tournaments, prizes should be scaled in a non-linear way, concentrating most of the total value in the first prize. This eliminates the "no-tomorrow aspects of competition in the final stages"[3] and maintains the incentive to climb higher (Rosen 1986; Clark and Riis 1998a; Fu and Lu 2012).[4] Kräkel (2000) proposes a theoretical model that predicts that people are averse to relative deprivation (which arises when one's rewards are less than that of the reference group); therefore, in order to avoid this, they maximise their efforts in tournaments. Yildirim (2005) proposes a model that incorporates information released during the tournament. In several cases, indeed, the contestants may or may not know the performance of their competitors; however, Yildirim's model shows that, for symmetric individuals, the release of information during the game does not affect the outcome. Moreover, the favourite competitors are more likely to win consecutive steps of the game and therefore tournaments reveal competitors' true abilities. To this model, Morgan and Várdy (2007) add the cost of obtaining information about the effectiveness of the competitors' efforts. They conclude that, when the cost of obtaining this information is low, then the "commitments in tournaments is *completely preserved*". In other words, the underdogs are not discouraged by knowing that somebody else is performing better. In particular, there are two possible effects of releasing information during the tournament: if the contestants are very far from each other, then the underdogs become discouraged and leave the competition; however, when all the competitors are close to each other, the opposite effect prevails and they maximise their effort (Ederer 2010). The issue of similarity between the contestants is also studied by Ryvkin (2009); he finds that the Nash equilibrium of a tournament with weakly heterogeneous players is the same as that with symmetrical individuals. Another issue related to multistage contests is how the subjects divide their total effort between the stages of the game. On the one

[3] Rosen (2006), p. 701.

[4] Regarding the incentives coming from prize differentiation, see also Gershkov and Perry (2009), Konrad and Kovenock (2009), and Cason, Masters, and Sheremeta (2010).

hand, losing in a stage entails losing the game (as the steps are consecutive); on the other hand, expending all their effort in the first stage means lacking energy in the next. However, Brown (2011) finds that the presence of “superstars” in a competition enhances the performance of “average” contestants. Arbatskaya and Mialon (2012) propose a theoretical model, which shows that the single-stage effort of both strong and weak players is lower in a two-stage than in an equivalent one-stage game. Moreover, the model predicts that the overall effort in a two-stage contest is lower than in an equivalent one-stage game.

The literature also provides some empirical evidence from real competitions and experiments. Ehrenberg and Bognanno (1990) analyse data from professional golf competitions in the USA and find that the performance increases with the prize level; however, in a study carried out two years later, Orszag (1992) finds the opposite result using the same data. Maloney and McOrmick (2000) use data from foot racing at different levels in the USA; in accordance with the theoretical predictions of Rosen (1986), they find that the effort level increases with the spread between the prizes, because, in order to maximise the expected pay-off, the contestants increase their effort. An ancillary result (also found by Leuven et al. 2011) is that competitions with higher prizes attract better runners (the predictions of the theoretical model of Cason et al. [2010] and of Ryvkin [2010] are in accordance with this result). This is relevant to data selection in empirical inquiries: if we want to consider data from more than just one competition, the level of those selected should be held constant or, at least, comparable. Eriksson (1999) also finds that “there is a positive relationship between the number of participants and the prize of tournament”.[5] Lynch and Zax (2000) examine professional road racing in the USA; they conclude that monetary prizes are not the only incentives for the athletes. While the best of them self-select into the tournaments with richer prizes, the prestige of a victory is also part of the total reward (Fershtman and Gneezy 2011). Harbring and Irlenbusch (2003) implement an experiment

[5] Eriksson (1999), p. 278.

based on a non-cooperative game with complete information. They find that the average effort increases with the number of the winner prizes, while as these latter increase, the variability of the effort decreases. Harbaugh and Klumpp (2005) study a two-round tournament (the NCAA men's basketball tournament) and find that the underdogs exert more effort than the strongest teams in the semi-finals, contrary to the theoretical predictions of Rosen (1986). Furthermore, Guryan, Kroft, and Notowidigdo (2009) do not find any evidence that peers' performances affect the individual results (although high-level professional golf players constitute their sample). Sheremeta (2010) uses a two-stage experimental framework and finds that "winning is a component in a subject's utility".[6] Indeed, it is not only in sports competitions that the contestants care about their position in the final ranking and retrieve utility (or disutility) from the position obtained (Ludwig and Lünser 2012), as a consequence of envy[7] and loss aversion (Eisenkopf and Teyssier 2013). Freeman and Gelber (2010) test how prizes and information affect the players' performances in a tournament. They find that the maximum effort is put in when differentiated prizes are given to the best contestants and that informing them about the others' performances also increases the individual effort. Ludwig and Lünser (2012) also observe that the release of information does not affect the subjects' effort within stages of the competition, while there is a significant effect between stages. In particular, the underdogs exert more effort in the second (last) stage than in the first stage, as they try to reduce the distance from the favourites. In particular, Eisenkopf and Teyssier (2013) also provide evidence about the effect of prize differentiation on the subjects' effort: the smaller the differential, the lower the level of effort exerted by the contestants. Genakos and Pagliero (2012) analyse data from weightlifting competitions and find two interesting results: first, the athletes who lag behind take more risk (and exert more effort) than the favourites, and second, the more risk the subjects take,

[6] Sheremeta (2010), pp. 731, 732.

[7] An alternative point of view is that of reference points: people generally have reference points and are disappointed if they perform worse than them (Gill and Prowse 2012).

the lower is their probability of succeeding in the round. Altmann, Falk, and Wibral (2012) run an experiment on promotions in firms using three schemes of tournament: the first is a single-stage game, the second involves two stages, and the third contains three stages. At the end of each stage, the participants are informed only about their performance and whether they passed the stage or not (i.e. no information about the others' performance is disclosed). The authors find that the "subjects in two-stage treatment provide excess effort in the first stage, both with respect to Nash predictions and compared to the strategically equivalent one-stage tournament".[8] Moreover, in the three-stage tournament, they observe that the "participants exert excess effort both in the first and the pre-final stage".[9] Mago et al. (forthcoming) study a three-stage setting and find that the effort of players in the third round is greater than that in the two previous rounds. This suggests that as the contenders become closer to the prize(s), they compete with more effort. While rewards based on relative performances may elicit less total effort than rewards based on absolute performances (Carpenter, Matthews, and Schirm 2010), promotions, admissions, etc. are generally not based on absolute abilities (which would be extremely difficult to observe) but rather on relative performances.

