Splash with A Teammate:
Peer Effects in High-Stakes Tournaments

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Abstract

This paper studies peer effects on individual performance among elite athletes in high-stakes tournaments. I ask whether the presence of a teammate affects athletes' performance using data from the latest seven World Swimming Championships. To identify causal effects I apply a regression discontinuity design by comparing athletes' performance in the finals when their teammate barely qualified and barely not qualified for the same final. Female athletes accompanied by a teammate swam 0.41%-0.56% of the average time faster, or ranked by 0.75 -1.16 higher in the final. Male athletes' performance is unaffected. Potential channels and gender differences are discussed.

Keywords: Peer Effects, Tournaments, Regression Discontinuity, Gender Difference

JEL Classification: C26, D03, J24, J44

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1 Introduction

Human beings are among the most socially dependent creatures. The existing literature has well documented how individual behavior reacts to the social environment and peer effects. Peer effects are central in various individual decisions such as school choice (Angrist and Lang 2004; Lavy and Schlosser 2011), retirement planning (Duflo and Saez 2002; Beshears et al. 2015), and social preferences (Bruhin et al. 2015; Bond et al. 2012). Most studies on peer effects focus on how one's behavior is affect by the average behavior and/or characteristics of one's peer group. Studies in the lab utilise randomly assigned peer groups to identify causal effects but lack social relationship among the subjects outside the lab. Studies in the field, on the other hand, grounded on existing real social relationship but typically suffer from the reflection problem among other identification problems (Manski 1993), and the identification strategies mostly rely on natural instruments or natural experiments.

This paper takes a different route and look at a particular form of peer effects, i.e., the presence of a peer. I compare the outcome of individuals when they act with a peer with the outcome when they act without a peer. This form of peer effects has been observed in several contexts in the workplaces. Falk and Ichino (2006) found that individuals are more productive in stuffing letters when randomly assigned with another individual in the lab. Mas and Moretti (2009) shown that staffs are more productive in scanning barcode when faced by a high productive co-worker in the grocery store. Bandiera, Barankay and Rasul (2010) reported that workers are more productive in picking soft fruits when working with a friend who is more able than themselves in the same field.

While the above studies are all conducted among low skilled subjects under fixed payment scheme, little is known about this type of peer effects among highly skilled individuals in competitive environment involving high stakes. It is important to understand the impact of peer effects in this environment as the society is on the one hand shifting labor force to more high-skilled sector which is highly rewarding and competitive, and on the other hand connected through denser networks where individuals can hardly isolate themselves from their peers. An obvious candidate for this environment is elite sports. In particular, I look at swimming tournaments. Swimming, as an individual sport, does not require team cooperation, nor does it involve physical interaction with the opponents. This allows isolating peer effects per se, unconfounded by aspects of complementarities in the production.

I use the data from the latest seven FINA (Fédération Internationale de Natation) World Swimming Championships which took place bi-annually between 2003 and 2015.[1] During the sample period, there are 182 same-sex individual tournaments in 26 short-distance disciplines.[2] Athletes can participate in multiple tournaments within the same championship and the championships repeatedly, which results in 727 observations in each of the female and male sample. Each individual tournament consists of three stages: multiple preliminary heats, two semifinal heats and a final heat. FINA regulates that every national federation can qualify two athletes for the preliminary stage of each individual tournaments.[3] This rule defines the peer group, here the dyads of athletes from the same national team in the preliminary stage of each tournament. During the course of the tournament, sixteen athletes can qualify for the semifinal and eight athletes can qualify for the final. The outcome of interest is athletes' performance in the final of the tournament, which means only the finalists are the focal athletes.

I test whether focal athletes' performance in the final is affected by quasi-random variation in the presence of their teammate in the same final of the tournament. Although athletes from the same national team may train separately, they see each other frequently in the national tournaments which provides good base for building strong social ties. The fact that they represent the same national federation in the international tournaments bounds them even tighter. If athletes are solely motivated by intrinsic passion, prize money and fame, their performance is independent of the presence of their teammate. However, if athletes are subject to peer effects, the presence of their teammate may influence their performance, and the sign of which is not straightforward.

This setting has several desirable features. First of all, the nationality decidedly identifies the peer group within which the athletes are connected through real social ties. Second, the tournament scheme involves high-stakes which includes prize money, potential commercial contracts, fame and etc. Third, female and male tournaments

[1] These are the long-course championships in the 50-meter pool.

[2] These are the disciplines in the distance of 50-meter, 100-meter and 200-meter.

[3] There are two qualifying entries, i.e., the B entry for qualifying one athlete and the A entry for qualifying *both* of two athletes from the same national federation. In order to analyse peer effects I only focus on national federations qualifying two athletes at the A entry.

take place in the same championship under the same conditions, which allows clean comparison across gender. Last but not least, the performance is standardised and precisely recorded by the official timekeeper.

However, unlike in controlled experiments, the presence of a teammate in the same final is endogenous in this setting. The endogeneity comes from non-randomised peer group, i.e., the dyads of the athletes are, by construction, not randomly formed. Non-randomised peer group is one of the major identification problems that many observational studies face (Manski 1993, Moffit 2001). Athletes from the same national team share much in common, and most importantly in this context, similar access to the facilities, coaching, supply of nutrition etc. As a result, there is substantial correlation between the performance of athletes from the same national team, especially from some traditional supremacies. In other words, athletes from strong teams are not only more likely to qualify themselves but also more likely to have a teammate qualified for the same final of the tournament.

In order to identify causal effects, I compare the focal athletes' performance in the final under two scenarios, i.e., when their teammate (i) barely qualified, and (ii) barely not qualified for the same final.[4] Conceptually, this is a regression discontinuity design (RDD) which has become one of the most widely used quasi-experimental identification strategies (Hahn, Todd and Van der Klaauw 2001). While the performance of the athletes in the semifinal are continuously distributed, the variation in their presence in the final comes from the discontinuous jumps in the qualification status at the cutoff, which is predetermined as being ranked top eight among the sixteen athletes in the semifinal. There appears to be no reason, other than the teammate qualifying for the final, for focal athletes' performance in the final to be a discontinuous function of the teammate's performance in the semifinal. Therefore, one can attribute the discontinuous jump in focal athletes' performance in the final at the qualification cutoff to the causal effect of teammate's presence in the final. Despite the fact that the cutoff is common knowledge, the qualification status of the teammate can be regarded as being quasi-randomized within a narrow window around the cutoff, given the unpredictableness in

[4] Alternatively, this effect can be interpreted as the difference between athletes' performance in the finals when their teammate did well and when their teammate did not so well in the semifinal. However, the distinction between the two interpretations lies in "barely". Since the teammate barely qualified for the final, it is rather the presence than the performance of the teammate that matters. Anyhow, either interpretation is a manifestation of peer effects.

the short-distance swimming races. Two windows are constructed based on the time and the rank, respectively. The time window takes a quarter of a standard deviation of the average time used in the semifinal above and below the cutoff as the boundaries. The rank window takes two ranks in the semifinal above and below the cutoff as the boundaries.

The baseline results show that female athletes accompanied by a teammate swam 0.41%-0.56% of the average time faster, or ranked by 0.75-1.16 (out of 8) higher in the final than those competing without a teammate.[5] The performance of male athletes does not seem to be affected by the presence of their teammate.

As a first placebo check, I look at the reduced forms with the real cutoff at the 8th rank and two placebo cutoffs at the 6th rank and the 10th rank, with the window size fixed. The reduced form coefficient of teammate is only significant at the real cutoff at which the variation in the qualification status actually occurs. As a second placebo check, I regress focal athletes' semifinal performance on the presence of a teammate in the final. The presence of a teammate in the final should not have an impact on focal athletes' performance in the semifinal as it could not be predicted beforehand. The results show that it is indeed the case.

