New Insights into Tournament Theory: Effort, Sabotage, Risk-Taking, and Heterogeneity

Empirical Analysis of Sporting Contests

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Vorwort

Die vorliegende Dissertation ist während meiner Tätigkeit als wissenschaftliche Mitarbeiterin in der Abteilung Sportwissenschaft der Universität Bielefeld entstanden – zunächst im Rahmen des Forschungsprojektes „Der Trainer als Determinante für den sportlichen Erfolg: Eine ökonomische Analyse“ unter der Leitung von Prof. Dr. Gerd Mühlheußer und Prof. Dr. Dirk Sliwka und anschließend als Lehrstuhlmitarbeiterin von Prof. Dr. Christian Deutscher. Ich hatte entsprechend das Glück, dass gleich zwei „Doktorväter“ (Prof. Dr. Gerd Mühlheußer und Prof. Dr. Christian Deutscher) meine Promotion begleitet und mich in meinem Vorhaben unterstützt haben. Ein ganz herzlicher Dank gilt beiden Professoren für die stets bereichernde und kollegiale Betreuung und Zusammenarbeit!

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Paderborn, April 2017

Contents

List of Figures

List of Tables

List of Abbreviations

Adj. R2	Adjusted R-squared
Avg.	Average
CBA	Collective Bargaining Agreement
CEO	Chief Executive Officer
CL	Champions League
Coeff	Coefficient
Condition F	Footprint condition
Condition MT	Mover-team condition
DEL	Deutsche Eishockey Liga, German Hockey League
DF	Defender
DFB	Deutscher Fußball Bund, German Football Association
ESPN	Entertainment and Sports Programming Network
F	Forward
FC	Fußball Club, Football/Soccer Club
FE	Fixed effects
G	Goalkeeper
IIHF	International Ice Hockey Federation
km	Kilometer
Man.	Manager
Max	Maximum
MF	Midfielder
Min	Minimum

Mov.	Mover
N	Number of observations
NBA	National Basketball Association
NBC	National Broadcasting Company
NIE	New institutional economics
NHL	National Hockey League
NHLPA	National Hockey League Player's Association
NMov.	Non-mover
Obs.	Observations
OLS	Ordinary least squares
PAT	Principal-Agent Theory
QMJHL	Quebec Major Junior Hockey League
R.	Rank
R2	R-squared
SD	Standard Deviation
SM-liiga	Suomenmestaruus Liiga, Finish Hockey League
Std. Dev.	Standard Deviation
SUR	Seemingly unrelated regression
T.	Teams
TNT	Turner Network Television
UEFA	Union of European Football Associations
US	United States

1 Introduction

"Incentives are the essence of economics." (Prendergast, 1999, p. 7)

While this assumption nowadays is widely accepted, economics have ignored incentives and internal arrangements within organizations for a long time. Economists only interests lie in the market, supply and demand, prices and outcomes. A firm itself was treated as a black box. It was not until Ronald Coase's article "The Nature of the Firm" (1937) that economists have recognized that institutions[1] and the inside of a firm also are of economic importance. A new perspective, the new institutional economics (NIE)[2], has broadened the scope of economics on institutions since then. It focuses on manifold aspects that are excluded from neoclassical economics, e.g. transaction costs, property rights, and incentives. In contrast to neoclassical economics, NIE assumes that individuals have "incomplete information and limited mental capacity and because of this they face uncertainty about unforeseen events and outcomes and incur transaction costs to acquire information. To reduce risk and transaction costs humans create institutions" (Ménard and Shirley, 2008, p. 1). The absence of perfect information is the starting point for the importance of incentives.

Incentives are essential in order to solve the "principal-agent problem". Principal-Agent (PAT) or Agency Theory is part of NIE and discusses potential conflicts that exist in the relationship between two economic actors: principal and agent. The division of labor implies the necessity for delegation: Principals delegate authority to agents to act on their behalf. "Whenever one individual depends on the action of another, an

[1] "Institutions are the written and unwritten rules, norms and constraints that humans devise to reduce uncertainty and control their environment" (Ménard and Shirley, 2008, p. 1).

