The Absence of "Order-Effects" in Dynamic Tournaments: Evidence from a Real-life Randomized Experiment

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Abstract

An important question in economics is the extent to which the order of repeated interaction in a tournament affects its outcome. We set-up a model with repeated interaction in which players have temporary (cost) advantages. We find that the order in which the players have this advantage does not have an effect on the probability of winning the tournament. We then test the conclusions of the model by using a randomized natural experiment in professional sports competitions. The setting is the two leg knock-out game structure in soccer tournaments where two teams are randomly allocated to have an advantage (to play at home) either in the first or the second stage of the game. In contrast to the previous literature that provides evidence for a first-mover advantage due to psychological pressure and preemptive behavior, we find strong support for the proposition that the winning probability in dynamic tournaments is independent from the order of interaction.

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1 Introduction

Tournaments are omnipresent in organizations and may have life-long consequences on participants. They range from job promotion tournaments between employees to competition for professorships and research grants between researchers;[1] from competition for bonus payments between sales persons to tournaments between managers in relative performance compensation schemes.[2]

The theoretic literature in labor economics and economics of organization has mainly focused on the analysis of tournaments as a device to rank relative performance and determine compensation schemes.[3] Also, there is substantial empirical literature testing tournament theory in the context of executive pay, incentives, and cooperation.[4] However, less work has been done studying the effects of tournament regulation on its outcome.[5] In particular studying the link between human psychology and the structure of tournaments can shed light on the optimality of tournament regulation and welfare effects on participants. Ginsburgh and van Ours (2003) and Page and Page (2010) analyze whether expert judgement can be influenced by the random allocation of the order of performance in "The Queen Elizabeth Piano Competition" and "Idol Series" respectively. Both find a strong and positive effect for participants performing last, indicating that a critical indicator of success is the order in which artists perform, which should be irrelevant information.

In this paper, we question if there are “order-effects” in dynamic tournaments[6] with clear and objective winning rules and without expert opinion. Under “order-effects” (OE) we mean the advantage or disadvantage of a player to perform under different conditions in

[1] For instance, see Schöttner (2008), Taylor (1995), and Baker, Gibbs and Holmström (1994).

[2] For instance, Boyle (2001) suggests that roughly 25 percent of the Fortune 500 companies have instituted forced-ranking systems to tie pay to performance. See also Gibbons and Murphy (1990).

[3] See, for instance, Lazear and Rosen (1981), Nalebuff and Stiglitz (1983), and Rosen (1986).

[4] See Knoeber and Thurman (1994), Eriksson (1999), and Bognanno (2001).

[5] See Apesteguia and Palacios-Huerta (2010). See also Che and Hendershott (2008).

[6] For instance, Moldovanu and Sela (2006) analyze the advantages of contests with multiple elimination rounds.

a randomly determined order given by the regulation of the tournament. We benefit from a randomized natural experiment in soccer knock out games with two rounds, where each team plays one game at home and the other away. Given the well established fact that home teams have an advantage[7], we investigate whether the random allocation of this advantage in either the first or second round has an impact on the probability of winning the knock out game.

Studying the effects of tournament regulations on the outcome is of great importance for two reasons. First, from the perspective of the organizer tournaments are often used as a selection mechanism and thus more able agents should win the tournament. This is not the case when the regulation randomly attributes a considerable advantage to one player. Second, from the perspective of the participant it is not fair if one player receives an advantage. Because of these issues when the dynamics of a tournament don't allow for symmetric conditions in each round,[8] the order or sequence of interaction must be carefully considered in order not to advantage one player over another. We refer to this condition as neutral structure of the tournament.

The setting of a knock out game allows us to go beyond what can usually be done in empirical work on psychological and emotional factors in corporate tournaments.[9] Studying corporate tournaments presents several difficulties as, for example, agents' efforts, outputs, and risk preferences are not observable. Thus, empirical identification and documentation of psychological elements at work is an extremely difficult task. In this respect professional sport competitions may help to understand how professionals react to changes in structure or incentives. In contrast to tournaments in organizations, most choices and strategies of professional players with high incentives are observable in sports. Thus Szymanski (2003)

[7]See Clarke and Norman (1995) on the advantage of playing at home in soccer. For an overview of the literature on this advantage in both team as well as individual sports, see Nevill and Holder (1999).

[8]See, for instance, Jost and Kräkel (2005) on sequential-move tournaments. See Szymanski (2003) for an excellent overview of the economic analysis of (dynamic) sporting contests.

[9]See, for instance, Kräkel (2008) for a theoretical analysis of the impact of emotions in rank-order tournaments.

concludes that sports data offers a rich laboratory for economists to understand the relationship between tournament structure and psychological effects and to test theoretical predictions against the data. Our setting of a natural experiment will allow us to study how the tournament structure might affect psychological and emotional factors as well as the role of these factors as determinants of the outcome of the tournament. Without any OE driven by emotional or psychological factors, teams should have equal winning probabilities independent of whether they play the first or second game at home.

Testing the presence of OE on a sample of 1068 games and 534 knock outs, we find that teams playing the second leg at home win 51.8% of games, which is not significantly different from 50% at a p-value of .38.[10]

The empirical part of the paper relates to Apesteguia and Palacios-Huerta (2010) who analyze 129 penalty shoot-outs in soccer tournaments and find that teams randomly allocated to take the first kick win the shoot-out 60.5% of the time, which is significant at the 1.7% level. They ascribe this effect of sequential moves in a tournament to psychological pressure on the second-kicking teams. One way these psychological effects have an influence on the outcome is that leading makes one confident while lagging behind gives a pessimistic focal point. They conclude that emotions and psychological pressure can turn the ex ante randomness of the sequence of kicking into an ex post bias. However, Kocher et al. (2010) cannot replicate the positive and significant effect of kicking first in a larger sample of shootouts with 262 observations. Our natural experiment differs from Apesteguia and Palacios-Huerta (2010) in several ways. We consider teams, not individual players. The time interval between the stages is larger. The interaction is only repeated once. However, our findings suggest that the presence of OE cannot be generalized for multi-stage tournaments with stage-specific advantages.