Several potential channels can lead to this peer effect. Some studies have concluded that observability is the key for this type of peer effects to operate (Mas and Moretti 2009; Yamane and Hayashi 2015). In sports, the chance to observe the performance of a teammate may help an athlete to position himself in the competition more accurately. To test the importance of observability, I exploit variation in the possibility of observing teammate's performance by taking the advantage of quasi-random seeding of the two heats in the semifinal. I compare focal athletes' performance in the semifinal when they and their teammate are in the same heat (weakly better observability) with the performance when they are in different heats (no observability). The results show that the performance in the semifinal does not depend on the possibly of observing the teammate.[6]

[5]This means, for example, in a race of which the average time is 50 seconds, the effect is 0.56% $\times$ 50 = 0.28 seconds.

[6]A better measure of observability would be whether the teammate is in an adjacent lane as one has the best vision over the movement in the adjacent lanes. However, since the assignment of the lane in the current stage is directly linked to the ranking in the previous stage, one cannot use the adjacent lane as an an exogenous treatment.

Another two potential channels are motivational support and in-group competition. Athletes in the elite level tournaments are under enormous stress which can lead to suboptimal performance. Motivational support, as a key element in the social support theory (Lakey 2000), can help them to cope better with this stress (Wills 1985; Cohen and Wills 1985). In sports, seeking social support is one of the most reported forms to cope with stress (Gould, Finch and Jackson 1993). In-group competition, on the other hand, can operate through the fact that the teammate is the only nationwide competitor and athletes might explicitly set a "beat-the-teammate" goal which pushes them to a better performance. In this particular context, one could disentangle these two channels by looking at to what extent are the two teammates competitors. Motivational support takes place presumably less dependent of the degree of being competitors while in-group competition might be highly dependent of the it. According to Locke and Latham (2002), the highest level of effort occurred when the goal is moderate and the lowest level of effort occurred when the goal is too easy or too difficult. Therefore, one can expect if the peer effect is driven by the goal of beating the teammate, it should be maximised when the two teammates are close competitors, i.e., when the goal is moderate. To test this hypothesis, I explore how does the degree of "close competitor", constructed by the rank difference in the preliminary stage of the tournament, interact with the effect of teammate's presence. The coefficients of the interaction term are insignificant in both female and male sample. On the other hand, research has shown that competition increases men's performance more than women's (Gneezy and Rustichini 2004). If the peer effect is drive by in-group competition and given that it is observed in the female sample, one should observe this effect in the male sample too, which is not the case.

Another interesting question is whether the peer effects differ across cultures, and in particular, the cultural dimension of individualism. Hofstede, Hofstede and Minkov (1991) introduced individualism as an index that explores the degree to which people in a society are integrated into groups. Individualists emphasise the "I" versus the "we", whereas the collectivists do the opposite. One would expect that having a teammate in the same competition might mean more to the collectivists than to the individualists. Since swimming competition has a broad international participation, the finalists in my sample are from 52 countries. I map their nationality to the individualism index (IDV).

For example, USA as a typical individualistic country scores 91 and China as a typical collective country scores 20 on a scale of 100. I interact this index with the presence of the teammate in the final. The results provide only marginal evidence for cultural difference in both female and male samples.

While the peer effects might be specific to this setting, the essence of the results is of general interest. This study directly contributes to the literature in peer effects in the workplaces. As mentioned before, Falk and Ichino (2006), Mas and Moretti (2009) and Bandiera, Barankay and Rasul (2010) all found that individuals' productivity is affected by the presence of peers in both lab and field working conditions, whereas Guryan, Kroft and Notowidigdo (2009) and Carroll (2012) did not find peer effects on the performance of professional golf players. Guryan, Kroft and Notowidigdo (2009) speculates that the professional experience and competitive environments can mitigate peer effects. My study adds evidence for peer effects even among the highly skilled subjects under tournament payment scheme.

To my knowledge, this is also one of the first study that found social incentive that motivates women in the same-sex competition at the elite level. Given that the female and male tournaments take place in the same championship and under the same conditions, the gender difference found here is unlikely to be driven by external factors. A first simple explanation could be, since male athletes use less time in the same disciplines than female athletes, there is not much room left for the mental effect to be translated into actual and detectable physical outcomes for male athletes. Another explanation could be that, since female athletes exhibit a higher level of stress than male athletes (Raglin, Morgan and O'Connor 1991) and their performance is more affected under stress in the competition (De Paola and Gioia 2015; Cahlikova, Cingl and Levely 2016), but at the meanwhile, women are more likely to lend and seek out social support (Thoits 1995; Tamres, Janicki and Helgeson 2002) which mitigates the negative influence from stress. Alternatively, as found in previous studies, women experience emotions more strongly (Harshman and Paivio 1987) and are more sensitive to social cues than men (Croson and Gneezy 2009).

The results of this study suggest important implications. In a narrow sense, if competing in the presence of a teammate is an advantage for female athletes, then those who competing "alone" should cope with this fact and train not to be affected by it. After all, racing at the elite level is more about mental than physical strength. In a broader context, organisations should take into account the gender difference when designing social incentives to motivate employees in competitive workplaces.

The remainder of the paper is organized as follows, section 2 describes the data, section 3 illustrates the identification problems and identification strategy, section 4 presents the empirical analysis, section 5 reports the main results and two placebo checks, section 6 discusses potential channels, and section 7 concludes.

2 Data

The data comes from the latest seven FINA World Swimming Championships (long-course) which took place bi-annually between 2003 and 2015. Each championship contains thirteen disciplines in Backstroke, Breaststroke, Butterfly, Freestyle, and Individual Medley combined with the distance of 50-meter, 100-meter and 200-meter for both genders.[7][8] Over the seven championships, these results in 182 same-sex individual tournaments. Each tournament consists of three stages: multiple preliminary heats, two semifinal heats and a final heat. During the course of the tournament, sixteen athletes can qualify for the semifinal and eight athletes can qualify for the final. Individual performances in each stage of the tournaments and the personal characteristics including age, gender and nationality are collected from the FINA homepage.[9] The outcome of interest is athletes' performance in the final stage of the tournaments, which means only the finalists are the focal subjects. As listed in Table 1, there are 112 finalists in each discipline during the sample period.[10]

The key feature of the FINA World Swimming Championship is that every national federation can qualify a maximum of two athletes for the preliminary heats of each

[7] Individual Medley does not have 50-meter or 100-meter discipline.

[8] For the analysis I focus only on short-distance disciplines. Disciplines in above 200 meter are not considered for three reasons: i) Only Freestyle and Individual Medley have disciplines in longer distances, and they do not have semifinals. ii) Long-distance disciplines involve more complex strategies, and conserving energy in the preliminary heats and semifinals are more likely to occur in long-distance than in short-distance disciplines. In that sense, 200-meter discipline is at the boarder line between short- and long-distance. iii) The identification strategy *Regression Discontinuity Design* is most valid in highly competitive disciplines in short distances as it requires imperfect control over the qualification status, which will be more clear in Section 3.3.

[9] http://www.fina.org

[10] The number 110 in the 50m Breaststroke comes from the fact that two athletes who were disqualified (DQ) in the final.

Table 1: Number of entries in each discipline (Final)

Stroke	50m	Distance 100m	200m
Backstroke	112	112	112
Breaststroke	110	112	112
Butterfly	112	112	112
Freestyle	112	112	112
Individual Medley	-	-	112
Total	446	448	560

individual tournament. The qualifying standard depends on the number of athletes a national federation wants to qualify. To qualify one athlete, one only needs to meet the B entry. To qualify two athletes, both of the athletes need to meet the A entry which is slightly higher than the B entry. In order to study peer effects, I focus only on athletes that qualify in pairs. The two athletes from the same national team in a particular tournament construct a dyad observation, which naturally and clearly determine the peer group. The fact that the dyads are endogenously formed based on nationality will be addressed later when the identification strategy is discussed in Section 3.