Taken together, these results suggest that: 1) effort increases during the passing from one stage to the next; 2) the results observed in the first stages are a good predictor of the final result. As I will describe in the next section, these competitions are organised as three- or two-stage tournaments, and the athletes receive information about their opponents in three ways: 1) they know the names of their opponents and their past performances; 2) they know the absolute times and the positions in the rankings of their opponents at each stage of the tournament; and 3) they can observe the other swimmers directly during the race. Then, what may the use of data from swimming competitions add to the extant empirical studies? There are some aspects to be

[8] Altmann, Falk, and Wibral (2012) p. 149.

[9] Altmann, Falk, and Wibral (2012) p. 151.

considered here. In sum, the advantage of swimmers' data is that they are cleaner than data from other types of competition. First, and more important, most of the papers using data from sports competitions consider sequential tournaments (where at each stage the contestants play after each other), while in the real world workers, students, etc. play parallel tournaments (i.e. at each stage they play all at a time). This difference is very relevant, since the responses of the players to the others' performances also depend on how this information flows in the group of contestants. In the real world, where people contend in parallel tournaments, all the players get information about the others' performance during the race. In sequential tournaments, the last player has full information about the others' performance at the same, while the first to play has no information on the others' performance at the same stage. Second, differently from runners and golf players, the "experimental conditions" are more stable in water than outside: runners and golf players are exposed to different intensities and directions of wind, which may affect the final results in unobservable ways. Third, runners and golf players can hear the supporters cheering for or against them, and this is likely to have some effect on their performance, which is not captured in the extant studies. For swimmers, this is much more unlikely, given that their heads are underwater for most of time. Fourth, swimmers have better information than runners during the race: turning their head to see the other competitors is costless for swimmers (in some cases – e.g. freestyle – they have to turn their head by default), since it does not influence their performance.[10] This is not the case for runners.

[10] Indeed, turning the head is sometimes required by the swimming style itself (as in the case of freestyle). In the other cases, this does not modify the performance substantially, as turning the head does not make the swimmer lose any pieces of information. While for a runner it is fundamental to look ahead, swimmers know at which point of the pool they are also looking towards the walls of the pool, as the lanes have different colours at different distances from the beginning and from the end of the pool.

3. The tournament: a brief description of swimming competitions

The World Swimming Championships are an example of sequential tournaments with seeding. We can distinguish short and long races: the first comprise races over 50, 100, 200, and 400 metres and the second over 800 and 1,500 metres. Each of the short-distance tournaments has three stages – heats, semi-finals, and finals – while each of the long-distance competitions is composed only of heats and finals. According to the federal rules, each country can enrol up to two swimmers for each competition; all the enrolled athletes first swim in the heats in groups of eight.[11] The final times are recorded and a final rank of all the swimmers is drawn up;[12] the best sixteen athletes (i.e. those who ended with the shortest times) are admitted to the semi-finals if they are competing over a short distance, or the best eight swimmers pass to the final if they are competing over a long distance. Semi-finals work as heats: two races with eight swimmers each are run and the best eight athletes will then swim in the final. As usual, the winner of the final receives the gold medal, the second in the ranking the silver medal, and the third the bronze medal. The FINA also awards a monetary prize for each of the first three positions. This prize decreases with the ranking and is not given to the swimmer directly; rather, it is invested in a nominal pension fund managed by the FINA Bank (with headquarters in Lausanne). Very often, the winner of a gold medal becomes a testimonial for advertising campaigns of sports and non-sports products. Some very top-level swimmers (for example, the German swimmer Franziska van Almisck) have earned many millions of dollars[13] thanks to these contracts. The swimmers are aware that these are part of the final prize for the gold medal winner, and they also know that as the fame (i.e. the number of gold medals won) of an athlete increases, so do the number

[11] A regular swimming pool has eight lanes. Furthermore, according to Gradstein and Konrad (1999), in order to maximise the participants' effort, the group size within each stage should be constant.

[12] As Fu and Lu (2009) show, this aggregation serves to stimulate the swimmers to maximise their effort in all the stages of the competition.

[13] Franziska van Almsick, for example, earned more than 7 million dollars in her career as a testimonial of advertising campaigns.

of advertising contracts and their remuneration. In general, the winners of silver and bronze medals do not receive such contracts, unless they are already renowned swimmers. The existence of these extra prizes for the winners of gold medals renders the spread between the first and the second prize very wide, and incentivises the swimmers to exert effort at each stage of the tournament (Rosen 1986; Clark and Riis 1998a).

The last characteristic of swimming competitions is seeding. Although the athletes who compete in the World Championships are top level, significant differences exist between them. If they were assigned to heats and semi-finals randomly, the known differences between them could discourage some from competing; this would render the spectacle less interesting, but it would also fail to induce the swimmers to expend the maximum effort (Clark and Riis 1998b).

In order to render each stage of a competition as homogeneous as possible to induce the athletes to exert the maximum effort, the federal rules establish that swimmers must be clustered in heats and semi-finals according to their qualification times (QTs). Practically, the eight swimmers with the lowest QTs swim in the first heat/semi-final, those with QTs between the ninth and the sixteenth swim in the second heat/semi-final, and so on. Furthermore, the swimmers are seeded in each heat, semi-final, and final. Let us consider the final: the swimmer with the best QT of the semi-finals swims in lane 4, the swimmer with the second QT swims in lane 5, the third in lane 3, the fourth in lane 6, and so on. The same disposition works for each of the semi-finals and for each of the heats. This gives an advantage to the athletes who swim in lanes 4 and 5: given the limited visibility in swimming competitions, the athletes in the central lanes are able to see all the competitors better than those who swim in the lateral lanes are. However, in addition, all the other contestants can easily see the swimmers in the central lines, and the cost of such monitoring is generally low, as the swimmers just have to turn their heads slightly.[14] In the light of the extant theoretical literature, if the athletes are weakly

[14] According to Morgan and Várdy (2007), this does not affect the results of the competition.

inhomogeneous, this procedure of seeding should induce all the swimmers to exert the maximum effort. Even in the presence of an outstanding contestant, the other swimmers are incentivised to compete for the silver and the bronze medals.

