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Psychological Pressure in Competitive Environments: New Evidence from Randomized Natural Experiments

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Dynamic competitive settings may create psychological pressure when feedback about the performance of competitors is provided before the end of the competition. Such psychological pressure could produce a first-mover advantage, despite a priori equal winning probabilities. Using data from a randomized natural experiment—penalty shootouts in soccer—we reexamine evidence by Apesteguia and Palacios-Huerta [Apesteguia J, Palacios-Huerta I (2010) Psychological pressure in competitive environments: Evidence from a randomized natural experiment. *Amer. Econom. Rev.* 100(5):2548–2564]. They report a 21-percentage-point advantage for first movers over second movers in terms of winning probabilities. Extending their sample of 129 shootouts to 540, we fail to detect any significant first-mover advantage. Our results are fully consistent with recent evidence from other sports contests.

Key words: tournament; first-mover advantage; psychological pressure; field experiment; soccer; penalty shootouts
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1. Introduction

Competitions for internal promotions in companies or organizations often involve situations where one competitor observes how other competitors have performed at an interim stage before the competition is over. Such dynamic competitive settings may put psychological pressure on competitors who feel that they have to react to the performance of their rivals. The pressure may, consequently, have an influence on a competitor's performance, thus possibly generating a first-mover advantage. This means that first movers might win the competition more often because the performance of second movers was negatively affected by psychological pressure, despite a priori equal probabilities of winning. Similar effects could arise in research and development (R&D) races between companies, political elections, or student competitions in school when interim information about the competitors' performance is released in the course of the competition (through preliminary research reports, election polls, or intermediate exams). Measuring the potential influence of psychological pressure in the field is a demanding task, because naturally occurring situations, for instance, in companies, are typically too complex to allow for causal inferences. Furthermore, the precise identification of the effect calls for the randomized assignment of agents to the sequence of performing a task (to avoid endogeneity problems).

One remedy is the use of sports contests as a source of excellent data.[1] Such data provide a formidable framework for studying the impact of psychological pressure on performance in competitive environments, because they often involve explicit randomization. Moreover, decisions are taken or effort is provided by highly paid professionals in their naturally occurring environment. A further advantage of sports data comes from often unambiguous measures for performance (like scoring a goal or not) and the one-dimensionality of the task (like kicking a ball or shooting a puck).

A recent paper by Apesteguia and Palacios-Huerta (2010; hereafter abbreviated as APH) used data from

[1] A seminal paper to use data from professional sports contests as the basis of an empirical test of game theory was Walker and Wooders (2001). They studied mixed-strategy equilibria in tennis serves.

a sports contest to examine the importance of psychological pressure in sequential tournaments. In particular, APH looked at soccer penalty shootouts where two teams, in alternating order, kick directly from the penalty mark to score a goal. Since 1970, such shootouts have been used to determine the winner of a tied match for which a winner is needed to determine the team that advances to the next round of a knockout tournament. Before July 2003, soccer penalty shootouts fulfilled the criterion of a randomized natural experiment (Harrison and List 2004), because the order of the kicks was decided by the toss of a coin, where the team that won the toss had to take the first kick. APH collected data from 129 shootouts, finding that in these shootouts the first-kicking team won in 78 cases (60.5%) and the second-kicking team won in only 51 cases (39.5%; see Figure 1 in APH). Hence, despite an a priori winning probability of 50% for both teams, the first-kicking team had a significant margin of 21 percentage points over the second-kicking team in their data. APH conclude from their evidence that the "results provide support for a source of psychological pressure that has a detrimental effect on performance, and that is different from others such as high stakes, social pressure or peer pressure previously documented in the literature" (p. 2563).