Table 2: Descriptive statistics (finalists)

Variable	Mean	Std. Dev.	Min	Max
Female				
Age	22.25	3.56	12	42
% of being in a dyad in the semifinal	57.08%			
% of being in a dyad in the final	36.86%			
# of individual observations in the final	727			
Male				
Age	24.13	3.46	18	41
% of being in a dyad in the semifinal	52.27%			
% of being in a dyad in the final	30.54%			
# of individual observations	727			

Table 2 provides the descriptive statistics of the focal athletes, i.e., the finalists of all the tournaments. Female finalists are on average 22.25 (std=3.56) years old and male finalists are on average 24.13 (std=3.46) years old. Among the 727 female observations, 57.08% of them were in a dyad in the semifinals and 36.86% of them were in a dyad in the finals. Among the 727 male observations, 52.27% of them were in a dyad in the semifinals and 30.54% of them were in a dyad in the finals.

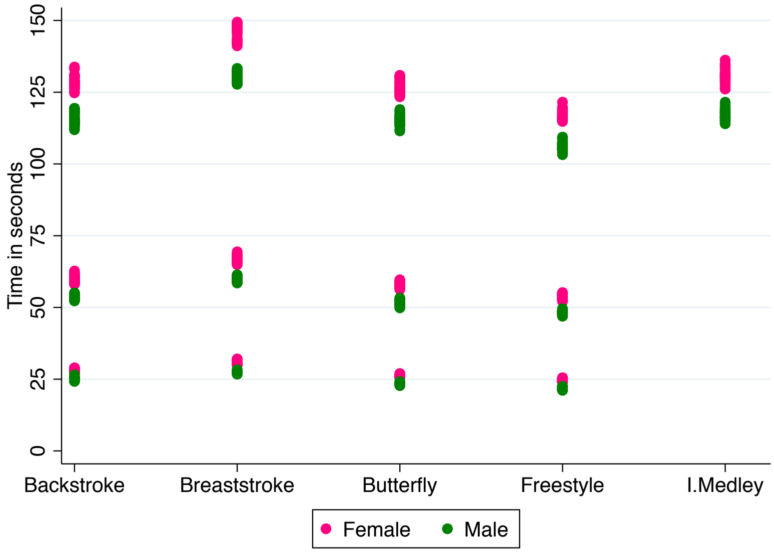
Table 3 reveals several characteristics worthy noting of this sample. First, the composition of the dyad is not necessarily fixed. This comes from two dimensions. The first is the tournament dimension, e.g., Phelps and Lochte in the Men's 200m Freestyle (2011) was one dyad, and Phelps and McGill in the Men's 100m Butterfly (2011) was another dyad. The second is the time dimension. Athletes reach their performance peak at different points in time and have their career of different length, thus, athletes may have different teammates through their career. Second, it is a hybrid of between- and within-subject design. The answer to the research question comes from the comparison of athletes' performances when their teammate is present and when their teammate is absent in the finals. On the one hand, it is a between-subject comparison when I compare the performance of Phelps in the Men's 200m Freestyle (2011) and Men's 100m Butterfly (2011) with the performance of Fujii, being the only athlete from Japan, in the Men's 100m Butterfly (2011). On the other hand, it is a within-subject comparison when I compare Phelps' performance in the Men's 200m Freestyle (2009) where he had no teammate in the final with his performance in the Men's 200m Freestyle (2011) and the Men's 100m Butterfly (2011).[11]

Table 3: A hybrid of between- and within-subject design (example)

Finalist	Country	Race
PHELPS	USA	Men's 200m Freestyle (2009)
$\emptyset$	USA	
PHELPS	USA	Men's 200m Freestyle (2011)
LOCHTE	USA	
PHELPS	USA	Men's 100m Butterfly (2011)
MCGILL	USA	
FUJII	JPN	Men's 100m Butterfly (2011)
$\emptyset$	JPN	

The performance is standardised and precisely recorded by the official timekeeper. Figure 1 gives an overview of the average performance in the finals of each discipline. The upper scatters are the 200-meter, the middle scatters are the 100-meter and the

[11] I assume that there are no spillover effects among the tournaments.



Note: The upper/ middle/ bottom scatters are the 200-meter/ 100-meter/ 50-meter disciplines.

Figure 1: Average time used in the final, by discipline

bottom scatters are the 50-meter disciplines. The performances vary across different strokes and gender, increasingly in the distance. Very roughly speaking, it takes about 25 seconds to finish in a 50-meter final, one minute to finish a 100-meter final and two minutes to finish a 200-meter final.

Finally, the elite level tournaments are featured with high stakes. Besides the uniform prize money, there are potential commercial contracts with hefty sums for outstanding athletes, and of course the worldwide prestige.

3 Identification of the Peer Effect

This section describes the identification problem, illustrates the identification strategy and determines the key parameter in the identification strategy.

3.1 Identification Problem

Unlike in a controlled experiment, the presence of a teammate in the final is endogenous in this setup. The endogeneity comes from the non-randomised peer group, i.e., the dyads are, by construction, not randomly formed. Non-randomised peer group is one of the major identification problems that many observational studies have (Manski 1993, Moffit 2001).[12] Athletes from the same national team share much in common. Most importantly in this context, they have similar access to facilities, coaching, supply of nutritions and even doping technology. As a result, there is substantial correlation between the performance of athletes from the same national team, especially from those traditional supremacies. When an athlete from a strong nation team qualifies for a final, the chance that his teammate qualifies for the same final is also high. Therefore, if one compares the performance of the two athletes from a national team with the performance of one athlete from another national team, it will reflect the gap in the overall strengthen between the strong nations and less strong nations.

3.2 Identification Strategy

In order to identify causal effects, one needs to make the non-random presence of a teammate "quasi-random". Figure 2 illustrates the identification strategy. I separate the dyads into two groups: a "control" group where focal athletes' teammate *barely* not qualified for the final and a "treated" group where focal athletes' teammate *barely* qualified for the final.

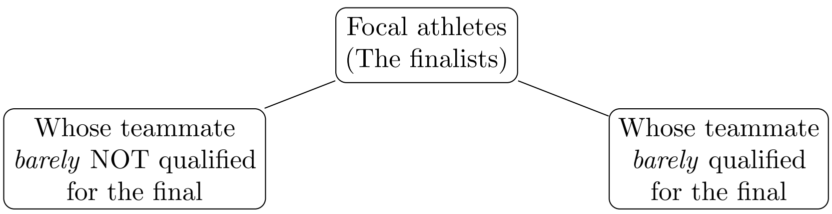


Figure 2: Identification strategy

Conceptually, I am applying a Regression Discontinuity Design (RDD). The RDD has become one of the most widely used quasi-experimental identification strategies (Hahn, Todd and Van der Klaauw 2001). While the performance of the athletes in the semifinal are continuously distributed, the variation in their presence in the final comes from the discontinuous jumps in the qualification status at the cutoff, which is predetermined as

[12]The others major problems are the simultaneity problem, or, the reflection problem, and the correlated unobservables problem. Notice that the reflection problem is not an issue here, because the presence of the teammate was determined before the action of the focal athlete in the final.

being ranked top eight among the sixteen athletes in the semifinal. Although the cutoff is a public knowledge to all, athletes ranked barely above or below the cutoff in the semifinal have imperfect control over their qualification status for the reasons that will be discussed in detail in Section 3.3. Thus, their presence in the final can be regarded as quasi-random. In the terminology of RDD, the running variable is the time, or the corresponding rank, of the teammate in the semifinal, and the treatment variable is the presence of the teammate in the final. It is important to notice that being ranked above or at the cutoff does not necessarily mean being present in the final due to the following reasons. First, if there are ties between or among the athletes ranked at the cutoff, i.e., two or more athletes are ranked at eight in the semifinal, these athletes need to swim again, which is called the Swim-off. Second, even if qualifying for the final, one can still drop out (DNS) due to injury, for example. In such cases, the athletes on the reservation list, typically ranked at nine or ten, will fill the blank. Therefore, this is a *fuzzy* RDD, in which the probability of the treatment jumps at the cutoff rather than being fully deterministic. The treatment variable is instrumented by an indicator of being ranked above or at the cutoff.