[10]Page and Page (2007) also analyze two-leg soccer knock out games. However, they find a positive and significant effect of playing the second leg at home (55% vs. 45%). But they do not consider randomly assigned games only and thus their results do not allow for a causal interpretation.

The theoretical part of the paper relates to the seminal paper by Lazear and Rosen (1981), in which tournaments provide incentives to work hard. In contrast to Lazear and Rosen (1981), however, we analyze the repeated interaction of players with different abilities and temporary advantages. Also, the probability of winning is given by a cumulative distribution of two stage-specific independent random variables. This functional form allows us to explicitly solve for equilibrium effort choices on each stage.[11] Our model also relates to the literature on multi-battle contests.[12] In a symmetric all-pay auction without noise, Konrad and Kovenock (2009) analyze multi-stage games in which players compete in a sequence of component contests. They find that under certain conditions without intermediate prizes the player lagging behind may be discouraged to exert effort. In contrast to their setting, we consider a model with randomness in which the players' utility only depends on the final outcome of the winner-take-all tournament. The randomness in the final outcome is introduced by the sum of stage-specific idiosyncratic shocks.

The remainder of the paper is organized as follows. In Section 2, we set-up a simple two-stage tournament model. Section 3 describes the natural experiment we are dealing with. Section 4 describes the dataset. In Section 5, we present our results on the absence of OE in dynamic tournaments and a series of robustness checks. Section 6 concludes.

2 A simple model

We set-up a generalized model and a specification. We prove the absence of OE in the generalized model. We then use the specification to do comparative statistics.

We consider a winner-take-all contest between two risk neutral players, denoted by sub-

[11] Romano and Yildirim (2005) also study two-period accumulation games. However, by applying a Tullock (1980) contest success function they analyze aggregate equilibrium effort choices and do not explicitly derive the equilibrium effort choices in each stage. See also Gradstein and Konrad (1999) for an excellent analysis of contests in the context of rent-seeking.

[12] See Konrad (2009) for an excellent overview of the literature on dynamic contests.

scripts i and j, that consists of two subsequent rounds, or component contests, denoted by subscripts $t = 1, 2$. The outcome of interest is binary: the player does or does not win the overall contest prize W. Players choose non-negative continuous efforts x_{it} and x_{jt} simultaneously in each of the two rounds. They observe effort choices of the first stage before they make their choices in the second stage. Players differ in two observable dimensions: ability and temporary cost advantage. First, let the non-negative γ_i and γ_j denote the ability of the respective player. For $\gamma_j > \gamma_i$, one may refer to Player j as the favorite and his opponent as the "underdog".[13] Second, let θ_i, with $\theta_i \geq 1$, and θ_j, with $\theta_j \geq 1$, denote the temporary cost advantage of the respective player. Without loss of generality, we assume that Player i (j) has the advantage in the first (second) round.[14]

2.1 Generalized model

Suppose that effort costs are increasing and convex in effort, $c(x_{kt})$ with $c'(x_{kt}) > 0$, $c''(x_{kt}) > 0$, and $c(0) = 0$, for Player $k = i, j$ at time $t = 1, 2$. Consider a symmetric distribution around zero, where $G\left(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}\right)$ is the cumulative distribution of the sum of the independent stage-specific random variables, $\epsilon \equiv \epsilon_1 + \epsilon_2$, which represent a player's luck relative to his opponent. The probability of winning depends on the difference between the sum of ability-adjusted effort choices between the two players. The utility functions can be written as:

$$U_i(x_{it}, x_{jt}) = \left[1 - G\left(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}\right)\right] W - \frac{1}{\theta_i} c(x_{i1}) - c(x_{i2}), \quad (1)$$

$$U_j(x_{it}, x_{jt}) = G\left(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}\right) W - c(x_{j1}) - \frac{1}{\theta_j} c(x_{j2}). \quad (2)$$

As players don't have intertemporal utilities, but only winning the round matters we can

[13] See Dixit (1987).

[14] In Proposition 1, we will relax this assumption.

state the First Order Conditions for the first and second stage, respectively:

$$\frac{\partial G(\cdot)}{\partial x_{i1}} = \frac{1}{\theta_i}\frac{\partial c(x_{i1})}{\partial x_{i1}}, \quad \frac{\partial G(\cdot)}{\partial x_{j1}} = \frac{\partial c(x_{j1})}{\partial x_{j1}}, \tag{3}$$

$$\frac{\partial G(\cdot)}{\partial x_{i2}} = \frac{\partial c(x_{i2})}{\partial x_{i2}}, \quad \frac{\partial G(\cdot)}{\partial x_{j2}} = \frac{1}{\theta_j}\frac{\partial c(x_{j2})}{\partial x_{j2}}. \tag{4}$$

As only the sum of efforts matters at optimum, the intertemporal marginal benefit of exerting more effort must be equal to the marginal cost of exerting more effort in each period.