The striking findings of APH are at odds with the results of a couple of related studies, however. Kocher et al. (2008) examined the determinants of scoring in penalty shootouts in the German Soccer Cup tournament (*DFB-Pokal*). Although their paper's main focus was not on a possible first-mover advantage, they report, based on a preliminary data set of 95 penalty shootouts in the seasons from 1986–1987 to 2006–2007, that the first-kicking teams won in only 48.4% of all cases. This is not only far below the 60.5% of APH, but also not significantly different from the expected 50%. More recent evidence by Kolev et al. (2010) showed that in ice hockey penalty shootouts in the National Hockey League, the first-moving team won in 49% of 145 cases in the last season before the sequence of penalty attempts became endogenous. Hence, Kolev et al. (2010) cannot reject the null hypothesis of no first-mover advantage either. A field experiment by Feri et al. (2010), with junior professional basketball players in Italy, provides further evidence against the conjecture of a first-mover advantage in sequential tournaments. Feri et al. (2010) let basketball players compete against each other in a sequential free-throw competition. For the 66 cases in which no tie prevailed after five throws, exactly 50% of the competitions were won by the first-throwing player. In the 18 cases with a tie, which required additional throws, only 5 (28%) were won by the first-throwing player. Although their data set is relatively small, the evidence by Feri et al. (2010) also speaks against the existence of a first-mover advantage.

The difference between APH's findings and all others reported above calls for more evidence. In principle, there are two approaches to provide further insights. First, it would be possible to analyze the data of other naturally occurring sequential contests than the ones studied so far or to conduct more (field) experiments. Second, one could extend the small sample of the APH paper that is the only empirical paper so far that provides evidence for a significant first-mover advantage in sequential tournaments. It is exactly the latter strategy that we follow in this paper.

More specifically, we extended the initial sample of 129 shootouts of APH to 540 shootouts. Our sample is a strict superset of APH's data, using the same set of soccer tournaments. In contrast to their study that selects games unsystematically from a set of tournaments, we have almost the full population of games with penalty shootouts from the set of tournaments used by APH. This larger sample allows us to reexamine the evidence and address the robustness of the alleged first-mover advantage in sequential tournaments.

Our data show that first-kicking teams win in 288 cases (53.3%). Although this figure is slightly above 50%, it is far from being significantly so, neither in a two-sided binomial test nor in a regression that controls for several potentially relevant covariates. Hence, we fail to find a significant first-mover advantage in a data set that is a strict superset of APH's data and has more than fourfold the size. We discuss why our findings and those of APH are different, revealing that issues of data selection are important for understanding the discrepancies. In a nutshell, our results indicate that sequential tournaments do not seem to be significantly affected by psychological pressure, or, to say the least, they are much less affected than APH suggests.

The rest of this paper is organized as follows. In §2 we describe the data and the rules that determine which team kicks first in a penalty shootout and how the outcome of a shootout is determined. Section 3 presents, first, our main results and, second, how our data set relates to the one used by APH. Section 4 concludes the paper.

2. Rules and Data

Penalty shootouts were introduced by the world governing body of soccer, the Fédération Internationale de Football Association (FIFA), in 1970 to determine the winner in knockout tournament games in which there was a tie between two teams after 90 minutes of regular time and 30 minutes of overtime. Before 1970,

Table 1 Shootout Data from 1970/1971 to 2002/2003

Tournament	[A] Number of shootouts in tournament	[B] Shootouts with order of kicks known	[C] First-kicking team wins (rel. frequency)	[D] *p*-value (two-sided binomial test)
[1] World Cup	16	16	0.438	0.80
[2] European Championship	9	9	0.333	0.51
[3] Copa America (South America)	12	12	0.667	0.39
[4] African Nations Cup	17	13	0.692	0.27
[5] Gold Cup (Northern and Middle America)	5	5	0.400	1.00
[6] Asian Cup	10	8	0.375	0.73
[7] European Champions League[a]	28	28	0.643	0.19
[8] UEFA-Cup[b]	76	74	0.527	0.73
[9] German Cups (*DFB-Pokal*, *Ligapokal*)	123	122	0.500	1.00
[10] English Cups (*FA-Cup*, *League Cup*, *Charity Shield*)	133	122	0.508	0.93
[11] Spanish Cup (*Copa del Rey*)	280	131	0.580	0.08
Sum [1] to [11]	709	540	0.533	0.13