3.3 Determine the window size

The word "*barely*" is vague. The size of the window is a key parameter in the framework of RDD which visualises "*barely*". In this section I will determine the size of the window around the cutoff within which the qualification status of the athletes can be regarded as being quasi-randomized. Before I do so, let us first look at a Swim-off event. In the case where exactly two athletes ranked at eight in the semifinal, the Swim-off perfectly demonstrates how one barely qualifies and the other barely not. While being both ranked at eight, the two semifinalists had an equal probability of qualifying for the final before the Swim-off. However, after an additional race, one would qualify and the other would not.[13] If each of the two athletes involved in the Swim-off has a teammate who already qualified for the final, then the one who won the Swim-off could retain the dyad in the final whereas the one who lost had to break the dyad, leaving the focal athlete "alone" in the final.

[13] If necessary, multiple swim-offs can take place.

There are two questions the answers of which are crucial for determining the size of the window. The first question is: If there is a window around the cutoff within which the athletes have little control over the qualification status, what are the main sources of the imperfect control?

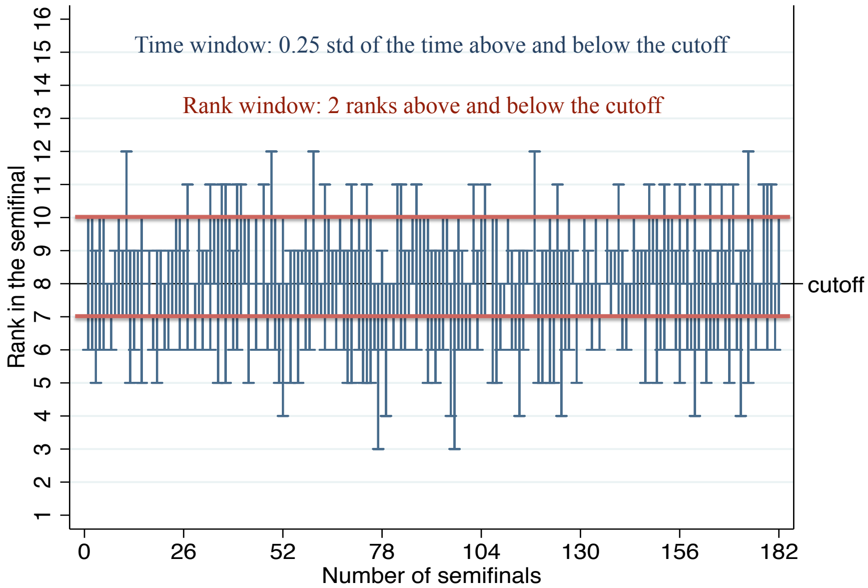
The first source is the reaction time. Besides the total time, the timekeeper also records the reaction time of each athlete, which is the time between the signal and the first movement of any kind after the signal. The reaction time depends on several aspects, e.g., how reactive the athlete is, how close the athlete is from the signal, the intensity of the signal, and etc.[14] In the semifinals of this sample, female athletes' average reaction time is 0.73 seconds (min=0.49; max=0.97) and male athletes' average reaction time is 0.71 seconds (min= 0.42; max=0.97). It is a nontrivial fraction of a race, especially in the short distances. Every fingernail counts in the tournaments, besides, a good start gives one a mental advantage that can not be discounted in an evenly matched race.

Another source of imperfect control may come from the "timed semifinal", under which two heats are swam in the semifinal, and the semifinal ranking is determined by times recorded in the heats. It is not the first four athletes in each heats qualify for the final, but the first eight athletes in the semifinal qualify. Without seeing half of the athletes in the other heat, it is hard to predict the qualification status of each athlete, especially for those who are around the cutoff. For example, being ranked at three or four in one of the semifinal heat does not guarantee the qualification for the final. These two sources of uncertainty are clearly out of perfect control from the athletes.

The second question is: within which time range around the cutoff can those sources of imperfect control operate? To answer this question, let us investigate the Swim-off again. The time difference between the athletes in the Swim-off tells us roughly to what extent can "equally" competent athletes differ if they race again. During the sample period, there were in total ten Swim-off events in the 50-meter disciplines, where the Swim-off took place most frequently. The average time difference is 0.17 seconds (min=0.01; max=0.52). As we noticed in Figure 1, the time varies a lot across disciplines, therefore, one needs a benchmark for the time difference.

I picked half of a standard deviation of the time used in the semifinal for each

[14] http://www.swimmingscience.net/2012/06/reaction-time.html



Note: The blue vertical lines indicate the time window which is specific for each tournament. The red horizontal lines indicate the rank window which is uniform for each tournament.

Figure 3: The window sizes

discipline. Using standard deviation to approximate the time is advantageous as it takes into account the dispersion of athletes' performances. Half of a standard deviation would corresponds to, for example, 0.1 seconds in the Men's 50m Freestyle. Within a 0.1-second difference, the rank can be easily reversed by a shorter or longer reaction time in the semifinals, and it is also approximately the same magnitude of the time difference in most Swim-off events. Hence, I construct the time window with a quarter of a standard deviation of the time above and below the cutoff time for all the 182 semifinals. Notice that the sizes of time window are thus specific for each tournament. Alternatively, I construct a rank window using a uniform range of ranks, i.e., two ranks above and below the cutoff. Figure 3 illustrates the range of ranks in the semifinal the two windows cover respectively. As we can see, the two windows contain different observations, however, they result in almost the same number of observations.

3.4 Caveats

After I constructed the windows, we need to be aware of two caveats that may affect the results. First, the relationship "teammate" is no longer symmetric under this construction. Taking a dyad with the focal athlete i and his teammate j as example: j is in the observation as a teammate of i only if j's rank is within the windows. Since there is no restriction on the focal athlete, i is not necessarily in the observation as a teammate of j when j is in the role of the focal athlete. Second, on average, the focal athletes are ranked higher than their teammate, because by the spirit of RDD, the teammate's rank has to be around the cutoff of the qualification, while the focal athletes can take any rank from one to eight.

4 Empirical Analysis

This section first performs a balance check of the covariates of the athletes whose teammate was around the cutoff of qualification, then compares their performances with and without a teammate in descriptive graphs, and finally presents the econometric model.

4.1 Balance Check of The Covariates

The purpose of a balance check is to verify whether the observed covariates are distributed similarly between the treated and the control group. If there exist sizable differences on observed covariates, the balance check should detect them and suggest misestimation of the treatment effects (Cochran and Chambers 1965). I check whether the characteristics of the focal subjects are comparable between the two sides of the cutoff using a two sample t-test. The results using the rank window are reported in Table 4 and the ones using the time window are in the Appendix. Conditional on having a teammate in the semifinal, the first column reports the characteristics of the finalists whose teammate's semifinal rank falls into 9 and 10 interval (barely unqualified), and the second column reports the characteristics of finalists whose teammates semifinal rank falls into 7 and 8 interval (barely qualified). The characteristics include age and the number of finals qualified in a single championship (Champ.) as well as during the whole sample period (Total). The number of finals qualified in a single championship approximates the ability from a different perspective than the performance in absolute time which are not directly comparable. The number of finals during the whole sample period additionally approximates the overall experience of participating in international championships. Table 4 shows that finalists whose teammate ranked at 9 or 10 in the semifinal are as old as finalists whose teammate ranked at 7 or 8 in the semifinal in both of the female and male sample. In the female sample, finalists in both columns are about 22 years old. Female finalists have qualified for 1.86 finals in column (1) and 1.75 finals in column (2). During the whole sample period, female finalists have qualified for 4.3 and 4 finals in the column (1) and (2), respectively. In the male sample, finalists in both columns are about 24.5 years old. Male finalists have qualified for 1.68 finals in column (1) and 1.54 finals in column (2). During the whole sample period, male finalists have qualified for 5.13 finals and 4.89 finals in the column (1) and (2), respectively. None of the conditional means is significantly different between the treated and the control group in both samples.