Thus we obtain that if we can shift effort through time, e.g. there is no intertemporal utility, then the intertemporal marginal benefit and cost at the optimal effort level must be such that:

$$\theta_i\frac{\partial G(\cdot)}{\partial x_{i1}^*} = \frac{\partial c(x_{i1}^*)}{\partial x_{i1}^*} = \frac{\partial G(\cdot)}{\partial x_{i2}^*} = \frac{\partial c(x_{i2}^*)}{\partial x_{i2}^*}, \tag{5}$$

$$\frac{\partial G(\cdot)}{\partial x_{j1}^*} = \frac{\partial c\left(x_{j1}^*\right)}{\partial x_{j1}^*} = \theta_j\frac{\partial G(\cdot)}{\partial x_{j2}^*} = \frac{\partial c\left(x_{j2}^*\right)}{\partial x_{j2}^*}. \tag{6}$$

Proposition 1 (Absence of Order-Effects) *Whether a player has the temporary advantage in the first or second round does not have ceteris paribus any impact on his probability of winning the contest.*

Proof. The proof is straightforward as by shifting the temporary advantage stage-specific effort levels adjust but the cumulative efforts remain constant. ■

It is immediate to see that there are no OE, as rational players anticipate that they will have an advantage either in the first or second stage.[15] Also, players are not "discouraged" by a bad performance in the period where they don't have an advantage. In contrast to the discouragement effect brought forward by Konrad and Kovenock (2009) where,

[15] We assume that there is an internal solution where players exert effort in both periods. The result also holds for corner solutions with sufficiently high advantages so that players only exert effort in the stage of advantage.

once one player is lagging behind, his marginal cost of effort increases, we have rational expectations over the allocation of the temporary advantage. For players with equal abilities and advantages, a lead in effort of the player with the advantage in the first stage will at optimum be compensated by the advantage-driven second-stage effort of the opponent.[16] Thus they have the same probability of winning as $G(0) = 1 - G(0) = \frac{1}{2}$.

Proposition 2 (Rent-Dissipation) *For $\gamma_i = \gamma_j = \gamma$ and $\theta_i = \theta_j = \theta$, a sufficiently high prize $(\widehat{W})$ may induce both players not to participate in the tournament.*

Proof. For $\gamma_i = \gamma_j = \gamma$ and $\theta_i = \theta_j = \theta = 1$, both players obtain the same expected utility, $U_j = U_i = W \cdot G(0) - c(W)$. Thus we obtain that while the marginal benefit of an increase in W is constant and equals $\frac{1}{2}$ the cost function is increasing and convex in W; $c'(W) > 0$ and $c''(W) > 0$. It follows that there exists a sufficiently high prize $(\widehat{W})$ such that players don't participate in the tournament because $\widehat{W} \cdot G(0) < c(\widehat{W})$. ■

Contrary to intuition, a sufficiently high prize may induce players not to participate in the tournament. This result points to a war of attrition in dynamic tournament competitions, in which players and temporary advantages are symmetric. In this case, a high prize and high temporary advantages may induce players to exert an inefficiently high effort that drives expected utility towards zero. This result is due to the failure of coordination of competing players. Both would be better off exerting less effort, optimally zero effort, and win with probability $\frac{1}{2}$ but, as we consider a non-cooperative game, they exert very high effort levels dissipating the rental value of the tournament.[17]

[16] In Appendix 1, we show that order-effects are also absent in a different accumulation game set-up with symmetric advantages in which we follow Romano and Yildirim (2005) by applying a Tullock (1980) contest success function.

[17] For instance, Posner (1975) postulates that total expenditures of rent-seekers in equilibrium equal the value of the prize. Furthermore, Baye et al. (1999) analyze overdissipation in rent-seeking contests.

2.2 Model specification

We now solve the model explicitly for special cost functions and a triangular distribution of random shocks. Effort costs are increasing and convex in effort and now given by $c(x_{i1}) = \frac{1}{2\theta_i}(x_{i1})^2$ and $c(x_{i2}) = \frac{1}{2}(x_{i2})^2$ for Player i, and $c(x_{j1}) = \frac{1}{2}(x_{j1})^2$ and $c(x_{j2}) = \frac{1}{2\theta_j}(x_{j2})^2$ for Player j, respectively. The structure of the game is as follows. Player j wins the component contest at the first [second] stage with probability $P_{j1}(\gamma_j x_{j1} - \gamma_i x_{i1} > \epsilon_1)$ $[P_{j2}(\gamma_j x_{j2} - \gamma_i x_{i2} > \epsilon_2)]$, where $\epsilon_t \sim U\left[-\frac{\epsilon}{2}, \frac{\epsilon}{2}\right]$ for $t = 1, 2$. By summing up the differences in effort and luck terms of the two stages, we obtain that Player j wins the whole contest with $P(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2} > \epsilon_1 + \epsilon_2)$. Players receive their payoffs at the end of the second round. Utility is intertemporally independent and given by:

$$U_i(x_{it}, x_{jt}) = \left[1 - G\left(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}\right)\right] W - \frac{1}{2\theta_i}(x_{i1})^2 - \frac{1}{2}(x_{i2})^2, \quad (7)$$

$$U_j(x_{it}, x_{jt}) = G\left(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}\right) W - \frac{1}{2}(x_{j1})^2 - \frac{1}{2\theta_j}(x_{j2})^2. \quad (8)$$

$G(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2}) = P(\gamma_j x_{j1} - \gamma_i x_{i1} + \gamma_j x_{j2} - \gamma_i x_{i2} > \epsilon_1 + \epsilon_2)$, where $G(\cdot)$ is the cumulative distribution of two independent random variables, $\Phi \equiv \epsilon_1 + \epsilon_2$. $\Phi \sim$ $Triangular\,[-\varepsilon, \varepsilon]$.[18] Player i wins with probability $1 - P(\cdot)$. The density function is given by:

$$f(x) = \left\{ \begin{array}{ll} \frac{1}{\varepsilon} + \frac{x}{\varepsilon^2} & -\varepsilon \leq x \leq 0 \\ \frac{1}{\varepsilon} - \frac{x}{\varepsilon^2} & 0 \leq x \leq \varepsilon \\ 0 & otherwise, \end{array} \right\}$$

and the corresponding cumulative distribution function

[18] See Kräkel (2007) on the triangular distribution.

$$F(x)=\left\{\begin{array}{ll} 0 & x\leq-\varepsilon \\ \frac{x}{\varepsilon}+\frac{1}{2}\frac{x^2}{\varepsilon^2}+\frac{1}{2} & -\varepsilon\leq x\leq 0 \\ \frac{x}{\varepsilon}-\frac{1}{2}\frac{x^2}{\varepsilon^2}+\frac{1}{2} & 0\leq x\leq\varepsilon \\ 1 & x\geq\varepsilon \end{array}\right\}$$

Following Gürtler (2011), we assume an upper bound on the prize, W, and that very high effort levels become unproductive in order to guarantee that players' objective functions are strictly concave and thus there is a pure strategy solution.