Swimming competitions allow the possibility to observe whether the effort in the two initial stages of the tournament is a reliable signal of the effort lavished on the last step. Moreover, differently from weightlifters, who compete sequentially and can adjust their effort only discretely in time (Genakos and Pagliero 2012), swimmers compete in parallel and, looking at their direct opponents, can adjust their effort continuously. The advantage of observing the results of a parallel instead of a sequential tournament is that in the real word colleagues competing for promotions work in parallel, and send and receive signals (although perhaps in an imperfect way) during each stage of the tournament. Therefore, swimming competitions mirror the reality better than weightlifting tournaments do. Altmann, Falk, and Wibral (2012) check whether one-stage tournaments are as efficient as multistage tournaments in making the subjects reveal their "true type" (i.e. how good they are at their job). However, they implement a one-shot interaction experiment, in which the subjects decide on a level of effort, given the cost for each level chosen. This effort has only a monetary cost, though, and it does not affect future performances. This design differs from the real word in some respects: 1) working is stressful, and stress affects future performances; 2) information about the others' performances generally spills over (i.e. competitors can – at least partially – observe each other and the reputation of a top swimmer is generally well known[15]); 3) in real life workers exert real effort. The data from the field experiment used in this paper include these three aspects. I would like to stress some aspects of observation (2). Reputation is based on the past performances of

[15] Nevertheless, the reputation of an athlete provides incomplete information: athletes' performances are variable and strongly depend on the individual conditions (physical and psychological health above all) during the race. Additionally, the performance of workers depends on these variables, which are even more important in the case of students (or workers) taking a test.

the swimmers; these are well known, but forecasting future results on this basis would be misleading. Not only do abilities decline with age, but they also depend on other factors (see footnote 13), some of which – moreover – are not entirely under the swimmer's control. Similarly, in the real world, employers and employees know the reputation of a worker, examination committees know the reputation of the college from which candidates graduated, etc., but these are only (perhaps good) proxies of the future performance of the person, and all know this. The performance during the competition might be more revealing of the actual abilities of the subject; however, he or she may behave strategically, saving effort for the following stages, sending noisy signals to the others, etc. In conclusion, the information in swimming competitions is far from perfect, as it happens in the real world. Furthermore, in this sense, the data used in the paper help to mirror other real situations.

Incidentally, I would like to add an observation about the presence of some gender effects in tournaments. Although there is no full consensus about what determines different behaviours between genders in games (Croson and Gneezy 2009), there is nevertheless empirical evidence that women tend to shy away from competition (Niederle and Vesterlund 2007), or, at least, that they behave somehow differently from men (Castillo and Cross 2008). Of course, considering swimming competitions at the top level rules out the possibility that these differences in behaviour affect the results, as, by definition, top athletes, even if they are female, do not shy away from competition. The focus of this paper is on understanding whether tournament schemes are effective and efficient in selecting the best among the contestants. Therefore, the elimination of gender biases cleans the results, while perhaps introducing some distance between these results and those of the real world.

4. Data and methodology

The data are from the World Swimming Championships from 2001 to 2011. As the empirical literature on tournaments suggests that as the prize increases so does the quality of the competitors, here I consider only top comparable events. The World Championships take place every two years in odd years. All the results of these competitions are freely available on the website of the Fédération Internationale de Natation Amateurs (FINA henceforth). Each step of each competition is recorded in a separate file, which provides the name, surname, and date of birth of each athlete, the final time and rank, the reaction time,[16] and the intermediate times,[17] for 2,410 observations. From this information, other variables were generated: the rank after each intermediate record for each phase of the competition, three dummies capturing the stage (heats, semi-finals, finals), a dummy for passing the phase or not, a dummy for each distance swum, a dummy for the length of the competition (1 if short – i.e. 50, 100, or 200; 0 if long – i.e. 400, 800, or 1,500 metres).[18] Short races are three-stage tournaments, while long races are two-stage tournaments. In order to render the comparisons as homogeneous as possible, they are made within short-race and long-race competitions. Of course, different lengths entail different distributions of effort: in shorter races, it is concentrated in short times, while longer races require more diluted and continuous effort. As a consequence, the analysis presented in this paper also allows for understanding whether the different distributions of the effort required by different tasks/jobs may affect the contestants' behaviour.

As such, these data present the major problem of being interdependent (see Zhang and Wang 2009). In the swimming pool, eight athletes swim at a time. While this allows them to

[16] This is the time elapsing from the starting signal and the first movement of the swimmer from the starting block.

[17] These are the times taken every 50 metres.

[18] This partition follows the international rules of swimming competitions: those classified as "short" entail three phases – heats, semi-finals, and finals – and the others only two – heats and finals.

adjust their effort continuously, it also renders the individual times interdependent: since an athlete needs to win the race, his/her effort will be a function of the others' effort. In the following section of the paper, I will define the first four finalists (in order of arrival)[19] as "winners" and the second (or last) four finalists as "underdogs".[20] Consider a strong swimmer: in order to win against the underdogs he will expend less effort (resulting in a higher time) than when competing against strong opponents. In other words, absolute times do not depend only on the ability of the swimmer, but also on that of the others and therefore the information provided by them is noisy. Nevertheless, they are useful for testing whether the absolute effort also varies across the stages of the competition. The relative ranks are not affected by interdependence: if the tournament is effective, the position in the rank reveals the actual relative ability of the athlete, which mirrors (and depends) only (on) the (unobservable) maximum level of ability of the swimmer. Finally, in the labour market, workers are promoted according to their relative performance with respect to their colleagues' and hence the positions in the final rank mirror the real world better than the final times. Of course, the swimmer's desire to establish a new personal, national, Olympic, or world record may mitigate the problem of interdependence: if the effort is finalised not only to win the competition, but also to establish a new record, then it depends on the others' effort less than in the absence of this motivation. However, it is likely that some interdependence still holds.