Sources. [1] http://www.fifa.com, http://www.kicker.de. [2] http://www.kicker.de, http://www.fussballdaten.de. [3] http://www.rsssf.com. [4] Ionescu (2010), *L'Equipe* (print edition), emails to soccer associations. [5] http://www.lexisnexis.com. [6] http://en.wikipedia.org, http://swe.worldfootball.net, http://sports.sina.com.cn, http://sports.sohu.com. [7] Ionescu (2004a, b). [8] Ionescu (2003; 2004c, d). [9] *Kicker Sportmagazin* (print edition), http://www.kicker.de, http://www.fussballdaten.de, http://www.weltfussball.de, emails to clubs, newspaper clips. [10] Brown (2006, 2007), http://www.lexisnexis.com, emails to clubs. [11] El Mundo Deportivo, ABC, AS, and La Vanguardia (online archives).

[a]Data include preceding European Champion Clubs' Cup.

[b]Data include preceding European Fairs Cup.

the winner in tied games in a knockout tournament was determined by the draw of a lot or a replay.

The basic rules for a penalty shootout are as follows (for details of the current rules, see the official "Rules of the Game" at http://www.fifa.com): First, each team selects five players (out of the players on the pitch in the 120th minute). Second, teams kick in alternating order. Third, the shootout is terminated as soon as the number of penalties converted by one team cannot be matched by the other team even if the other team would convert all their remaining penalties. If, after both teams have taken five kicks, both have scored the same number of goals, teams continue kicking in the same alternating order until one team has scored one goal more than the other from the same number of kicks (i.e., in a sequential one-on-one competition). Each penalty kick during the shootout must be taken by a different player, and all eligible players must have taken a kick before any player can take a second kick. In principle, this sequence can go on infinitely. However, the longest shootout in our data set includes 26 kicks, i.e., 13 for each team.[2]

From 1970 until June 2003 the team that won the referee's toss of a coin before the shootout *had* to take the first kick. Such a rule constitutes an explicit randomization to determine the beginning team. In July 2003 the FIFA changed the rules by giving the winner of the referee's toss of a coin the *option* of choosing whether to kick first or second. This choice option gives rise to endogeneity problems, and therefore we only use data from 1970 to June 2003 (i.e., the end of the season 2002/2003), thus following the convincing argument by APH that only until then can shootout data be used for an unbiased estimation of a potential first-mover advantage.

Table 1 lists the 11 tournaments that were considered in APH (see their Table 1 on p. 2552). Tournaments [1]–[6] are for national teams, including the arguably most important tournaments in the world of soccer, the World Cup and the European Championship. If psychological pressure were particularly strong in penalty shootout situations, it should be strongest in these tournaments, because they attract the most public attention and media coverage, and they are of the utmost importance for the standing and career prospect of every kicker on the pitch.[3] Tournaments [7] and [8] are for clubs on the European level, including the most prestigious European Champions League (with its predecessor, the European Champion Clubs' Cup), and the UEFA-Cup

[2] A soccer penalty shootout belongs to a class of games that Walker et al. (2011) call binary Markov games. For a theoretical account of such games, see their paper. Penalty shootouts are a good example for studying mixed strategies in games (see Chiappori et al. 2002). Consequently, soccer players—because of their penalty-shooting experience—have been used to examine mixed-strategy play of professionals in the laboratory, yielding mixed evidence, however (see Palacios-Huerta and Volij 2008, versus Levitt et al. 2010, and Wooders 2010).

[3] However, very high stakes may have detrimental effects on performance, as shown by Dohmen (2008) or Ariely et al. (2009), for instance.