We solve the game by backward induction and obtain the following equilibrium effort levels:

$$x_{j1}^* = \frac{W\left(2\left(1+\theta_i\right)\gamma_i W-\varepsilon^2\right)}{\varepsilon\left(W\left(\gamma_j\left(1+\theta_j\right)+\gamma_i\left(1+\theta_i\right)\right)-\varepsilon^2\right)}, \quad x_{j2}^*=\theta_j\cdot x_{j1}^*, \quad X_j^*=\left(1+\theta_j\right)\cdot x_{j1}^* \tag{9}$$

$$x_{i1}^* = \theta_i\cdot x_{i2}^*, \quad x_{i2}^*=\frac{W\left(2\left(1+\theta_j\right)\gamma_j W-\varepsilon^2\right)}{\varepsilon\left(W\left(\gamma_j\left(1+\theta_j\right)+\gamma_i\left(1+\theta_i\right)\right)-\varepsilon^2\right)}, \quad X_i^*=\left(1+\theta_i\right)\cdot x_{i2}^* \tag{10}$$

Total equilibrium effort is given by X_j^* and X_i^*, respectively. As players are symmetric, we can do comparative statistics for Player j without loss of generality.

Stage 1	Stage 2	Total effort
$\frac{\partial x_{j1}^*}{\partial\theta_j}=\frac{-\frac{1}{\varepsilon}\gamma_j W^2\left(2(1+\theta_i)\gamma_i W-\varepsilon^2\right)}{\left(-\varepsilon^2+\gamma_i W+\gamma_j W+\theta_i\gamma_i W+\theta_j\gamma_j W\right)^2}<0$	$\frac{\partial x_{j2}^*}{\partial\theta_j}=\theta_j\cdot\frac{\partial x_{j1}^*}{\partial\theta_j}+x_{j1}^*>0$	$\frac{\partial X_j^*}{\partial\theta_j}=\left(1+\theta_j\right)\cdot\frac{\partial x_{j1}^*}{\partial\theta_j}+x_{j1}^*>0$
$\frac{\partial x_{j1}^*}{\partial\gamma_j}=\frac{-\frac{1}{\varepsilon}W^2(1+\theta_j)\left(2(1+\theta_i)\gamma_i+W-\varepsilon^2\right)}{\left(-\varepsilon^2+\gamma_i W+\gamma_j W+\theta_i\gamma_i W+\theta_j\gamma_j W\right)^2}<0$	$\frac{\partial x_{j2}^*}{\partial\gamma_j}=\theta_j\cdot\frac{\partial x_{j1}^*}{\partial\gamma_j}<0$	$\frac{\partial X_j^*}{\partial\gamma_j}=\left(1+\theta_j\right)\cdot\frac{\partial x_{j1}^*}{\partial\gamma_j}<0$
$\frac{\partial x_{j1}^*}{\partial\theta_i}=\frac{\frac{1}{\varepsilon}\gamma_i W^2\left(2(1+\theta_j)\gamma_j W-\varepsilon^2\right)}{\left(-\varepsilon^2+\gamma_i W+\gamma_j W+\theta_i\gamma_i W+\theta_j\gamma_j W\right)^2}>0$	$\frac{\partial x_{j2}^*}{\partial\theta_i}=\theta_j\cdot\frac{\partial x_{j1}^*}{\partial\theta_i}>0$	$\frac{\partial X_j^*}{\partial\theta_i}=\left(1+\theta_j\right)\cdot\frac{\partial x_{j1}^*}{\partial\theta_i}>0$
$\frac{\partial x_{j1}^*}{\partial\gamma_i}=\frac{\frac{1}{\varepsilon}W^2(1+\theta_i)\left(2(1+\theta_j)\gamma_j W-\varepsilon^2\right)}{\left(-\varepsilon^2+\gamma_i W+\gamma_j W+\theta_i\gamma_i W+\theta_j\gamma_j W\right)^2}>0$	$\frac{\partial x_{j2}^*}{\partial\gamma_i}=\theta_j\cdot\frac{\partial x_{j1}^*}{\partial\gamma_i}>0$	$\frac{\partial X_j^*}{\partial\gamma_i}=\left(1+\theta_j\right)\cdot\frac{\partial x_{j1}^*}{\partial\gamma_i}>0$

We have showed that the effort levels in the two periods are interrelated and equal to $x_{j2}^*=\theta_j\cdot x_{j1}^*$ for player j and $x_{i1}^*=\theta_i\cdot x_{i2}^*$ for player i. Thus the derivatives with respect to ability and opponent's advantage have the same sign in both periods as can be seen by comparing the results in column one and two.

The interesting part is the marginal effect of an increase in its own advantage on effort. In this case as can be seen in the first row there are two effects going in opposite directions. For player j, who has the advantage in the second period, $\frac{\partial x_{j1}^*}{\partial \theta_j} < 0$. He will shift effort efficiently through the periods so that the intertemporal marginal cost and benefit of effort are equalized. The intuition for this result is that as he knows that effort will be less costly in the second period he reduces his effort in the first one. In the second period the derivative is positive and thus he will exert more effort. The total effect is also positive, indicating that total effort is increasing in its own advantage.

A different result holds for ability. In this case total effort of Player k is decreasing in his ability, as the two are substitutes. In contrast to the temporary advantage, ability stays constant and thus does not cause a shift of efforts between stages. On the other hand when the opponent's ability increases Player k will exert more effort to compensate for the ability differential. Ceteris paribus a less able agent must exert more effort to keep the winning probability constant.