Using the position in the ranking rather than the times has two advantages: the first is to solve the problem of interdependency; the second is to mirror the real world better. However, the final times may also provide some information. In particular, they are an absolute measure of effort; therefore, it is interesting to investigate whether, within the same group of swimmers,

[19] I.e. the three medalled swimmers and the one ranked fourth.

[20] This strong classification might be unfair to those defined as underdogs, but it eases the presentation of the results and the narrative of the paper.

they vary across the phases of the competition. In order to eliminate the interdependence between observations, I use the mean of the times in each step of the competition over each distance and for the eight finalists only as a single observation. At this point, the average times at different steps can be compared to see whether the effort increases across the phases of the competition.

A major difference between long and short races is in the value of the heats. In the short races, the best sixteen swimmers pass to the semi-finals (and therefore will still compete for the medals); instead, in the long races, only the best eight athletes in the heats will dispute the final (as there is no semi-final and finals have eight places irrespective of the length of the race). For this reason, the performance of the best eight swimmers is compared between heats and semi-finals, while that of the four best between semi-finals and finals: I have, therefore, chosen to use the best half of the rankings for comparisons. This is, of course, an arbitrary choice; however, given the data, some level of arbitrariness was necessary. Since in the comparison between heats and semi-finals I consider the eight athletes who swim in the final, their average rank at the end of the semi-final is 4.5 forcefully, as the best eight swimmers (out of sixteen) pass from the semi-final to the final. For the same reason, when I compare the ranking of the best four finalists between the semi-finals and the finals, their average rank in finals is 2.5. In other words, this procedure compares the actual average position in the ranking of the eight (four) best semi-finalists (finalists) with the average position of the top-half contestants[21] in the next stage. Further, I compare the ranks of the medal winners across the different steps of each competition. There are two reasons for this. Firstly, since the choice of the first half of the rankings is arbitrary, running the analysis again using another sub-sample serves as a robustness check for

[21] In the case of semi-finals, the top-half contestants are the winners of the stage; in the case of finals, only the best three swimmers win a medal. However, for the sake of homogeneity with respect to the previous case, in the comparison between the semi-finals and the finals I also consider the top-half swimmers (i.e. the best four).

the results. Secondly – and perhaps more importantly – the best three swimmers in the final are also those who win prizes, and the scope of the tournament is indeed the selection of these three contestants (i.e. the selection of the best three individuals).

In the analysis, I also use the data from the intermediate recordings. During competitions, the electronic time measurement system records the times at each swimmer's turn (i.e. every 50 metres); from these, the ranking at each turn can also be computed. This information is useful for checking the swimmers' behaviour during each stage of the competition and comparing the intermediate results of each stage of the competition with the total results between stages. This allows the determination of whether the behaviour between stages (where the expected pay-offs differ from one stage to the other) is similar or not to the behaviour in different steps of the same stage.

The advantage of using these data instead of performing a controlled experiment in a lab with recruited students is twofold. On the one hand, the extant experimental literature shows that men and women react to competition differently (Niederle and Vesterlund 2007). Top swimmers are in the pool to compete, and therefore their attitude towards competition is clear. On the other hand, swimmers are performing a real task, which can actually be considered as the "true" job of the experimental subjects, while recruited students in general perform tasks that try to mirror – but are not – real jobs.

It is worthwhile considering a last point: the difference between three- and two-stage tournaments. The extant literature does not find – to my knowledge – any relevant differences between these two settings. However, even if there were some, the comparisons allowed by the data and the analyses presented in the paper are always between tournaments with an equal number of stages.

All the statistical analyses are performed using STATA 10.

5. Results and discussion

This section reports and discusses the results of the analysis. It is divided into two sub-sections: the first presents the analysis of the swimmers' rankings between and within stages; the second presents the analysis of the swimmers' average times between and within stages.

5.1 Rankings

[Tables I and II about here]

Table I shows that the best four[22] swimmers (those who enter the final) perform sensibly worse in the heats than in the semi-finals: their average ranking in the heats is much higher than in the semi-finals. The same pattern emerges when the relative performances in the semi-finals and finals are compared, considering the sub-sample of the best four swimmers in the final. Two main features are interesting here: 1) the relative performance of the players considered here improves as the final step (which awards the prizes) approaches; 2) the results do not change significantly (both from a statistical and from a qualitative point of view) between different lengths of the race. Table II presents the comparisons for the best three finalists (i.e. the three medal winners). Furthermore, these figures confirm the previous results: the relative performance of the medal winners improves as the final approaches. Let us now consider the results of long-race competitions. The lower halves of the tables present the results for long races, which basically are two-stage tournaments involving only heats and finals. Let us now focus on these. The behaviour of the swimmers is qualitatively the same as in short races: the relative performance of the best improves from the heats to the finals, and this does not seem to depend on the increasing effort that is necessary as the length of the competition increases. In other words, the swimmers who end highest in the final rank show behaviours and strategies that are consistent across different lengths. They reveal their "real" quality only in the last stage of the competition. Another possible interpretation of this result is that the other

[22] This allows for the comparison of very homogeneous behaviours.

athletes (i.e. those who end in fifth or lower ranks in finals) exert excessive efforts in the early stages of the competition, consuming too much energy. Let us consider the three-stage tournaments. In the early stages of the competition (heats and semi-finals), the best swimmers care only about entering the next stage, saving their energy for the final, in which the prizes are allocated. Considering the job market, this behaviour is consistent with the standard microeconomic theory: workers' wages increase with their hierarchical position. Since the marginal productivity depends on effort, and since the marginal productivity should be equal to the wage, then the effort should increase with the wage, and therefore the hierarchical rank. Interpreting the different stages of a multistage tournament as different hierarchical ranks, the results shown in the tables are consistent with this classical theory. This may suggest that tournaments may not be the optimal mechanism to maximise the effort (and therefore the production[23]) during the whole life of the individuals. However, effort is energy consuming, and saving energy for more remunerated and more productive stages might be optimal anyway.