(with the European Fairs Cup as its predecessor). Tournaments [9]–[11] are national tournaments where clubs compete for a national cup title. The three countries chosen are the top-three countries in the current UEFA-ranking of nations according to their clubs' performance in international tournaments. In Germany, the Soccer Cup Competition (*DFB-Pokal*) is by far more important than the Supercup (*Ligapokal*), but we include the Supercup's four shootouts because they have also been included in APH. For England we consider the *FA-Cup*—the oldest soccer club tournament in the world—the *League Cup* and the *Charity Shield* (with only three shootouts in the history of the latter). The Spanish data originate from the *Copa del Rey* (which was staged under different names in the earlier years of the tournament). Detailed information on our data sources is provided in the caption below Table 1.

Column [A] of Table 1 reports the number of shootouts in the 11 tournaments. Column [B] presents the number of shootouts for which we know which team took the first kick. For tournaments [1]–[10] we have been able to verify the necessary data for 409 out of 429 shootouts (95.3%) that ever took place in these 10 tournaments from 1970 to June 2003. The 20 missing data points are due to the unavailability of data on kicking orders mainly in the 1970s and early 1980s. For Spain (tournament [11]) we could determine the kicking order for 131 out of 280 shootouts (46.8%). The four Spanish newspapers to which we resorted for match reports typically only reported the final results of shootouts in the early rounds of the yearly Spanish cup, but no further details on kicking order. Hence, the fraction of shootouts whose order could be determined is smaller for the Spanish cup than for the other tournaments, albeit the total number of shootouts where the kicking order is known is larger in Spain than in any other tournament.[4]

3. Results

3.1. Reexamining the First-Mover Advantage Hypothesis for Our Extended Data Set

Column [C] in Table 1 presents the relative frequency with which teams that took the first kick in a shootout actually won it. This relative frequency varies considerably across tournaments, reaching a low of 33% for the European Championship and a high of 69% for the African Cup of Nations. Note that in the presumably most important tournaments for national teams, the World Cup and the European Championship, the relative frequency is *below* 50%. However, given the relatively low number of observations for some tournaments, it is more informative to look at statistical tests for single tournaments and for the aggregate data set. Column [D] reports the p-value from a two-sided binomial test to check whether the observed frequency of first-kicking teams winning a shootout is significantly different from 50%. None of these p-values is significant for a single tournament at the 5% level. Closest to significance are the Spanish shootouts with $p = 0.08$. Note, however, that the two other tournaments with more than 100 observations (England and Germany) have p-values of 0.93 and 1.00. Looking at the aggregate data (see row "Sum"), it can be seen that 53.3% of the 540 shootouts were won by the first-kicking team. A two-sided binomial test yields $p = 0.13$, thus failing to identify a significant first-mover advantage.

Table 2 Probit-Regression

Team wins shootout as dependent variable (= 1)	(1)	(2)
Constant		
Coefficient	−0.0837	−0.1360*
Standard error	(0.0541)	(0.0761)
p-value	(0.122)	(0.074)
Team kicks first		
Coefficient	0.1673	0.1583
Standard error	(0.1081)	(0.1086)
p-value	(0.122)	(0.145)
Home field		
Coefficient	—	0.1137
Standard error	—	(0.1163)
p-value	—	(0.328)
Neutral field		
Coefficient	—	0.0568
Standard error	—	(0.0582)
p-value	—	(0.328)
N (teams)	1,080	1,080
Adjusted R^2	0.0032	0.0045
Log-likelihood	−746.20	−745.24

Notes. Using logit regressions instead of probit does not change the results qualitatively. Robust standard errors in parentheses (clustering at the level of the shootout-ID).