Finally we consider the role of risk in determining the optimal effort level. By now we have modelled risk as a stage specific and idiosyncratic random shock, which we referred to as luck. $\Phi \equiv \epsilon_1 + \epsilon_2$. In our analysis we treat Φ as an exogenous characteristic of the tournament. The players cannot influence the distribution of Φ by choosing more or less risk. Thus Φ will represent the natural level of variability in the tournaments' outcome. With natural level we mean that each tournament be it executive compensation or research grant has some intrinsic randomness. In some environments luck can play a great role in determining the outcome, and this will influence the players' optimal choice of effort. There are two extreme cases. For $\varepsilon \to 0$, the tournament converges to an all pay first price auction. For $\varepsilon \to \infty$, no effort will be spent by participants because effort is costly but wouldn't influence the winning probability. Variations of effort will have a higher impact the lower the variance of outcome.

Consider total effort for player j: $X_j^* = (1+\theta_j) \cdot x_{j1}^*$. This can be written explicitly as: $\frac{(1+\theta_j)W\left(2W\gamma_i(1+\theta_i)-\varepsilon^2\right)}{W\varepsilon\left(\gamma_j(1+\theta_j)+\gamma_i(1+\theta_i)\right)-\varepsilon^3}$. Now we can plot total effort as a function risk ε and for increasing values of W, and leave all other parameters equal to 1.

We can see that risk decreases the optimal effort choice. This negative effect can be compensated by higher prize levels. In the graph thicker lines indicate higher prizes pointing to the fact that risk and prize have opposite effects on total effort.

[Graph 1]

We next analyze the role of symmetric advantages on utility.

Proposition 3 (The Disadvantage of Symmetric Advantages) *(i) For* $\gamma_i = \gamma_j = \gamma$, $\varepsilon = 2$, *and* $\theta_i = \theta_j = \theta$ *an increasing symmetric advantage decreases the expected value of participation. (ii) For* $U_j\left(\theta, \overline{W}\right) = U_i\left(\theta, \overline{W}\right) > 0$, *where* $\overline{W}$ *is constant, there exist a* $\widehat{\theta} > \theta$ *such that* $U_j\left(\widehat{\theta}, \overline{W}\right) = U_i\left(\widehat{\theta}, \overline{W}\right) < 0$ *and thus the players do not participate in the tournament.*

Proof. (i) For $\gamma_i = \gamma_j = \gamma$ and $\theta_i = \theta_j = \theta$, both players obtain the same expected utility, $U_j = U_i = \frac{W}{2} - \frac{(1+\theta)W^2}{32}$. Straightforwardly, $\frac{\partial U_j}{\partial \theta} = \frac{\partial U_i}{\partial \theta} = -\frac{W^2}{32} < 0$.

(ii) Assume that $U_j = U_i = \frac{\overline{W}}{2} - \frac{(1+\theta)\overline{W}^2}{32} > 0$. As the expected utility is decreasing in θ, there is a $\widehat{\theta} > \theta$ such that $U_j\left(\widehat{\theta}, \overline{W}\right) = U_i\left(\widehat{\theta}, \overline{W}\right) < 0$. ■

As players and advantages are symmetric, the probability of winning is constant. An increase in total effort does not increase the probability of winning. In this case, players would be better off to agree not to use the advantage and choose zero effort. But due to a failure of coordination they try to exploit their temporary advantage which only leads to higher cost.

3 Natural experiment

We study a randomized natural experiment in which the order of interaction and thus treatment and control group are determined via explicit randomization. One team is drawn to play the first leg home, and the other to play the second leg home. In the natural experiment we consider professionals who know exactly the tournament's setting; the payoffs are very high and the process of allocating teams is random. This real-life situation guarantees internal validity.

In the final phase of the major European soccer tournaments such as the Champions League of the Union of European Football Associations (UEFA) or the UEFA Europa League[19], teams are randomly drawn to play against each other with a time interval of one to three weeks between the two legs. There is a fundamental difference between knock outs at the final rounds of the tournament, i.e. quarter-finals and semi-finals, and the games of the qualification for the main tournament. For instance, Section 8.07 of the Regulations of the UEFA Champions League 2008/09 prescribes that "(t)he ties are determined by means of a draw. The club drawn first plays the first leg of the tie at home".[20] On the other hand, with respect to the qualification phase Article 9 of the Regulations of the UEFA Champions League 2008/09 states that "(t)he UEFA administration seeds clubs for the qualifying phase, the play-offs and the group stage in the UEFA Champions League, in accordance with the club coefficient ranking established at the beginning of the season and with the principles set by the Club Competitions Committee." Thus teams are not randomly drawn to play in a given order, but better teams are allocated to play the second game at home. In the light of this fundamental difference, causal inference about the order can only be drawn from the final phases.

[19] UEFA Europa League replaced the UEFA Cup after season 2008/2009.

[20] Section 6.09 states: "The quarter-final pairings are determined by means of a draw. The quarter-finals are played under the cup (knock-out) system, on a home-and-away basis (two legs)." and Section 6.10 prescribes: "The semi-final pairings are determined by means of a draw."

There are four ways of passing the round which apply in the following order. First, the goal difference rule states that the team which scores the greater aggregate of goals in the two matches qualifies for the next round. Second, the away-goals rule if the two teams score the same number of goals over the two legs, the team which scores more away goals qualifies for the next rounds. Third, according to Article 8 of the Regulations of the UEFA Champions League 2008/09 states that: "if both teams score the same number of goals at home and away, two 15-minute periods of extra time are played at the end of the second leg", and fourth: "(i)f no goals are scored during extra time, kicks from the penalty mark (...) determine which club qualifies for the next stage." We will come back to the relevance of these rules in **Table 2** in the next section. Because of the random draw, the Average Treatment Effect (ATE) is defined as the difference between the two groups' mean winning probability. Formally, let y_1 (y_0) denote the winning probability of a team playing the second game at home (away) and w the allocation of home and away games. In this case, the average treatment effect is $ATE_1 = ATE_2 = E(y|w = 1) - E(y|w = 0)$ if w is statistically independent from y_1 and y_0.