[Table III about here]

Let us now consider the other half of the sample: the swimmers who end in the last four positions in the final (Table III). These underdogs, who know that there are opponents who are stronger than they are, instead have to exert more effort (relative to their absolute ability) to increase the probability of accessing the following stage of the competition. Indeed, in the three-stage tournaments, the relative performance of the underdogs is better in the semi-finals than in the heats, but then worsens, and their relative performance in the finals is poorer than in the semi-finals. In the two-stage competitions, the underdogs end the finals in worse positions than in the heats. This may indicate either that they consumed too much energy in the early stages of the competition, resulting in inefficient allocation of their resources, or that the

[23] Here production must be given a wide meaning, which includes workers' physical product, students' and politicians' global achievements, etc.

winners are able to increase their effort relatively more than the underdogs (I will test this hypothesis later). In both cases, tournaments would be the most appropriate mechanisms to select the best. If the losers are unable to allocate their efforts properly, while the winners are, the latter are to be preferred to the former, since their allocation strategy is not optimal (as they consume too much energy in the early stages). If the winners are able to increase their efforts more than the losers, then tournaments are again the most appropriate mechanism to select the best. The analysis – presented further in this paper – of how times vary from one stage to another will help us to understand which of the two interpretations is more likely. However, this result may also be read in another way: consuming a great deal of energy in early stages is an aggressive but also a risky strategy. Knoeber and Thurman (1994) analyse broiler producers and notice that the most able players choose less risky strategies. Indeed, this is a possible interpretation of the figures presented in Table III.

[Tables IV and V about here]

Tables IV and V present the comparison between the average rank of the best four finalists at the end of each stage of the competition and that at the halfway point of the same stage. In other words, if we are considering a 400 m long race, here I compare the average rank at the end of a stage (for instance the heats) with the average rank at the 200 m turn in the same stage (again the heats). What counts in order to pass the stage is the position in the final rank of the stage, and not the intermediate relative result. However, in a sense, the comparison between the intermediate and the final average position at the end of each stage of a competition mirrors the comparison between the average final ranks at the end of two successive stages. We can observe that the within-stage behaviour of the swimmers is analogous to that between stages: the rank of the best athletes is better in the second part of each stage, as it is between two subsequent stages. Once more, this results holds for all the lengths considered, suggesting that it does not depend on the total effort required by a specific competition (proxied by its length).

The results of the worst four finalists also confirm the previous findings: their ranks improve from the first to the second half of heats and semi-finals. However, considering the ranks in the finals, the last four swimmers rank higher halfway through the stage than at the end of it. These results are of particular interest: they suggest that the underdogs do not become discouraged during the competition (otherwise their position in the ranking would not increase from stage to stage and within each phase) and "fight until the end". This is consistent with the hypothesis that the first four swimmers are able to improve their performance more than the second four.

[Tables VI and VII about here]

Finally, Tables VI and VII present the following results. The first column reports the average gain in terms of positions in the rank from one stage to another for the four best finalists (or the three medalled swimmers in Table VII); the second column reports the same variable (i.e. the underdogs in Table VI and the five non-medalled finalists in Table VII), calculated for the worst four finalists. The table shows two interesting results. Between the heats and the semi-finals, all the swimmers considered (both the best four and the last four finalists) improve their performance. In particular, both the underdogs and the winners "climb the ranking" and the improvements in their relative performances are statistically undistinguishable. Let us now consider how the average positions in the ranking vary from the semi-finals to the finals. Here we notice that the winners gain better positions, whereas the underdogs lose positions with respect to the previous stage. This suggests that both the underdogs and the winners put effort into improving their relative results, contrary to the possibility that the underdogs become discouraged. This does not imply that, under some circumstances, the worst contestants give up from the beginning, but it shows that, when the competitors have almost homogenous skills, all of them fight (at least) in the early stages. The results for long-distance competitions, which schedule only heats and finals, are qualitatively equal to those between finals and semi-finals in short races. Here we notice that the winners gain on average around one position from the heats to the finals. Another interesting result is that gains and losses are almost equal across the different lengths. This suggests that the swimmers behave more or less in the same way, regardless of the total effort required. The results also suggest that the two stages of a two-stage tournament are more or less equivalent to the last two stages of a three-stage competition.

5.2 Times

This section presents the absolute results (times) of the tournaments. As mentioned before, the individual data are clustered for each competition, since they are interdependent. The average time taken by the winners to complete each stage decreases from the heats to the semi-finals and from these to the finals (Table VIII). This suggests that their effort also increases from one stage to the next. The only exception seems to be the competitions over 100 metres, in which no decrease in times (i.e. no increase in effort) is observable from the semi-finals to the finals.

[Tables VIII, IX and X about here]

The results for the medalled swimmers also confirm these findings (Table IX) Furthermore, the underdogs (Table X) increase their effort in short competitions, while the opposite happens for long competitions (although this is not true for the 1,500 metres and only one difference is statistically significant[24]). On the one hand, this means that – in short competitions – both the winners and the underdogs increase their effort as the last stage of the competition approaches. On the other hand, this confirms that the underdogs do not give up in early stages, but fight for high ranks, in line with what the theoretical literature predicts, when the skills and the abilities of the contestants are similar.[25]

[24] However, the weak statistical significances might be due to the low number of independent observations available.

[25] Again, this evidence is limited to the short competitions.

[Tables XI, XII and XIII about here]

The analysis of intermediate times (Tables XI–XIII) reveals that in general the swimmers are faster in the first half of each stage, but the differences are significant only for short and medium (i.e. 400 metres) length competitions.[26] Over 800 and 1,500 metres, the figures show that the swimmers are faster in the second than in the first half of the stages, although the differences are not statistically significant. These differences between short and long competitions might be because of the different strategies of the swimmers. The allocation of effort during the swim also depends on its length. Table IX shows the same results for the medal winners only. Again, the figures confirm the previous findings.

[Table XIV about here]

Table XIV is analogous to Table VI: here I check whether the reductions in times presented in the previous tables are statistically larger for the winner than for the underdogs. This is very important, since it provides information about the effectiveness of the tournaments examined actually to select the best contestants. Indeed, the previous results show that both the winners and the underdogs increase their effort from one stage to the next. Now, if the winners are able to increase it more than the underdogs, this means that the tournament is effective (and perhaps efficient) in selecting the best. In other words, this would mean that all the contestants fight for the medals, but only the best actually win them. The figures presented in the table support this interpretation: the winners on average reduce their times (i.e. increase their effort) more than the underdogs.