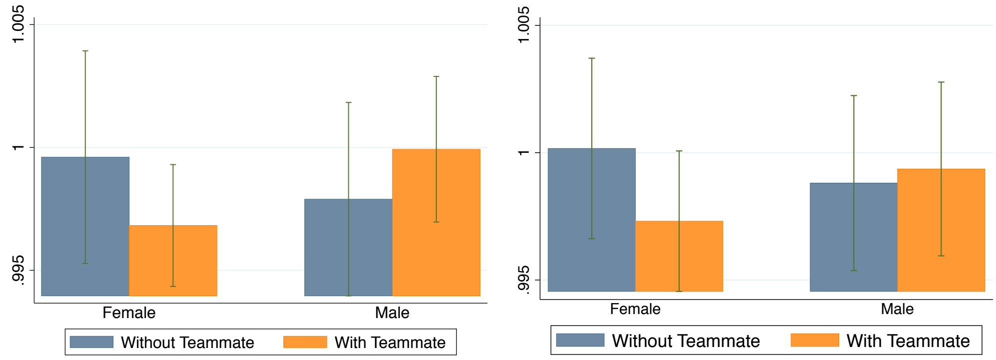
Table 4: Two sample t-test using the rank window

Mean of Covariates	(1) Teammate's SF rank $\in \{9, 10\}$	(2) Teammate's SF rank $\in \{7, 8\}$	p-value
Panel A: Female sample			
Age	22.07	21.67	0.56
	(0.61)	(0.35)	
No. Finals (Champ.)	1.86	1.75	0.56
	(0.14)	(0.13)	
No. Finals (Total)	4.30	4.00	0.60
	(0.43)	(0.39)	
Total	43	52	
Panel B: Male sample			
Age	24.55	24.45	0.91
	(0.59)	(0.59)	
No. Finals (Champ.)	1.68	1.54	0.42
	(0.13)	(0.11)	
No. Finals (Total)	5.13	4.89	0.82
	(0.67)	(0.76)	
Total	47	46	

Note: Standard errors in parentheses

4.2 Descriptive Graphs

As a descriptive illustration, I compare the performance of the focal athletes when their teammate barely not qualified (in blue) and when their teammate barely qualified (in orange) for the same final, respectively. Figure 4 presents the performance in time which

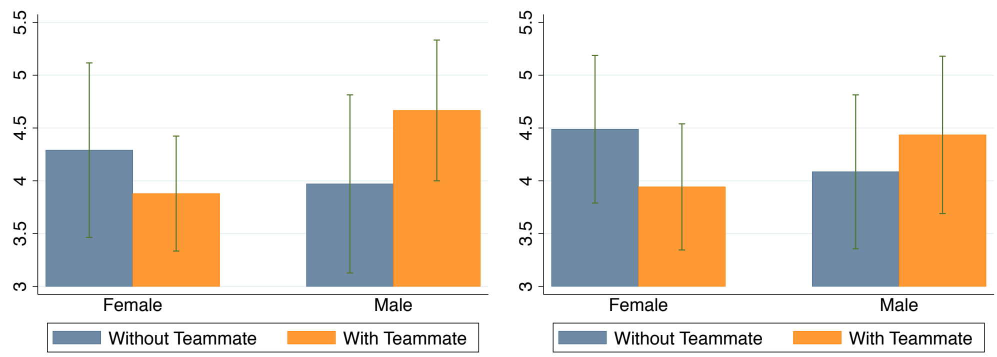


(a) Teammate within time window (b) Teammate within rank window

Note: Time is normalised by taking the ratio of own time over the average time in the final.

Figure 4: Normalised time as outcome (with 95% CI)

is normalised by taking the ratio of own time over the average time in the final. Notice that without peer effects and unconditional on teammate's semifinal performance, the normalised time of an average athlete is equal to 1. In Figure 4a, the finalists compete without a teammate if their teammate's time is a quarter of a standard deviation longer than the cutoff, and with a teammate if their teammate's time is a quarter of a standard deviation shorter than the cutoff in the semifinal. In Figure 4b, the finalists compete without a teammate if their teammate's rank is two below the cutoff, and with a teammate if their teammate's rank is two above the cutoff in the semifinal. Both figures deliver qualitatively similar messages. Female athletes use less time if accompanied with a teammate, and almost the opposite for male athletes.



(a) Teammate within time window (b) Teammate within rank window

Figure 5: Rank as outcome (with 95% CI)

Figure 5 presents the performance in rank. Notice that without peer effects and unconditional on teammate's semifinal performance, the rank of an average athlete is equal to 4.5. In Figure 5a, the finalists compete without a teammate if their teammate's time is a quarter of a standard deviation longer than the cutoff, and with a teammate if their teammate's time is a quarter of a standard deviation shorter than the cutoff in the semifinal. In Figure 5b, the finalists compete without a teammate if their teammate's rank is two below the cutoff, and with a teammate if their teammate's rank is two above the cutoff in the semifinal. Similarly, female athletes are ranked slightly higher if accompanied with a teammate, and the opposite for male athletes.

4.3 The Econometric Model

In the econometric model, I regress finalist i's performance on a dummy variable indicating whether his teammate j is present in the same final, controlling for i's and j's age, and i's ability, as shown in Equation 4.1. Three fixed effects are included. The discipline fixed effects take care of the differences across the strokes and distances. The championship fixed effects get rid of the differences across years and locations. Finally, the finalist's country fixed effects controls for the differences in the overall strength across countries.

$$\text{Performance}_i = \beta_1 \text{Age}_i + \beta_2 \text{Age}_j + \beta_3 \text{Ability}_i + \delta \text{Teammate}_i + \epsilon_i \tag{4.1}$$

The official performance is recorded in absolute time. In order to pool all the tournaments together, I use i) normalised time and ii) rank as the performance measure. The time is normalised by taking the ratio of own time in the final over the average time of the sixteen athletes in the semifinal, and multiplied by 100.[15] The ability is approximated by the own normalised time in the semifinal and multiplied by -100.[16]

The variable of interest is the teammate dummy. It is instrumented by the indicator of being ranked above or at the qualification cutoff in the first stage of the TSLS estimation. The coefficient of interest is δ, which captures the difference between i's per-

[15] Unlike in the descriptive graphs, here I use the average time in the semifinal as the denominator because it is not contaminated by the peer effects on the performance in the final.

[16] One could also use the qualifying time as an ability measure, however, the qualifying time is achieved during the qualifying period which is more than one year before the current championship, the same holds for the personal best time. The time in the semifinal of the current championship is much more up to date and predictive for the final performance.

formance in the finals when his teammate is present and in the finals when his teammate is absent.

5 Results

This section presents the baseline results of the peer effects and two placebo checks. The first check looks at the reduced forms with the real and two placebo cutoffs, and the second check tests whether the focal athletes' performance in the semifinal is affected by their teammate's presence in the final.

5.1 Baseline Results

Table 5 reports the TSLS estimates of the effect of having a teammate in the same final on the performance.[17] Panel A presents the results in the female sample and Panel B the male sample. Columns (1) and (2) use normalised time and columns (3) and (4) use rank as the outcome variable. Column (1) and (3) use the time window and column (2) and (4) use the rank window within which the teammate has little control over the qualification status. Notice that a negative coefficient means positive effect on the performance, as the shorter the time, or the higher the rank, the better the performance is. In Panel A column (1) and (2), the coefficient of teammate is 0.41 and 0.56. Since the normalised time is divided by the average time in the semifinal, this means that female athletes accompanied by a teammate swam 0.41%-0.56% of the average time faster. To see the magnitude of this effect, for example, if the average time in the semifinal is 50 seconds, the effect would be $0.56\% \times 50 = 0.28$ seconds. In column (3) and (4), the coefficient of teammate is 0.75 and 1.16. This means female athletes accompanied by a teammate are ranked by $0.75-1.16$ higher in the final where rank spans from one to eight. The effects are smaller using the rank window than using the time window for both of the outcomes in normalised time and rank, but they are not statistically different in the z-test. In Panel B, the coefficients of teammate are insignificant, much smaller in magnitude, and have the opposite sign as in the female sample in all the columns.