4 Dataset

We have constructed a dataset with 2310 matches and thus 1155 knock out games. The data come from UEFA and IMPIRE, a professional provider of soccer data. A summary of the data can be found in

[**Table 1**]

The dataset consists of games played in the UEFA Champions League and UEFA Europa League from 1955 until 2009. 1680 observations are from the period of 2005-2009, 128 from 2000-2004, and 502 from 1955-1999. For each match we observe the date, the result, the location, the round, the tournament, and whether the team passed the round by goal difference, extra time, penalty kicks, or away goals rule.

In **Table 2** we summarize the relative importance of each UEFA regulation. The goal difference rule is by far the most important one. In the third column we summarize the winning probability of a single match from the perspective of the home team.

The data on home winning probabilities clearly shows that the place where the match is disputed has a great importance for the outcome. It is therefore in line with previous literature on the advantage of playing at home.

[**Table 2**]

5 On the absence of Order-Effects

We show that our theoretical prediction of the absence of OE and the effects of temporary advantages are consistent with the empirical evidence.

Proposition 4 (Absence of Order-Effects) *(i) The winning probability in dynamic tournament competitions is independent from the order of interaction. (ii) The absence of order-effects is independent from country-specific effects.*

As soccer knock-out rounds with an explicit randomization mechanism constitute a natural experiment, it is sufficient to restrict the dataset to the relevant matches and only consider the average winning probability of teams playing the second leg home, without further regressions. We analyze our dataset consisting of 2310 observations of games of Champions League and UEFA Europa League accordingly.

As can be seen from the first column in **Table 3**, there are significant differences in the three coefficients representing different rounds of the tournaments. While there are no

OE in the final rounds of a tournament,[21] the same is not true for the qualification round, where the mean winning probability of the second team is 59%. It is significantly different from 50% with a p-value of .0001. To test if the significance of OE is entirely driven by the qualification rounds, we tested mean equality between qualification and final rounds and reject the hypothesis with a p-value of .017.

[**Table 3**]

The overall mean without considering the qualification is 51.8%. Doing an F-test with the hypothesis H_0: 50%, we get a p-value of .38 so that we cannot reject the hypothesis of the mean to be 50%. This result suggests that Proposition 4(i) is correct: In this tournament context, there are no OE. On average, teams playing second home have a slight advantage, but this is not significantly different from no-advantage. So in this case, there is neither a first nor a second home advantage. In contrast to the alleged "first-kicker advantage" due to psychological pressure in penalty kicks, the two leg structure in soccer games is a neutral structure, as it doesn't give a team significant advantages over the opponent.

[**Table 4**]

In **Table 4** we use two model specifications, a probit and logit, to provide further evidence on the absence of OE in randomly assigned rounds and perform some robustness checks. The coefficient on Second Home, which is a dummy variable being 1 if the team plays the second game at home, is insignificant in both specifications, with a p-value of .59. If we consider the interaction between Second Home and Qualification, which is a dummy variable being 1 if the order is non-random, we see that it is positive and highly significant. In addition, as the interaction between Second Home and Champions League, which is a dummy variable being 1 if the game is a Champions League game, is insignificant. This

[21] Round of the last 16 in UEFA Cup and semifinal and quarter final in both Champions League and UEFA Cup.

shows that these results on OE hold for both competitions. As better teams play in the Champions League and monetary incentives as well as the number of spectators are higher we can state that the absence of OE is robust with respect to teams' abilities and incentives.

In **Table 5** we perform further robustness checks and control for possible heterogeneous and unobservable characteristics. For instance, it could be that some teams, due to regional reasons as weather differences or fan support, perform better or worse if they play the first or second game at home. This could happen if the population being studied is heterogeneous. This can be controlled for by dividing up the dataset in country-specific subsamples. We construct variables for each group of countries with similar geographic characteristics.[22] Then we perform a sample mean comparison test across country groups to test for OE. We consider only randomly assigned games where the teams of these country groups play either the first or the second game at home. Then we compare the conditional probability of winning and test if this is the same for the two groups (first/second home), that is if the difference in winning probability is different from zero. We find that although there are substantial differences across groups and the mean ATE of playing the second game at home varies from a minimum of -7% for Anglo-Saxon teams to a maximum of 11% for Central European teams, this effect is never significant for a specific country group. This points to the fact that also within heterogeneous groups there are no OE. A puzzling question remains to explain the variation of these effect across groups as reported in **Table 5**.

[**Table 5**]

[22] For the detailed list, see Appendix 2.

6 Conclusion

In this paper, we provide empirical evidence on order-effect in tournaments, which is whether the random order of a temporary advantage for a team or an individual has an impact on its probability of passing the round. In previous research, it has been argued that psychological effects as lagging behind, pessimistic focal point, or the relation between leading and confidence can turn an ex ante neutral decision (random assignment of the order of interaction) in an ex post biased outcome of the game. These findings cannot be generalized to other similar tournament structures with repeated interaction.