Taken together, the results of this paper suggest that: 1) tournaments are effective in selecting the best subjects; 2) in the intermediate phases, on average the winners aim to pass the

[26] In other types of tournaments, the opposite result is observed (Lynch 2005). These different behaviours may just reflect the different strategies elicited by different rules.

step rather than to win it (as, on average, they gain positions in the ranking from one stage to the following one); 3) if the contestants are of similar abilities, then both the winners and the underdogs put effort into the competition. Result (3) might be explained by different effort allocations during the phases of the competition. In other words, the underdogs – differently from the winners – might distribute their effort in an inefficient way, expending too much energy during the early stages. Nevertheless, the ability to calibrate effort is likely to be a positive trait, and, if tournaments prize it as well, the results of the paper are still valid (if not strengthened).

6. Conclusions

This paper reports the results of tournaments in which highly skilled and competitive individuals are involved. Their performance improves systematically as the final step approaches. This result suggests that tournaments are an effective way to stimulate the participants to perform and to select the best performers, but casts some doubts on its efficiency: the best are almost always induced to save their energy for the last step, and this reduces their performance during the process of selection. However, it is possible that the effort exerted by the others in the stages in which the best do not maximise their effort compensates (the society) for this loss. Using the initial analogy with tournaments in the labour market, and taking the total effort as a proxy for the total product, it might be that the aggregate product does not suffer (too much) from the saving of energy of the best workers in the early stages of the competition. However, the data do not allow for the assessment of whether the total effort is maximised or not.

The results also suggest that the contestants may behave strategically during the competition, saving their energy in the early stages (although I cannot prove this). Should further research confirm this interpretation, then tournaments would still be effective in selecting the best, but they would be ineffective in maximising the total effort of the participants.

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Table I. Average ranks of the best four finalists at the end of each stage of each competition

	Heats	Semi-finals	Significance		Semi-finals	Finals	Significance
50 metres	4.01	3.26	***	50 metres	3.26	2.50	***
	(0.231)	(0.166)			(0.166)	(0.090)	
100 metres	4.22	2.97	***	100 metres	2.97	2.50	***
	(0.257)	(0.143)			(0.143)	(0.090)	
200 metres	4.27	3.01	***	200 metres	3.01	2.50	***
	(0.253)	(0.139)			(0.139)	(0.090)	

	Heats	Finals	Significance
400 metres	3.56	2.50	***
	(0.257)	(0.180)	
800 metres	3.18	2.50	***
	(0.308)	(0.180)	
1,500 metres	3.53	2.50	***
	(0.334)	(0.180)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: 161 (50 m.), 144 (100 m.), 156 (200 m.), 80 (400 m.), 40 (800 m.) and 40 (1,500 m.). The ranks are in absolute numbers. Long-race competitions (i.e. 400 metres and longer) only have heats and finals. The average position of the best four finalists in finals is 2.50 by construction.

Table II. Average ranks of the medalled swimmers at the end of each stage of each competition

	Heats	Semi-finals	Significance		Semi-finals	Finals	Significance
50 metres	3.88	3.12	***	50 metres	3.12	2.00	***
	(0.272)	(0.195)			(0.195)	(0.075)	
100 metres	3.68	2.63	***	100 metres	2.63	2.00	***
	(0.268)	(0.154)			(0.154)	(0.076)	
200 metres	4.19	2.76	***	200 metres	2.76	2.00	***
	(0.299)	(0.161)			(0.161)	(0.076)	

	Heats	Finals	Significance
400 metres	3.32	2.00	***
	(0.297)	(0.106)	
800 metres	3.00	2.00	***
	(0.349)	(0.152)	
1,500 metres	3.22	2.00	***
	(0.375)	(0.160)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: 121 (50 m.), 114 (100 m.), 119 (200 m.), 60 (400 m.), 30 (800 m.) and 30 (1,500 m.). The ranks are in absolute numbers. Long-race competitions (i.e. 400 metres and longer) only have heats and finals. The average position of the best four finalists in finals is 2.50 by construction.

Table III. Average ranks of the "underdogs" at the end of each stage of each competition

	Heats	Semi-finals	Significance		Semi-finals	Finals	Significance
50 metres	7.32	5.63	***	50 metres	5.63	6.50	***
	(0.304)	(0.142)			(0.142)	(0.088)	
100 metres	7.31	5.99	***	100 metres	5.99	6.50	***
	(0.330)	(0.131)			(0.131)	(0.092)	
200 metres	7.22	5.97	***	200 metres	5.97	6.50	***
	(0.304)	(0.142)			(0.142)	(0.089)	

	Heats	Finals	Significance
400 metres	5.40	6.50	***
	(0.212)	(0.125)	
800 metres	5.88	6.50	***
	(0.288)	(0.185)	
1,500 metres	5.47	6.50	***
	(0.366)	(0.189)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: 158 (50 m.), 150 (100 m.), 156 (200 m.), 80 (400 m.), 40 (800 m.) and 36 (1,500 m.). The ranks are in absolute numbers. Long-race competitions (i.e. 400 metres and longer) only have heats and finals. The average position of the best four finalists in finals is 2.50 by construction. The four finalists with the last times in the final are defined "underdogs" here.

Table IV. Average ranks of the best four swimmers at the halfway point and at the end of each stage of each competition

	Heats			Semi-finals			Finals		
	Halfway point	Final	Significance	Halfway point	Final	Significance	Halfway point	Final	Significance
100 metres	6.23	4.22	***	5.12	2.97	***	3.35	2.50	***
	(0.354)	(0.257)		(0.327)	(0.143)		(0.158)	(0.090)	
200 metres	5.97	4.27	***	4.46	3.01	***	3.37	2.50	***
	(0.324)	(0.253)		(0.256)	(0.139)		(0.168)	(0.090)	

	Heats			Finals		
			Significance	Halfway point	Final	Significance
400 metres	3.85	3.56	**	3.29	2.50	***
	(0.182)	(0.257)		(0.215)	(0.180)	
800 metres	3.47	3.18		2.90	2.50	*
	(0.362)	(0.308)		(0.260)	(0.180)	
1,500 metres	4.00	3.53		2.87	2.50	**
	(0.420)	(0.334)		(0.256)	(0.180)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: 161 (50 m.), 144 (100 m.), 156 (200 m.), 80 (400 m.), 40 (800 m.) and 40 (1,500 m.). The ranks are in absolute numbers. Long-race competitions (i.e. 400 metres and longer) only have heats and finals. The average position of the best four finalists in finals is 2.50 by construction.