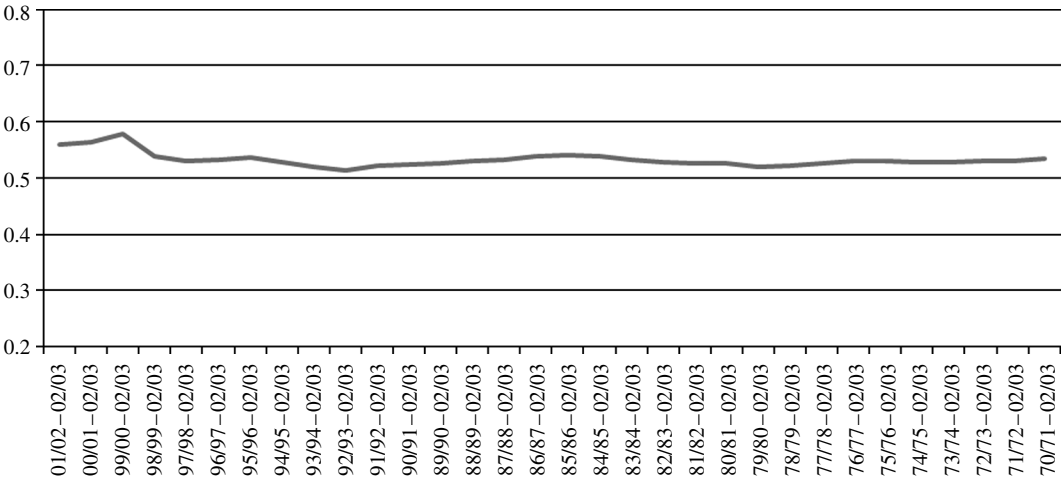
*Denotes significance at the 10% level.

Our result remains unchanged when applying a probit regression that controls for covariates such as whether a team is the home team ("home") or whether the match was staged on neutral ground ("neutral"). Table 2 presents the regression results, again indicating that the dummy for the first-kicking team is not significant ($p = 0.15$).[5]

[4] We retrieve information on the kicking order for 46.8% of the shootouts in Spain, compared to only 10.4% in APH.

[5] It seems noteworthy that the regressions in Table 3 of APH report wrong (i.e., too small) standard errors because the two teams involved in a single shootout are treated as two independent observations in APH, although they are actually dependent (if the first-kicking team wins, the second-kicking team must lose, and vice versa). We control for the dependency by clustering on the level of the shootout.

Figure 1 Relative Frequency with Which the First-Kicking Team Wins—Cumulating Backward Season by Season, Starting from Season 2002/2003



3.2. Reasons for the Different Results—Remarks on Data Selection

Even though our data set of 540 shootouts represent 76.2% of all shootouts from 1970 to 2003 in the tournaments considered (compared to the 18.2% of the APH sample), we fail to find a significant first-mover advantage. One reason for the discrepancy in results between the two studies could have to do with different data collection methodologies. As becomes clear from their Table 1, APH (p. 2552) select subsamples of shootouts in the various tournaments, covering different time periods. More precisely, whereas APH take into account (almost) all shootouts in tournaments of national teams, the time periods that they choose for the various club tournaments seem to lack a systematic pattern and a clear rule for inclusion. For the Champions League and the UEFA Cup, they consider the years 2000–2003 plus all prior finals. For the Spanish Cup, they use data from 1999 to 2003 and all prior finals. For the German cups, they take the years 2001–2003 as well as all prior finals. Finally, for the English cup competitions, their paper does not contain information on the years being taken into account.[6]