[2] "The new institutional economics [...] is an interdisciplinary enterprise combining economics, law, organization theory, political science, sociology and anthropology to understand the institutions of social, political and commercial life" (Klein, 2000, p. 456).

agency relationship arises. The individual taking the action is called the agent. The affected party is the principal" (Pratt and Zeckhauser, 1985, p. 2). The central problem in this agency relationship is that agents might not serve the principal's interests. This problem is mostly due to two factors: incomplete or asymmetric information and conflicting objectives. Principal's and agent's interests typically are not consistent with one another.[3] In a world without private information such conflicting objectives would not cause incentive problems as a principal could induce agents to operate in the firm's interest by offering "a contract which perfectly controls the agent" (Laffont and Martimort, 2002, p. 2). However, NIE starts out from imperfect information, i.e. the principal is not able to monitor or evaluate agent's action perfectly. In this case agents have options open to pursue private goals. As both principal and agent seek to maximize their own utility, agents will exploit their informational advantage at the expense of the principal (moral hazard). PAT considers incentives to be an essential instrument to reduce agent's self-serving behavior. It aims at proposing solutions to lessen moral hazard and "offers insights used in the construction of contracts to guide and influence principal-agent relations in the real world" (Arrow, 1985, p. 38).

An extensive literature has emerged that deals with different kinds of incentives and their effects on agents' behavior, both theoretically, experimentally, and empirically. Most of the considered incentives refer to compensation contracts. There is a multitude of different compensation schemes, such as piece rates, discretionary bonuses, promotions, efficiency wages, profit sharing, etc., that can be used to align a principal's and an agent's interests (Prendergast, 1999). A body of work shows that relating pay to performance has indeed incentive effects.[4] A popular field of economic research on incentive effects of compensation schemes refers to rank order tournaments. A rank order tournament represents a compensation structure in which individuals compete against each other for a given set of prizes.[5] In contrast to other payment systems, earnings do

[3]Consider, for example, a situation in which a firm's owner (principal) assigns a certain task to a worker (agent). While the owner is interested in maximizing the firm's (and hence the worker's) output, the worker typically aims at minimizing effort costs.

[4]See e.g. Fernie and Metcalf (1999); Gielen et al. (2010); Lazear (2000); Shearer (2004).

[5]Examples of such tournaments are promotions or sporting contests.

not depend on individual's absolute output but on their performance relative to other competitors. The prospect of winning the first prizes sets incentives to exert effort (Lazear and Rosen, 1981). Hence, prize levels and prize distribution are important factors influencing incentives. As it becomes less likely to win a contest when the number of participants is large, incentives (i.e. prizes) for winning a competition have to increase in the number of contestants (Prendergast, 1999). Numerous studies confirm that tournaments indeed induce contestants to expend effort[6] and that prizes are increasing with respect to the number of participants.[7] Only few studies find that performance is not affected by prize money.[8]

Theoretical considerations on rank order tournaments[9] largely stem from Lazear and Rosen's (1981) early findings that under certain conditions, rank order tournaments can be superior to other payment schemes. These conditions refer to monitoring costs, symmetric information, and risk-neutrality.[10] The authors argue that if the principal is able to monitor agent's effort in a reliable and cost-effective way, input-based wages will be optimal. "However, when monitoring is difficult, so that workers can alter their input with less than perfect detection, input-wage schemes invite shirking" (Lazear and Rosen, 1981, p. 842). If monitoring is difficult or costly, tournaments "can elicit effort to mitigate the moral hazard problem" (McLaughlin, 1988, p. 225).

To what extent tournaments are able to induce agents to exert effort also depends on contestants' ex-ante heterogeneity and information being available. When contestants are heterogeneous and information is asymmetric, i.e. contestants have knowledge on

[6] Ehrenberg and Bognanno (1990a,b) were the first to test with non-experimental data whether tournaments have incentive effects. Analyzing data from professional golf tournaments they find that prize level and prize distribution do indeed have incentive effects. The higher the prize level and differentials, the better is the performance. Furthermore, results indicate that a contestant's decision to enter a tournament is affected by the total prize money. Subsequent work mostly confirms Ehrenberg and Bognanno's results and the theoretical implication that higher prizes result in better performance (see e.g. Becker and Huselid (1992); Frick and Prinz (2007); Knoeber and Thurman (1994); Lynch (2005); Maloney and McCormick (2000)).

[7] See e.g. Eriksson (1999); Main et al. (1993); Conyon et al. (2001).

[8] Orszag (1994), for example, finds that performance is unrelated to prize money, while Lynch and Zax (2000) suggest that better performances in tournaments with larger prize spreads are not due to incentive but rather selection effects.

[9] "Tournament theory is a reduced form of an agency model" (Lambert et al., 1993, p. 439).