Table V. Average ranks of the medalled swimmers at the halfway point and at the end of each stage of each competition

	Heats				Semi-finals				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance		Halfway point	Final	Significance
100 metres	5.87	3.68	***	100 metres	4.91	2.63	***	100 metres	2.93	2.00	***
	(0.395)	(0.268)			(0.387)	(0.154)			(0.169)	(0.076)	
200 metres	5.72	4.19	***	200 metres	4.12	2.76	***	200 metres	2.80	2.00	***
	(0.363)	(0.299)			(0.295)	(0.161)			(0.165)	(0.076)	

	Heats				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance
400 metres	3.53	3.32		400 metres	2.73	2.00	***
	(0.299)	(0.297)			(0.219)	(0.106)	
800 metres	3.22	3.00		800 metres	2.63	2.00	***
	(0.390)	(0.349)			(0.260)	(0.152)	
1,500 metres	4.19	3.22	**	1,500 metres	2.33	2.00	***
	(0.478)	(0.375)			(0.227)	(0.160)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: 121 (50 m.), 114 (100 m.), 119 (200 m.), 60 (400 m.), 30 (800 m.) and 30 (1,500 m.).The ranks are in absolute numbers. Long-race competitions (i.e. 400 metres and longer) only have heats and finals. The average position of the best four finalists in finals is 2.50 by construction.

Table VI. Average differences between the ranks of the four best swimmers and the "underdogs" at the end of each pair of stages of each competition

	Semi-finals - Heats		Significance		Finals - Semi-finals		Significance
	Best four	Underdogs			Best four	Underdogs	
50 metres	-0.752	-1.692	***	50 metres	-0.758	0.805	***
	(0.224)	(0.299)			(0.165)	(0.143)	
100 metres	-1.253	-1.320		100 metres	-0.481	0.520	***
	(0.235)	(0.308)			(0.136)	(0.133)	
200 metres	-1.263	-1.250		200 metres	-0.526	0.506	***
	(0.246)	(0.330)			(0.128)	(0.156)	

	Finals - Heats		Significance
	Best four	Underdogs	
400 metres	-1.062	1.087	***
	(0.243)	(0.221)	
800 metres	-0.675	0.683	***
	(0.325)	(0.326)	
1,500 metres	-0.675	1.575	***
	(0.361)	(0.432)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: best four swimmers: 121 (50 m.), 114 (100 m.), 119 (200 m.), 60 (400 m.), 30 (800 m.) and 30 (1,500 m.). Underdogs: 158 (50 m.), 150 (100 m.), 156 (200 m.), 80 (400 m.), 40 (800 m.) and 36 (1,500 m.). The differences displayed in the table are computed as the difference between the average rank (of the respective group, either winners or “underdogs”) in a stage and the average rank in the previous stage of each competition. Figures are in absolute numbers.

Table VII. Average differences between the ranks of the medalled swimmers and the other five finalists at the end of each pair of stages of each competition

	Semi-finals - Heats medalled	Semi-finals - Heats Other five	Significance		Finals - Semi-finals medalled	Finals - Semi-finals Other five	Significance
50 metres	-0.760	-1.497	**	50 metres	-1.116	0.709	***
	(0.265)	(0.254)			(0.184)	(0.130)	
100 metres	-1.053	-1.426		100 metres	-0.675	0.426	***
	(0.241)	(0.272)			(0.152)	(0.121)	
200 metres	-1.429	-1.150		200 metres	-0.756	0.451	***
	(0.286)	(0.282)			(0.145)	(0.134)	

	Finals - Heats medalled	Finals - Heats Other five	Significance
400 metres	-1.317	0.810	***
	(0.276)	(0.208)	
800 metres	-1.000	0.608	***
	(0.362)	(0.296)	
1,500 metres	-0.900	1.260	***
	(0.411)	(0.384)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Observations: medaled: 121 (50 m.), 114 (100 m.), 119 (200 m.), 60 (400 m.), 30 (800 m.) and 30 (1,500 m.). Other five finalists: 198 (50 m.), 180 (100 m.), 193 (200 m.), 100 (400 m.), 50 (800 m.) and 46 (1,500 m.). The differences displayed in the table are computed as the difference between the average ranks (either of the respective group, medaled or non-medaled) in a stage and the average rank in the previous stage of each competition. Figures are in absolute numbers.

Table VIII. Average times of the best four finalists at the end of each stage of each competition

	Heats	Semi-finals	Significance		Semi-finals	Finals	Significance
50 metres	26.20	26.00	***	50 metres	26.00	25.86	***
	(0.498)	(0.505)			(0.505)	(0.512)	
100 metres	57.02	56.21	***	100 metres	56.21	56.26	
	(1.040)	(0.929)			(0.929)	(1.026)	
200 metres	125.01	123.75	***	200 metres	123.75	122.97	***
	(2.333)	(2.274)			(2.274)	(2.308)	

	Heats	Finals	Significance
400 metres	252.03	249.05	***
	(5.087)	(4.936)	
800 metres	489.43	483.87	***
	(2.129)	(1.864)	
1,500 metres	943.06	924.26	**
	(7.760)	(2.774)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The displayed figures are times are in seconds.

Table IX. Average times of the medalled swimmers at the end of each stage of each competition

	Heats	Semi-finals	Significance
50 metres	26.17	25.98	***
	(0.489)	(0.502)	
100 metres	56.93	56.15	***
	(1.028)	(0.927)	
200 metres	124.96	123.59	***
	(2.309)	(2.244)	

	Semi-finals	Finals	Significance
50 metres	25.98	25.80	***
	(0.502)	(0.507)	
100 metres	56.15	56.13	
	(0.927)	(1.023)	
200 metres	123.59	122.64	***
	(2.244)	(2.275)	

	Heats	Finals	Significance
400 metres	251.89	248.48	***
	(5.064)	(4.884)	
800 metres	489.17	482.79	***
	(2.044)	(1.867)	
1,500 metres	942.79	922.25	**
	(7.868)	(2.730)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The displayed figures are times are in seconds.