[17] I did not cluster the standard errors at the individual level, as the key regressor teammate dummy is as good as randomly assigned within individual cluster, there is no need to cluster standard errors (Cameron and Miller 2015). The results with standard errors clustered at individual level are not different and can be found in Table 12 in the Appendix.

The performance of male athletes does not seem to be affected by the presence of a teammate.[18]

Neither own age nor teammate's age has a significant effect on the performance in the final in both female and male samples. Semifinal performance is highly positively correlated with the final performance in both female and male samples.

5.2 Placebo Check 1

Can it be that the effects are still driven by the correlation between the performance of the two teammates even within the very narrow window? In order to answer this question, I fixed the window size and look at the reduced forms with the real cutoff at the 8th rank and two placebo cutoffs at the 6th rank and the 10th rank. Table 6 reports the reduced form coefficients. Panel A presents the results in the female sample and Panel B the male sample. Column (1)-(3) use normalised time and column (4)-(6) use rank as outcome variable. In column (1) and (4) I compare the performance of finalists whose teammate is ranked at 5 to 6 with whose teammate is ranked at 7 to 8. Both cases are above the real cutoff, i.e., there is not variation in the qualification status. In column (2) and (5) I compare the performance of of finalists whose teammate is ranked at 7 to 8 with whose teammate is ranked at 9 to 10. The former is above and the latter is below the real cutoff. In column (3) and (6) I compare the performance of finalists whose teammate is ranked at 9 to 10 with whose teammate is ranked at 11 to 12. Both cases are below the real cutoff, i.e., there is not variation in the qualification status either. In Panel A, the coefficient of teammate is only significant in column (2) and (5) at the real cutoff, where the variation in qualification status actually occurs. In Panel B, no significant effects of teammate occurs in any columns.

5.3 Placebo Check 2

In the second placebo check, I regress finalists' semifinal performance of the same tournament on the presence of a teammate in the final within the same windows. The presence of a teammate in the final should not have an impact on finalists' performance in the

[18]One possibility is, male athletes may take more risky strategy in the presence of a teammate, which could lead to worse performance than less risky ones, which is likely to happen in the 200-meter tournaments.

semifinal as it can not be predicted beforehand. Again, the performance is measured in normalised time and rank. The time is normalised by taking the ratio of own time in the semifinal over the average time in the preliminary heat and multiplied by 100. The ability is approximated by the normalised time in the preliminary heat by taking the ratio of own time in the preliminary heat over the average time in the preliminary heat and multiplied by -100. As shown in Table 7, none of the coefficients is significant in all specifications in both female and male sample, which confirms that the presence of a teammate in the final indeed has no impact on finalists' performance in the semifinal.

Table 5: TSLS estimates of the effect of having a teammate in the final on the performance

Panel A: Female

VARIABLES	(1) Time	(2) Time	(3) Rank	(4) Rank
Teammate	-0.563***	-0.412**	-1.159***	-0.746**
	(0.215)	(0.170)	(0.444)	(0.348)
Age	-0.00332	-0.0435	-0.0207	-0.0933
	(0.0398)	(0.0409)	(0.0636)	(0.0649)
Teammate's age	-0.00489	0.000420	0.00636	0.00252
	(0.0262)	(0.0244)	(0.0633)	(0.0460)
Ability	-0.957***	-1.132***	-1.733***	-2.122***
	(0.121)	(0.124)	(0.237)	(0.246)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	469.903	632.228	469.903	632.228
Observations	97	95	97	95
R-squared	0.448	0.466	0.382	0.448

Panel B: Male

VARIABLES	Time	Time	Rank	Rank
Teammate	0.0955	0.0494	0.322	0.405
	(0.163)	(0.151)	(0.373)	(0.343)
Age	0.0258	0.0137	0.0105	-0.0234
	(0.0169)	(0.0191)	(0.0358)	(0.0445)
Teammate's age	-0.00226	0.00568	-0.0125	0.0245
	(0.0219)	(0.0289)	(0.0504)	(0.0671)
Ability	-1.150***	-1.128***	-2.468***	-2.357***
	(0.123)	(0.125)	(0.268)	(0.276)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	653.775	797.344	653.775	797.344
Observations	88	93	88	93
R-squared	0.671	0.601	0.649	0.578

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Normalised time is the ratio of own time in the final over the average time of the sixteen athletes in the semifinal, and multiplied by 100.

Table 6: Reduced form with the real and two placebo cutoffs

Panel A: Female

VARIABLES	(1) Time	(2) Time	(3) Time	(4) Rank	(5) Rank	(6) Rank
Teammate (cut=6)	0.0608			0.103		
	(0.135)			(0.297)		
Teammate (cut=8)		-0.389**			-0.705**	
		(0.160)			(0.322)	
Teammate (cut=10)			-0.171			-0.333
			(0.256)			(0.432)
Controls	yes	yes	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes	yes	yes
Observations	127	95	83	127	95	83
R-squared	0.574	0.473	0.618	0.447	0.465	0.629

Panel B: Male

VARIABLES	Time	Time	Time	Rank	Rank	Rank
Teammate (cut=6)	0.0526			-0.0934		
	(0.149)			(0.313)		
Teammate (cut=8)		0.0495			0.405	
		(0.151)			(0.341)	
Teammate (cut=10)			-0.145			-0.607
			(0.149)			(0.370)
Controls	yes	yes	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes	yes	yes
Observations	93	93	80	93	93	80
R-squared	0.661	0.602	0.699	0.644	0.583	0.635

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Placebo check in the semifinal

Panel A: Female				
	(1)	(2)	(3)	(4)
VARIABLES	Time (SF)	Time (SF)	Rank (SF)	Rank (SF)
Teammate (F)	-0.116	0.117	-0.397	-0.227
	(0.188)	(0.0909)	(0.468)	(0.337)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Controls	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
Observations	97	95	97	95
R-squared	0.464	0.507	0.378	0.391

Panel B: Male				
VARIABLES	Time (SF)	Time (SF)	Rank (SF)	Rank (SF)
Teammate (F)	0.135	-0.0589	0.491	0.272
	(0.110)	(0.118)	(0.435)	(0.383)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Controls	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
Observations	88	93	88	93
R-squared	0.608	0.475	0.474	0.440

Note: Robust standard errors in parentheses.

6 Potential Channels

This section discusses the main potential channels through which the observed peer effects operate, including observability, motivational support, in-group competition and a cultural channel.

6.1 Observability

An often mentioned factor behind this form of peer effects in the previous literature is observability. Mas and Moretti (2009), for example, found that when more productive workers arrive into shifts, they induce a productivity increase only in workers that are in their line-of-vision. Besides, the effect appears to decline with distance between workers. In sports, the chance to observe the performance of a teammate may help an athlete to position himself in the competition more accurately (Guryan, Kroft and Notowidigdo 2009; Yamane and Hayashi 2015). This subsection exploits the variation in observability in the semifinal heats.[19]

There are two heats in the semifinal, each seeded with eight athletes. Being in the same heat means racing in the same pool. Conditional on having a teammate in the semifinal, one can either be seeded in the same heat as or a different heat from the teammate. Whether being seeded in the same heat in the semifinal can be considered as quasi-random given the following rule:

FINA SW 3.1.1.2: If two heats, the fastest swimmer shall be seeded in the second heat, next fastest in the first heat, next fastest in the second heat, next in the first heat, etc.

Given that there are only a few minutes between the heats and that athletes in the call room typically isolate themselves from outside before their own turn, athletes seeded in different heats do not observe each other. Therefore, athletes in the same heat have weakly better vision over each other than if they are not.

Conditional on having a teammate in the semifinal, 328 female athletes were seeded

[19] A better measure of observability would be whether the teammate is in an adjacent lane, as one has the best vision over the movement in the adjacent lanes. However, since the assignment of the lane in the current stage is directly linked to the ranking in the previous stage, one can not use it as an exogenous treatment. Besides, given this setup, conditional on having a teammate who barely qualified for the final at the 7th and 8th rank in the semifinal and assigned to the peripheral lanes 1 and 8 in the final, the "physically closer" to the teammate, the "lower ranked" the focal athlete has to be, by construction. So the higher ranked the focal subject is, the worse is her vision over her teammate.

in the same heat as their teammate while 366 were not, and 266 male athletes were seeded in the same heat as their teammate while 388 were not.[20] I regress the semifinal performance on a dummy indicating whether the teammate is in the same heat or not, together with the controls and three fixed effects. The performance is measured in normalised time and rank. The time is normalised by taking the ratio of own time over the average time in the preliminary heat and multiplied by 100.