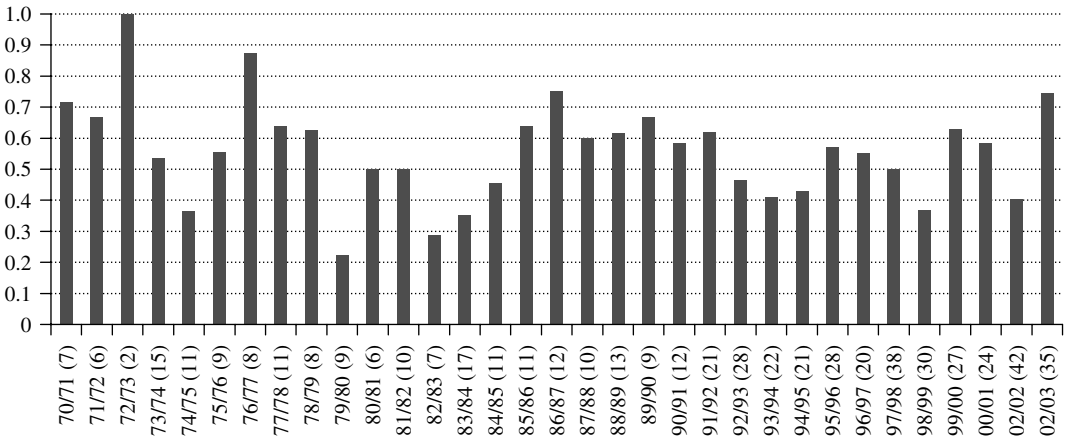
In our view, there is no apparent reason for different inclusion periods for the various club tournaments and no reason to focus on finals in earlier years either. To see whether APH's sampling might explain the difference between their results and ours, we have looked at what happens to the relative winning frequency of first-kicking teams *if* for all 11 tournaments the same time periods are taken into account. Figure 1 presents the evidence for our data set. On the horizontal axis, we denote the years that were taken into account. We work backward, starting from the season 2002/2003 (indicated as season "02/03" in the figure) and successively add prior season after season. We see that all relative winning frequencies fall clearly short of 60.5%. For instance, if one would consider only seasons 1992/1993–2002/2003 (labeled as "92/93–02/03" in the figure), the relative winning frequency of first-kicking teams were 51.4% based on a total of 315 shootouts.

A second reason for the discrepancy between the previous results by APH and our results might be driven by the fact that APH use *relatively* more recent data. If first-kicking teams were more likely to win in more recent years than in earlier years, this could add to explaining the difference. Therefore, we present in Figure 2 the relative frequency with which first-kicking teams won in single seasons (where "70/71" in Figure 2 denotes season 1970/1971).[7] We notice

[6] Downloading APH's data from the website of the *American Economic Review*, we have found that the five matches from English cups included in APH are one final (out of three) in the *Charity Shield*, one second-round, one third-round, and one fourth-round match of the *League Cup* (out of 71 matches with a shootout in the *League Cup*), and one final of the *Charity Shield* that took place *after* July 2003 (and hence should not have been included given the rule change of FIFA in July 2003). It seems noteworthy that APH did not include any of the 59 matches in the *FA-Cup*, the world's oldest and England's most prestigious cup competition.

[7] A season XX/YY in Figure 2 covers the shootouts that took place from August in year XX to July in year YY. This is important to consider, for instance, for World Cups and European Championships that take place every four years, typically from June to early July. These competitions are then regarded as the end of a season. Therefore, the World Cup 2002, for example, is included in season 2001/2002, thus showing up in the bar "01/02" in Figure 2. The number of shootouts is generally smaller in the 1970s and 1980s because of a change in rules of national cup competitions. In the late 1980s and early 1990s, it was decided to proceed immediately to a penalty shootout if a match ended with a draw after 120 minutes, rather than continuing with the former tradition of staging a replay (or even more than one replay, if necessary, as in England). This new practice—introduced to save on the number of matches to be played—increased the number of shootouts considerably.

Figure 2 Relative Frequency with Which the First-Kicking Team Wins a Shootout in Single Seasons



Note. Number of shootouts in parentheses.

ups and downs in Figure 2, but no systematic pattern in either direction over time. According to binomial tests, the relative winning frequency of first-kicking teams in a shootout is not significantly different from 50% in any single season.