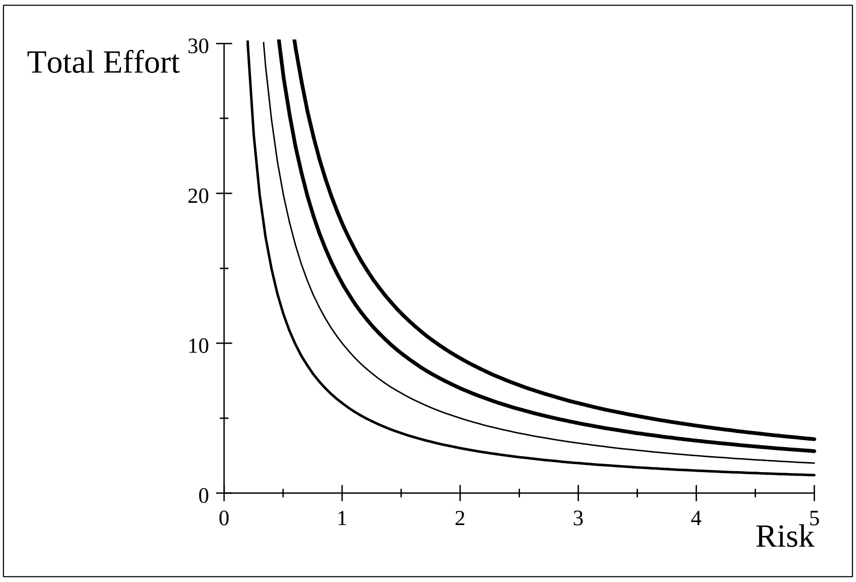
We set-up a winner-take-all model with two stages and two players where the probability of winning depends on the difference of cumulative effort and ability. We find that this probability is independent from the order in which the players have an advantage. Thus if there aren't unobservable psychological effects the winning probability is independent from the order of play. We then test this prediction in a natural experiment. In two-leg soccer knock out games teams are randomly drawn to play either the first or second game at home, and thus have an advantage either early in the game or later. We find that teams have statistically the same winning probability irrespective of whether they have an advantage in the first or second stage of the game. Using a large dataset with 1068 games and 534 knock outs we show that teams playing first (second) home win 48.2% (51.8%), not statistically different from 50% with a p-value of 38%. Thus empirical evidence confirms our theoretical prediction of the absence of order-effects. Rational players anticipate that they either have an advantage in the first or second period and, as players can shift effort through time and only the final outcome matters (win the tournament), their winning probability is unchanged.

This question is of great importance as tournaments are widely used for two main purposes: as a selection mechanism and to provide incentives to work hard. We focus on tournaments as selection mechanisms. If the structure of the multi-stage tournament systematically influences its outcome through psychological effects, then tournaments may not be an efficient selection mechanism when multiple repetition under different conditions is needed. Some players could benefit from an advantaged position and the winner may not be the best participant, but the luckiest one! We provide evidence that if there are psychological factors affecting the outcome through the tournament structure at all then they cannot be generalized for each multi-stage tournament. Further research is needed in a controlled environment, such as laboratory experiments, to analyze whether the differences between our natural experiment and Apesteguia and Palacios-Huerta (2010) can shed light on the factors affecting the winning probability.

7 Appendix

7.1 Appendix 1: Tables and Graphs

Graph 1: The effect of risk and prize on total effort



Note: Higher and thicker lines correspond to higher prize levels, W.

Table 1: Summary of data and time periods

Competition	Phase	Time Period			
		1955-1999	2000-2004	2005-2009	1955-2009
Champions League	Overall	502	128	510	1140
	Final Round	502	80	28	610
	Qualification	0	48	482	530
UEFA Cup	overall	0	0	1170	1170
	Final Round	0	0	456	456
	Round of last 16	0	0	80	80
	Qualification	0	0	634	634

Note: Final Round comprehends quarter- and semi-finals.

Table 2: Relevance of UEFA regulation and summary statistic on Home Advantage

UEFA Regulation	Observations	Frequency	Home Result	Observations	Frequency
Goal-difference	1942	.84	Home win	1181	.52
Penalty kicks	66	.03	Home draw	550	.23
Home/Away rule	236	.10	Home Lost	579	.25
Supplementary time	66	.03			

Note: There are several ways of passing the round as discussed in Section 3. This Table summarizes the relative importance of each of them. The "goal-difference" regulation is the most important one. For a detailed description of the regulation see UEFA.com. "Home Result" is defined as the result from the perspective of the Home team, irrespective of whether it is the first or second game of the knock-out. One observation is a single game and thus two observations constitute a knock-out round.

Table 3: Absence of Order-Effects

	Type of Round	T-test H_0:	p-values
Random Rounds			
Mean win. prob.	.518	>.5	.19
Confidence interval (95%)	.47 / .56	<.5	.8
Observations	534	=.5	.38
Non-random Rounds			
Mean win. prob.	.591	>.5	.0
Confidence Interval (95%)	.55/.63	<.5	1.0
Observations	582	=.5	.0
Mean Difference			
Mean win. prob.	.073	>0	0
Confidence Interval (95%)	.01/.13	<0	.99
Observations	1116	=0	.01

Note: Probabilities are computed for the team playing the second game at Home for the random and non random observations. Mean difference of population is computed as the subtraction of “Mean winning probability of non-randomly assigned games” and “Mean winning probability of randomly assigned games”, which is .591-.518=.073. One observation is a knock-out round consisting of two games.

Regression Table 4: The Absence of Order Effects

	Winning the Round	Winning the Round
Second Home	.034	.055
	(.59)	(.59)
(SecondHome)*(ChampionsLeague)	.037	.059
	(.61)	(.61)
(SecondHome)*(Qualification)	.178*	.285*
	(.015)	(.016)
Constant	dropped	dropped
Observations	1116	1116
Model specification	probit	logit

Note: Probit and Logit regressions in second and third column respectively; p-values in parenthesis, *significant at 5% level. One observation is a knock-out round consisting of two games. Interaction terms are denoted by "(VarName1)*(VarName2)".