Table 8 reports the results. Column (1) and (2) reports the results from the female sample and column (3) and (4) from the male sample. Having a teammate in the same heat in the semifinal is not statistically significantly different from having a teammate in a different heat for both female and male athletes.

Table 8: Having a teammate in the same heat (SF)

	(1)	(2)	(3)	(4)
	Female	Female	Male	Male
VARIABLES	Time (SF)	Rank (SF)	Time (SF)	Rank (SF)
Same Heat (SF)	0.0169	-0.207	-0.00946	-0.382
	(0.0631)	(0.256)	(0.0671)	(0.311)
Controls	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
Observations	688	688	645	645
R-squared	0.612	0.549	0.495	0.424

Note: Robust standard errors in parentheses.

This result should be taken with a caveat for two reasons. First, the outcome variable is the performance in the semifinal rather than in the final. Second, observability can be very tricky in the swimming tournaments. It depends on the lane, the stroke, the breathing technique, the relative position and etc. Besides, observability is less of importance in the short-distance tournaments than in the long-distance tournaments, because there is less strategy space and distribution of energy during the whole race.

[20] This number also include those who later did not start (DNS) or were disqualified (DQ) in the semifinal.

6.2 Motivational Support or In-Group Competition

Is the teammate a friend, foe or "frenemy"? The teammate may provide motivational support which is a key element in the social support (Wills 1985). The stress-buffering hypothesis in Cohen and Wills (1985) predicts that social support can help a person to cope better with problems and is mostly beneficial during stressful times. "Racing is 10% physical and 90% mental." says the seven-time gold medalist Mark Spitz. Athletes in the elite level tournaments are under enormous stress. Many athletes race faster in practice, relays or off events than they would at big meets. Stress tightens athletes' muscles, chokes off their breathing and jeopardizes their confidence. If the teammates lends motivational support to each other, they can cope better with the stress and reach better performance. In the relay of four athletes, for example, we often see that the three teammates cheer up for the one in the race, which can be another factor for better performance besides the reduced stress than in the individual tournaments. Interestingly, gender differences have been found in research on social support too. Women provide more social support to others (Thoits 1995; Taylor et al. 2000), are more likely to seek out social support to deal with stress (Tamres, Janicki and Helgeson 2002), and benefit more from social support (Schwarzer and Leppin 1989). Additionally, gender difference is also found in stress. Female athletes are found to exhibit a higher level of stress than male athletes (Raglin, Morgan and O'Connor 1991) and they perform worse under stress than males in the competition (De Paola and Gioia 2015; Cahlikova, Cingl and Levely 2016). Last but not least, women experience emotions more strongly (Harshman and Paivio 1987), and are more sensitive to social cues (Croson and Gneezy 2009). These findings are consistent with my results, if the peer effect is driven by motivational support.

The teammate can also be a foe when the relationship is more competitive than supportive. Athletes from the same country share much in common. Given that individuals tend to choose more similar peers as reference point (Shibutani 1955), athletes may take their teammate as the reference point and set the goal as "beat-the-teammate". Reference points are highly relevant for effort provision (Abeler et al. 2011). Charness, Masclet and Villeval (2010) found that subjects exert effort in a status competition without any monetary incentives associated with their effort in a lab experiment. Similarly, Azmat and Iriberri (2010) showed in the lab that, despite being rewarded via a piece rate for their efforts, subjects given information about the performance of their teammates makes significantly higher effort than the control group given no such feedback.

Both channels would generate positive effects of having a teammate in the same final on the performance. However, they are different in terms of welfare in case of losing to the teammate, as the athlete will feel much worse if he is motivated through in-group competition rather than motivational support. The key to disentangle the two channels lies in to what extent are the two teammates competitors. Motivational support takes place presumably less dependent of the degree of being close competitors while in-group competition might be highly dependent of the it. If the teammate is far apart in the previous ranking, the "beat-the-teammate" goal would be either too easy or too difficult. According to Locke and Latham (2002), the highest level of effort occurred when the goal is moderate and the lowest level of effort occurred when the goal is too easy or too difficult. Therefore, one can expect if the peer effect is driven by in-group competition, it should be maximised when the two teammates are close competitors. The less competitor is one of the other, the smaller the effect of the teammate's presence is.

In the following analysis, I first create a measure of distance of the competence by taking the absolute value of the rank difference between the two teammates in the preliminary heat.[21] The rank difference in the preliminary heat spans from 0 to 15, as the highest rank is 1 and the lowest is 16. Based on this measure, I create a variable "close competitor" as follows:

$$\text{close competitor} = \begin{cases} 1 & \text{if rank difference} \subset [0,4] \\ 0 & \text{if rank difference} \subset [5,9] \\ -1 & \text{if rank difference} \subset [10,15] \end{cases}$$

Extending the Equation 4.1, I interact the dummy of teammate's presence with the variable "close competitor", as shown in Equation 6.1. The presence of the teammate is instrumented by the indicator of teammate's rank in the semifinal, and the interaction

[21]Here is crucial to notice that it is much more risky for the athletes to conserve energy in the preliminary heats of the tournaments of 50m, 100m and (sometimes) 200m than those of longer distances. Therefore, it is much less frequent that athletes do so at a substantial magnitude. Besides, notice again that on average, the teammate is weaker than the focal athlete due to the restriction imposed in the RDD framework.

term is instrumented by the interaction of the indicator with the rank difference in the first stages. One expects a negative sign of the interaction term if the peer effect is driven by in-group competition.

$$
\begin{aligned}
&\text{Performance}_i = \theta_1 \text{Age}_i + \theta_2 \text{Age}_j + \theta_3 \text{Ability}_i \\
&+ \gamma_1 \text{Teammate}_i + \gamma_2 \text{Teammate}_i \times \text{Close Competitor}_{ij} + \gamma_3 \text{Close Competitor}_{ij} + \nu_i
\end{aligned}
\tag{6.1}
$$

Table 9 reports the results. Column (1) and (2) use normalised time and column (3) and (4) use the rank as outcome variables. Column (1) and (3) use the time window and column (2) and (4) use the rank window. In panel A (female sample), the estimated coefficients of the interaction term, γ_2, are positive except in column (4). However, none of them is significant. In panel B (male sample), although the baseline results were not significant for male athletes, the signs of the interaction term are negative in all the specifications and even marginally significant in column (4), suggesting some subtle in-group competition. Previous studies show that competition increases men's performance more than women's (see Gneezy and Rustichini (2004) for a review). If it were the in-group competition that drives the peer effect, men should increase their performance more than women. One straightforward reason for that we do not observe it could be that since the time in the male tournaments are less than in the female ones, there is not much room left for the improvement of the performance. Another reason could be that the male athletes choose a more risky strategy which lead to worse performance than safer ones. Given these results, it would be attempting to speculate that the peer effect we observed here is driven by motivation support among the female athletes and by in-group competition among the male athletes. However, one needs more solid evidence to draw a firm conclusion.