Given the evidence so far, it seems that sampling issues can explain the different results and conclusions of APH and this paper. As a final exercise to demonstrate the consequences and importance of sampling, we calculate the probability with which one would get at least 60.5% of first-kicking teams winning in a sample of 129 shootouts if one sampled randomly from our data set of 540 shootouts. Because our data set is a strict superset of APH's data set, this is equivalent to asking the question of how likely it is to get their results under the assumption that our data were considered the true population of shootouts from which APH sampled. This likelihood is $p = 0.03$. It is also noteworthy that if we split our data set into APH's data ($N = 129$; 60.5% winning percentage of first-kicking teams) and the *Rest* ($N = 411$; 51.1% winning percentage of first-kicking teams), we find that APH's subset is noticeably different from the *Rest* ($p < 0.08$; χ^2-test). Of course, our data set "only" covers 76.2% of the entire population of shootouts in the 11 tournaments. Hence, in a final step, we imagine a scenario in which the true relative frequency of first-kicking teams winning a shootout would be the one found in APH, i.e., 60.5% in the whole population of the 709 shootouts that ever took place from 1970 to June 2003 in the 11 tournaments. Under this assumption, we can calculate the probability with which one would get at most 53.3% of first-kicking teams winning in a subsample of 540 shootouts (i.e., in our subsample given our main result). This probability is $p = 3 \cdot 10^{-13}$.

Finally, we have also compared our data set with the one of APH that can be downloaded on the website of the *American Economic Review*, game by game. For the 129 shootouts that they use, we find 21 inconsistencies between the two data sets. We have double-checked our sources and could not resolve the issue. Assuming that our sources are correct and using this data, the size of the first-mover advantage reported in the APH paper is reduced considerably and, most importantly, turns insignificant. This is in line with the results in this paper for the much larger data set.

4. Conclusion

Penalty shootouts from 1970 until June 2003 constitute a truly randomized experiment that allows examining whether the order of making moves in dynamic tournaments with interim performance feedback influences tournaments' outcomes. If psychological pressure were at work, then first movers might have a distinct advantage over second movers. Examining the existence of a first-mover advantage is therefore relevant for evaluating the chance of winning in dynamic tournaments with interim feedback and observability of performance. Such tournaments can be found on internal labor markets, when employees compete for promotions and are able to observe the performance of their competitors, or in R&D races between companies, political elections, or student competitions in school, whenever interim information about the competitors' performance is released (through preliminary research reports, election polls, or intermediate exams).

Sports contests provide a unique opportunity to examine the influence of the order of moves on the winning frequencies of first or second movers under controlled and truly randomized conditions, thus avoiding problems of observability of effort and performance or endogeneity issues. Whereas recent

contributions by Kolev et al. (2010) for ice hockey penalty shootouts and Feri et al. (2010) for basketball free-throw competitions do not find any first-mover advantage, a recent publication by Apesteguia and Palacios-Huerta (2010) reported a very large and significant first-mover advantage in soccer penalty shootouts. We have reexamined the question by collecting a strict superset of the sample by Apesteguia and Palacios-Huerta (2010), including in our data set of 540 shootouts their 129 shootouts, but we have failed to find a significant first-mover advantage in penalty shootouts. The discrepancy between our findings and the results reported in Apesteguia and Palacios-Huerta (2010) can most probably be explained, in our view, by the nonsystematic sampling or collection of data points for the data set used in Apesteguia and Palacios-Huerta (2010).

At 53.3%, the average winning probability of first-kicking teams is above the a priori probability of 50%, although the difference is not significant. The small effect away from the a priori probability is mainly driven by the Spanish tournament. One can only speculate on whether a first-mover advantage would become significant or whether one would even obtain evidence for a second-mover advantage if one were able to collect data on the kicking order of many more shootouts in many more tournaments. Obviously, with very large numbers of observations, even tiny differences can become significant in either direction. However, tiny differences, even if significant, call the economic relevance of underlying effects into question. Given the evidence provided in this paper and in recent working papers based on different approaches, we are confident in concluding that psychological pressure, if present in penalty shootouts and, more generally, in many dynamic tournaments, does not seem to influence overall actual winning probabilities in a symmetric sequential tournament with an a priori winning probability of 50%. Consequently, there does not seem to be inherent unfairness created by the order of moves in dynamic sports tournaments. Nevertheless, there is still room for much more research: The role of effort costs in the tournament, the role of disappointment and reference points (see, e.g., Gill and Prowse 2012), and the relationship of psychological effects with the actual dynamics in a sequential tournament call for much more empirical (experimental) evidence.

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