[10] Rosen (1986) extended the original theory to multistage elimination tournaments.

their own ability but no information on competitors' quality, tournaments are considered to be less efficient than piece rates (Lazear and Rosen, 1981; McLaughlin, 1988). In such contests, competitors are not sorted efficiently into their own leagues. Hence, firms consisting of high-quality workers are contaminated by low-quality ones (adverse selection). But even in the case of full information, heterogeneous tournaments fail to induce incentive effects. In a two-player tournament, low probability of winning likely results in the less capable contestant (underdog) reducing his effort to avoid effort costs. The more capable competitor (favorite) anticipates this reduction and decreases his effort as well. Accordingly, in asymmetric contests, incentive effects are weak (Knoeber and Thurman, 1994). Solutions to this incentive problem are handicapping systems or specific prize structures indexed by participant quality (McLaughlin, 1988). The theoretical prediction that ex-ante heterogeneity negatively affects performance has been tested in multiple ways. Most of the results are in line with theory.[11]

The problem of ex-ante heterogeneity mostly exists in static tournaments, i.e. agents decide one-time on their behavior. In dynamic tournaments, though, competitors are able to adjust their behavior over the course of a competition. Here, another trouble can arise that has similar effects to ex-ante heterogeneity: the availability of intermediate information. Intermediate information describes the knowledge contestants gain during the course of the competition about interim results and competitors' abilities. "The release of interim information creates endogenous asymmetries between contestants" (Ederer, 2010, p. 738). Information suggesting a victory has been secured can be an important determinant of effort exerted, because it determines negative incentives, similar to ex-ante heterogeneity (McLaughlin, 1988). Experimental and empirical evidence on intermediate information is mixed. While some experimental studies find that providing information does not influence agents' effort[12], other (both experimental and empirical) works show that contestants adjust behavior according to the release of information[13].

[11] Bach et al. (2009); Berger and Nieken (2016); Brown (2011); Bull et al. (1987); Frick et al. (2008); Sunde (2009).

[12] See e.g. Bull et al. (1987); Schotter and Weigelt (1992).

[13] See e.g. Gürtler and Harbring (2010); Ludwig and Lünser (2012); Azmat and Iriberri (2010); Casas-Arce and Martínez-Jerez (2009).

A further condition under which tournaments are more efficient than piece rates refers to the risk attitude of contestants. "Tournaments successfully elicit effort especially if the contestants are risk neutral" (McLaughlin, 1988, p. 247). If competitors are risk-averse, the optimal compensation scheme depends on the utility function and the variance of chance (Lazear and Rosen, 1981). "Contests may be preferred to individualistic reward schemes, especially when the risk associated with common environmental variables is large" (Nalebuff and Stiglitz, 1983, p. 23). To sum up, tournaments can induce agents to act in line with principals' interests. However, certain circumstances can reduce incentive effects of tournaments, e.g. heterogeneity, intermediate information or risk-aversion.

In general, tournaments aim at increasing the effort choice of agents. However, relative performance evaluation systems can also affect behavior in other - unintended - ways: incentives resulting from tournaments can lead to collusion, high risk-taking or sabotage (Chowdhury and Gürtler, 2015; Genakos and Pagliero, 2012; Harbring, 2006; Kräkel and Sliwka, 2004; Nieken, 2010). Both collusion, risk-taking and sabotage are associated with negative effects on effort or efficiency. "Whenever compensation by tournaments [...] are implemented, there is an incentive for the agents involved in the tournaments to collude in reducing their effort levels, thereby obtaining a simultaneous increase in the utilities of the colluding participants" (Dye, 1984, p. 148). If agents are able to make an arrangement prior to the contest (collusion), they will choose low efforts in order to minimize effort costs (Harbring, 2006).[14]

In case rewards depend only on the relative performance of participants, decreasing the performance of the opponent can serve as a substitute for providing effort in tournaments. That is, sabotage among competitors might occur. Sabotage denotes resources expended to reduce the winning probability of rivals and typically is associated with illegal, unfair, or immoral actions. Therefore, sabotage is often characterized as destructive; these costly actions by one worker to decrease the output of another (Lazear, 1989) have negative effects on overall welfare (Balafoutas et al., 2012). Competitors expect a positive net benefit of engaging in sabotage if its costs are lower than the amount of performance

[14]Harbring (2006) and Sutter and Strassmair (2009) confirm that in case communication between participants is possible effort slightly decreases in tournaments.

reduction by the opponent it induces. Empirical research indicates that the magnitude of sabotage activities indeed increases with prize spreads in tournaments.[15] Several studies also illustrate that sabotage depends on the homogeneity of contests: Results show that contestants are more prone to engage in sabotage when ability differences are small.[16]