Table 9: The effect of being close competitor

Panel A: Female				
	(1)	(2)	(3)	(4)
VARIABLES	Time	Time	Rank	Rank
Teammate	-0.704***	-0.493**	-1.370***	-0.835**
	(0.238)	(0.216)	(0.516)	(0.414)
Teammate × Close competitor	0.340	0.174	0.469	-0.0460
	(0.303)	(0.285)	(0.643)	(0.576)
Close competitor	-0.355	-0.0963	-0.244	0.366
	(0.250)	(0.237)	(0.482)	(0.441)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Controls	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	231.075	293.992	231.075	293.992
Observations	97	95	97	95
R-squared	0.461	0.469	0.388	0.457

Panel B: Male				
VARIABLES	Time	Time	Rank	Rank
Teammate	0.198	0.141	0.551	0.647*
	(0.175)	(0.405)	(0.388)	
Teammate × Close competitor	-0.126	-0.209	-0.747	-0.970*
	(0.243)	(0.519)	(0.503)	
Close competitor	-0.118	-0.0219	0.209	0.469
	(0.177)	(0.402)	(0.372)	
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Controls	yes	yes	yes	yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	138.760	158.526	138.760	158.526
Observations	88	93	88	93
R-squared	0.676	0.651	0.581	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6.3 Cross Cultural Effects: Individualism Score

Another interesting question is whether the effect operates through a culture channel, and in particular, the dimension of individualism. Hofstede introduced individualism as an index that explores the degree to which people in a society are integrated into groups (Hofstede, Hofstede and Minkov 1991). Individualists emphasise the "I" versus the "we", whereas the collectivists do the opposite. Although swimming is not a team sport, athletes representing the same country may still feel belonging to the national team. One would expect that having a teammate in the same tournament might mean more to the collectivists than to the individualists. Since swimming competition has a broad international participation, the finalists in my sample are from 52 countries. I map their nationality to the individualism index (IDV). For example, USA as a typical individualistic country scores 91 and China as a typical collective country scores 20 on a scale of 100. In Equation 6.2 I interact this index with the presence of the teammate in the final.

$$\begin{aligned}\text{Performance}_i = {} & \theta_1 \text{Age}_i + \theta_2 \text{Age}_j + \theta_3 \text{Ability}_i \\ & + \gamma_1 \text{Teammate}_i + \gamma_2 \text{Teammate}_i \times \text{IDV}_{ij} + \gamma_3 \text{IDV}_{ij} + \nu_i \end{aligned} \tag{6.2}$$

The presence of the teammate is instrumented by the indicator of teammate's rank in the semifinal, and the interaction term is instrumented by the interaction of the indicator with the IDV scores in the first stages. One expects positive coefficient as a group membership is more salient for athletes from collective countries than from individualistic countries. Table 10 reports the results. In Panel A (female sample), the estimated coefficients of the interaction term are indeed positive, however, insignificant in column (1) and (2) and only marginally significant in column (3) and (4). In Panel B (male sample), similarly, the estimated coefficients of the interaction term are positive but only marginally significant in column (2).

Table 10: The peer effects interacting with the IDV score

Panel A: Female

VARIABLES	(1) Time	(2) Time	(3) Rank	(4) Rank
Teammate	-0.507**	-0.477***	-1.126***	-1.071***
	(0.224)	(0.170)	(0.433)	(0.360)
Teammate×IDV	0.0110	0.00967	0.0416*	0.0358*
	(0.00998)	(0.00806)	(0.0215)	(0.0192)
IDV	-0.00584	-0.00393	-0.0151	-0.00952
	(0.00825)	(0.00571)	(0.0166)	(0.0130)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
F-statistics of Instrument	51.309	87.167	51.309	87.167
Observations	97	95	97	95
R-squared	0.417	0.466	0.324	0.406

Panel B: Male

VARIABLES	Time	Time	Rank	Rank
Teammate	0.0951	0.0921	0.419	0.482
	(0.146)	(0.156)	(0.340)	(0.345)
Teammate× IDV	0.00650	0.0119*	0.0159	0.0203
	(0.00749)	(0.00662)	(0.0155)	(0.0136)
IDV	-0.00276	-0.00762	-0.00696	-0.0226**
	(0.00654)	(0.00504)	(0.0128)	(0.0104)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
F-statistics of Instrument	192.707	243.642	192.707	243.642
Observations	88	93	88	93
R-squared	0.674	0.656	0.658	0.633

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
IDV score is demeaned.

7 Conclusion

This paper uses the concept of a regression discontinuity design to identify a special form of peer effects, namely, the effect of a teammate's presence on the performance in high-stakes tournaments among elite athletes. Despite strong performance-based incentives and the fact that elite athletes learn with professional experience not to be affected by social circumstances, the performance of female athletes is still affected by the presence of the teammate in a positive way. Instead of competing "alone" against pure out-group athletes, female athletes accompanied by a teammate swam 0.41%-0.56% of the average time faster, or ranked by 0.75-1.16 higher in the final. The performance of male athletes, however, does not seem to be affected by the presence of their teammate.

This study differs from the earlier literature on peer effects in several aspects. First of all, the subjects are highly skilled in the task they perform. Secondly, the payment scheme is tournament and the stakes are high. Thirdly, the group identity is strong as it is based on the same nationality at the international level. Finally, the conditions of the tournaments are the same for females and males, which allows a clean comparison across gender.

An obvious limitation in the data is that the peer groups are same-sex dyads. I cannot say anything about how a female athlete reacts to the presence of a male athlete, nor the other way around. This is an inevitable limitation for studies using sports data. On the other hand, the evidence of the potential channels found here is only suggestive. It is hard to identify the true channel behind the peer effects using observational data. After all, individuals can take action without being fully aware of what is motivating them (Murphy 2001). Further research could use controlled experiment to identify the underlying channel.

8 Appendix

Table 11: Two sample t-test using the time window

Mean of Covariates	(1) teammate's SF Time $\subset$ (Cutoff, Cutoff + 0.25 std]	(2) teammate's SF Time $\subset$ [Cutoff, Cutoff - 0.25 std]	p-value
Panel A: Female			
Age	22.19	21.71	0.49
	(0.70)	(0.35)	
No. Finals (Ch)	1.90	1.91	0.98
	(0.16)	(0.12)	
No. Finals (Tot)	4.16	4.44	0.66
	(0.51)	(0 .36)	
Total	31	66	
Panel B: Male			
Age	24.56	23.96	0.51
	(0.74)	(0.53)	
No. Finals (Ch)	1.65	1.59	0.77
	(0.15)	(0.11)	
No. Finals (Tot)	4.88	4.81	0.95
	(0 .82)	(0.66)	
Total	34	54	

Standard errors in parentheses

Table 12: TSLS estimates of the effect of having a teammate in the final on the performance
(standard errors clustered at ID level)

Panel A: Female				
	(1)	(2)	(3)	(4)
VARIABLES	Time	Time	Rank	Rank
teammate	-0.563***	-0.412**	-1.159**	-0.746**
	(0.218)	(0.160)	(0.500)	(0.333)
Age	-0.00332	-0.0435	-0.0207	-0.0933
	(0.0402)	(0.0415)	(0.0642)	(0.0642)
teammate's age	-0.00489	0.000420	0.00636	0.00252
	(0.0257)	(0.0239)	(0.0621)	(0.0456)
Ability	-0.957***	-1.132***	-1.733***	-2.122***
	(0.117)	(0.126)	(0.228)	(0.249)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	469.903	632.228	469.903	632.228
Observations	97	95	97	95
R-squared	0.561	0.581	0.528	0.583
Panel B: Male				
VARIABLES	Time	Time	Rank	Rank
teammate	0.0955	0.0494	0.322	0.405
	(0.149)	(0.138)	(0.342)	(0.314)
Age	0.0258*	0.0137	0.0105	-0.0234
	(0.0154)	(0.0171)	(0.0338)	(0.0431)
teammate's age	-0.00226	0.00568	-0.0125	0.0245
	(0.0233)	(0.0291)	(0.0516)	(0.0673)
Ability	-1.150***	-1.128***	-2.468***	-2.357***
	(0.127)	(0.129)	(0.264)	(0.284)
[-0.25, +0.25] Std	yes		yes	
[-2, +2] Ranks		yes		yes
Discipline FEs	yes	yes	yes	yes
Championship FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
F-statistics of Instrument	653.775	797.344	653.775	797.344
Observations	88	93	88	93
R-squared	0.753	0.742	0.718	0.710

Notes: Standard errors clustered at ID level in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Normalised time is the ratio of own time in the final over the average time
of the sixteen athletes in the semifinal, and multiplied by 100.

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