Table 5: Heterogeneous effects; Winning probabilities for different sets of countries against whole set when playing first/second game at home

	South European	East European	Anglo-Saxon	Scandi-navian	Southeast European	Central European
Winning probability, SH	.65	.37	.53	.29	.48	.57
Standard error.	.05	.06	.07	.12	.12	.05
Observations	230	188	144	62	52	238
Winning probability, FH	.69	.31	.6	.24	.42	.46
Standard error.	.06	.05	.07	.08	.1	.05
Observations	206	178	134	52	62	254
H_0 :	p-values of t-tests testing heterogeneous effects among different subgroups of the population					
Difference in probability	-.04	.06	-.07	.05	.06	.11
$\triangle$p=0	.62	.48	.50	.63	.67	.13
$\triangle$p>0	.68	.24	.74	.31	.33	.06
$\triangle$p<0	.31	.75	.25	.68	.66	.93

Note: FH and SH refer to first game at home and second game at home respectively. "Difference in probability" is defined as the subtraction between the average winning probability when playing the second game at home and the first game at home. Probabilities computed from the perspective of the group listed in the first row. Only randomly assigned games with more than 50 observations were considered.

7.2 Appendix 2: Tullock Contest Success Function

We adopt the accumulation game set-up originally formulated by Romano and Yildirim (2005) in order to analyze the following contest. The (winner-take-all) contest for the prize W between two players $k = i, j$ consists of two subsequent rounds or component contests, $t = 1, 2$. Players choose non-negative continuous efforts x_{kt} simultaneously in each of the two rounds. Before players make their choices in the second round they observe first-round choices. Cost are given by $c(x_{kt}) = x_{kt}$. Let $X_k \equiv x_{k1} + x_{k2}$ denote the cumulative value of Player k's effort. Player k receives his payoff at the end of the second round. The probability of success (Tullock (1980) contest success function) depends on the cumulative effort contribution and the abilities of players:

$$p_j(X_j, X_i) = \frac{\gamma X_j}{\gamma X_j + X_i} \text{ and } p_i(X_j, X_i) = \frac{X_i}{\gamma X_j + X_i},$$

if $X_j > 0$ or $X_i > 0$, and $p_j(0,0) = p_i(0,0) = \frac{1}{2}$. Let γ measure the heterogeneity of players in terms of ability. Players differ in their abilities according to whether $\gamma \gtreqless 1$, with $\gamma \in [0, \infty)$. The utility function of Player j, exerting total effort X_j, when Player i exerts total effort X_i is given by:

$$\begin{aligned} U_j(X_j, X_i) &= p_j \cdot W - \frac{1}{2}\frac{1}{\theta}x_{jt} - \frac{1}{2}x_{jt} - \frac{1}{2}x_{j,-t} - \frac{1}{2}\frac{1}{\theta}x_{j,-t} \\ &= \left(\frac{\gamma X_j}{\gamma X_j + X_i}\right) \cdot W - \frac{1+\theta}{2\theta} \cdot X_j. \end{aligned}$$

Let $\frac{1}{\theta}$, with $\theta > 1$, denote the symmetric temporary advantage. The stage in which a player has this advantage is determined via explicit randomization. For Player i, we have:

$$U_i(X_j, X_i) = \left(\frac{X_i}{\gamma X_j + X_i}\right) \cdot W - \frac{1+\theta}{2\theta} \cdot X_i.$$

Following Romano and Yildirim (2005), we employ the standard one-period reaction functions for the total efforts (X_j, X_i), as given by

$$X_j\left(X_i\right) = \sqrt{\frac{2\theta W}{\gamma\left(1+\theta\right)} \cdot X_i} - \frac{1}{\gamma} \cdot X_i \text{ and } X_i\left(X_j\right) = \sqrt{\frac{2\gamma\theta W}{1+\theta} \cdot X_j} - \gamma X_j,$$

assuming that $X_i \leq \frac{2\gamma\theta W}{1+\theta}$ and $X_j \leq \frac{1}{\gamma}\frac{2\theta W}{1+\theta}$. We obtain the following total effort choices in the Cournot-Nash outcome (denoted by superscript c):

$$X^c = X_j^c = X_i^c = \frac{2\gamma\theta W}{\left(1+\theta\right)\left(1+\gamma\right)^2}.$$

In the Cournot-Nash equilibrium with symmetric cost advantage players choose the same total effort.[23] The probabilities of winning the contest are thus given by

$$\begin{aligned} p_j &= \frac{\gamma X^c}{\gamma X^c + X^c} = \frac{\gamma}{1+\gamma}, \text{ with } \frac{\partial p_j}{\partial \gamma} = \frac{1}{\left(1+\gamma\right)^2} > 0, \\ p_i &= \frac{1}{1+\gamma}, \text{ with } \frac{\partial p_i}{\partial \gamma} = -\frac{1}{\left(1+\gamma\right)^2} < 0. \end{aligned}$$

In equilibrium, the probability of winning only depends on the heterogeneity of players in terms of ability. It is straightforward to see that players of equal abilities, $\gamma = 1$, have the same probability of winning, $p_j = p_i = \frac{1}{2}$, in the Cournot-Nash equilibrium. Also, whether a player has the temporary advantage in the first or second round does not have ceteris paribus any impact on his probability of winning the contest, seeing as $X_j^c = X_i^c = X^c$. This result suggests that order-effects are absent in a Romano and Yildirim (2005)-accumulation game set-up with a Tullock (1980) contest success function.

[23] Note that $X_i^c \leq \frac{2\gamma\theta W}{1+\theta}$ and $X_j^c \leq \frac{1}{\gamma}\frac{2\theta W}{1+\theta}$ hold.

7.3 Appendix 3

Summary of country groups

Group Name	Countries	Observations
South European Countries (SEC)	Italy, Portugal, Spain	436
East European Countries (EEC)	Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine	366
Anglo-Saxon Countries (AC)	England, Ireland, Northern Ireland, Scotland, Wales	278
Central European Countries (CEC)	Austria, Belgium, France, Germany, Netherlands, Switzerland	492
Southeast European Countries (SEC)	Greece, Israel, Turkey	114
Scandinavian Countries (SCC)	Denmark, Finland, Iceland, Sweden, Norway	114

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