Table X. Average times of "underdogs" at the end of each stage of each competition

	Heats	Semi-finals	Significance		Semi-finals	Finals	Significance
50 metres	26.53	26.47	***	50 metres	26.47	26.29	***
	(0.519)	(0.530)			(0.530)	(0.539)	
100 metres	57.70	57.15	***	100 metres	57.15	57.14	
	(1.070)	(0.969)			(0.969)	(1.085)	
200 metres	126.23	125.94	***	200 metres	125.94	125.11	***
	(2.400)	(2.374)			(2.374)	(2.361)	

	Heats	Finals	Significance
400 metres	252.58	253.32	
	(5.043)	(5.259)	
800 metres	492.19	493.58	**
	(2.044)	(1.763)	
1,500 metres	945.74	941.49	
	(6.794)	(1.933)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The displayed figures are times are in seconds.

Table XI. Average times of the best four swimmers at the halfway point and at the end of each stage of each competition

	Heats		Significance		Semi-finals		Significance		Finals		Significance
	Halfway point	Final			Halfway point	Final			Halfway point	Final	
100 metres	27.22	29.80	***	100 metres	26.78	29.43	***	100 metres	26.75	29.52	***
	(0.465)	(0.591)			(0.422)	(0.528)			(0.471)	(0.534)	
200 metres	60.60	64.41	***	200 metres	60.06	63.69	***	200 metres	59.65	63.32	***
	(1.075)	(1.272)			(1.050)	(1.239)			(1.069)	(1.251)	

	Heats		Significance		Finals		Significance
	Halfway point	Final			Halfway point	Final	
400 metres	122.86	129.17	***	400 metres	122.10	126.95	***
	(1.873)	(3.243)			(1.794)	(3.157)	
800 metres	243.14	246.29		800 metres	241.93	241.94	
	(0.843)	(2.066)			(0.919)	(0.972)	
1,500 metres	476.88	466.18		1,500 metres	467.84	456.42	
	(5.422)	(8.946)			(5.752)	(6.727)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.).The displayed figures are times are in seconds. Long-race competitions (i.e. 400 metres and longer) only have heats and finals.

Table XII. Average times of the medalled swimmers at the halfway point and at the end of each stage of each competition

	Heats				Semi-finals				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance		Halfway point	Final	Significance
100 metres	27.19	29.54	***	100 metres	26.75	29.39	***	100 metres	26.69	29.44	***
	(0.461)	(0.583)			(0.421)	(0.527)			(0.470)	(0.571)	
200 metres	60.55	64.41	***	200 metres	59.98	63.61	***	200 metres	59.49	63.16	***
	(1.057)	(1.268)			(1.034)	(1.225)			(1.053)	(1.235)	

	Heats				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance
400 metres	122.62	129.27	***	400 metres	121.69	126.79	***
	(1.828)	(3.271)			(1.721)	(3.177)	
800 metres	242.72	246.45		800 metres	241.54	241.25	
	(0.811)	(2.202)			(0.930)	(0.988)	
1,500 metres	476.98	465.81		1,500 metres	466.88	455.36	
	(5.416)	(8.988)			(5.825)	(6.829)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The displayed figures are times are in seconds. Long-race competitions (i.e. 400 metres and longer) only have heats and finals.

Table XIII. Average times of the "underdogs" at the halfway point and at the end of each stage of each competition

	Heats				Semi-finals				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance		Halfway point	Final	Significance
100 metres	27.48	30.23	***	100 metres	27.12	30.02	***	100 metres	27.08	30.07	***
	(0.484)	(0.604)			(0.443)	(0.548)			(0.492)	(0.617)	
200 metres	61.10	65.13	***	200 metres	60.95	64.99	***	200 metres	60.39	64.72	***
	(1.101)	(1.310)			(1.093)	(1.292)			(1.103)	(1.271)	

	Heats				Finals		
	Halfway point	Final	Significance		Halfway point	Final	Significance
400 metres	123.67	128.91	***	400 metres	123.80	129.51	***
	(2.009)	(3.052)			(2.066)	(3.200)	
800 metres	245.70	246.49	*	800 metres	245.99	247.59	
	(0.914)	(0.904)			(1.393)	(1.305)	
1,500 metres	479.78	470.82		1,500 metres	474.03	467.46	
	(5.223)	(9.340)			(6.038)	(6.864)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The displayed figures are times are in seconds. Long-race competitions (i.e. 400 metres and longer) only have heats and finals.

Table XIV. Average differences between the times of the four best swimmers and the "underdogs" at the end of each pair of stages of each competition

	Semi-finals - Heats		Significance		Finals - Semi-finals		Significance
	Best four	Underdogs			Best four	Underdogs	
50 metres	-0.194	-0.067	***	50 metres	-0.142	0.076	***
	(0.013)	(0.016)			(0.018)	(0.022)	
100 metres	-0.809	-0.743		100 metres	0.051	0.438	*
	(0.244)	(0.259)			(0.241)	(0.253)	
200 metres	-1.263	-0.906	***	200 metres	-0.779	0.264	***
	(0.084)	(0.066)			(0.083)	(0.066)	

	Finals - Heats		Significance
	Best four	Underdogs	
400 metres	-2.984	0.741	***
	(0.200)	(0.487)	
800 metres	-5.558	1.387	***
	(0.698)	(0.407)	
1,500 metres	-11.918	4.190	***
	(1.025)	(2.921)	

Significance: *** = 99% level; ** = 95% level; * = 90% level. Standard errors in parentheses. Independent observations (swimmers are clustered): 20 (50 m.), 20 (100 m.), 20 (200 m.), 10 (400 m.), 5 (800 m.) and 5 (1,500 m.). The differences displayed in the table are computed as the difference between the average times in seconds (either of the respective group, winners or "underdogs") in a stage and the average rank in the previous stage of each competition.