Competitors' variance of performance is affected by their choice of risk, i.e. a higher risk strategy enlarges both the positive and negative tail of the performance distribution (Knoeber and Thurman, 1994). Risk-taking per se is not inevitably harmful. However, high risk strategies are associated with lower selection efficiency (Grund and Gürtler, 2005; Hvide and Kristiansen, 2003; Miller, 2008) and effort (Grund and Gürtler, 2005; Hvide, 2002; Nieken, 2010). If contestants increase their choice of risk, tournaments become more noisy so that the outcome of a competition might not be decided by contestants' effort but risk factors. Furthermore, marginal gains of effort decrease with increasing noise (Nieken, 2010). Therefore, high risk is typically associated with low effort. A main theoretical prediction is that less able agents typically opt for the risky strategy while more able agents avoid high-risk strategies (Bronars, 1987; Ederer, 2010; Grund et al., 2013; Hvide, 2002; Knoeber and Thurman, 1994; Kräkel and Sliwka, 2004). Similar effects are assumed for the release of information: Agents lagging behind are supposed to increase risk, while contestants leading a competition rather decrease risk. Several empirical studies confirm this assumption.[17]

In summary, tournament compensation can - under certain conditions - induce agents to elicit effort and hence, reduce moral hazard. Relative compensation systems might not only affect effort but other unintended behavior: collusion, sabotage and high risk-taking can follow from incentives set by tournaments. The assumptions made by tournament theory represent well-formulated and empirically or experimentally testable hypotheses. Hence, extensive literature on tournaments and their effects on contestants' behavior exist. Most of the empirical and experimental studies confirm theoretical beliefs. Howe-

[15] See e.g. Carpenter et al. (2010); Del Corral et al. (2010); Falk et al. (2008); Garicano and Palacios-Huerta (2014); Harbring and Irlenbusch (2011); Lazear (1989).

[16] See e.g. Berger and Nieken (2016); Frick et al. (2008); Nieken and Stegh (2010).

[17] See e.g. Brown et al. (1996); Chevalier and Ellison (1997); Genakos and Pagliero (2012); Grund and Gürtler (2005); Grund et al. (2013); Knoeber and Thurman (1994); Koski and Pontiff (1999).

ver, some research gaps still remain. The present dissertation provides new insights into some of these gaps. *First*, empirical studies on the impact of intermediate information on effort are rare at best (Casas-Arce and Martínez-Jerez, 2009; Genakos and Pagliero, 2012). Furthermore, existing work that focus on effort use rather performance than effort variables since effort is difficult to measure. In an attempt to close this gap, we present empirical analyses on effort in dynamic tournaments in chapter 2 which is a joint work with Christian Deutscher.[18] In order to analyse the impact of within-tournament information on effort, we use running data gathered from professional soccer players in the German Bundesliga and extensive within-game information. Detailed game-level statistics for each player's running distance and number of high-intensity runs and sprints provide proxies for effort. Using sports data offers several advantages: "There is no research setting other than sports where we know the name, face, and life history of every production worker and supervisor in the industry" (Kahn, 2000, p. 75). Manifold statistics on player's performance are publicly available and can be used to test incentive effects of tournaments. The results presented in chapter 2 indicate strong incentive effects of intermediate results.

Second, field evidence about sabotage is very scarce. As sabotage typically entails illegal, unfair, or unethical activities, agents engaging in it try to hide their activities (Balafoutas et al., 2012; Del Corral et al., 2010). In response to these difficulties, researchers use data from sports competitions, often in static settings. Empirical evidence about the impact of within-tournament dynamics on sabotage is sparse, and questions remain about the link between interim results and agents' sabotaging behavior. Therefore, further empirical evidence on the impact of interim results on sabotage activities of contestants is presented in chapter 3[19]. This study is again a joint work with Christian Deutscher. Using sports data, we analyze the effect of the goal difference at a certain time of the match on the number of penalized fouls conducted by a team, and to what

[18]The study presented in chapter 2 is based on the research article "Intermediate Information, Loss Aversion, and Effort: Empirical Evidence" by Sandra Schneemann and Christian Deutscher. The article has been published by "Economic Inquiry" (2017, volume 55, issue 4).

[19]Chapter 3 is based on the article "The Impact of Intermediate Information on Sabotage in Tournaments with Heterogeneous Contestants", published in "Managerial and Decision Economics" (2017, volume 38, number 2).

extent this effect depends on a team's status of being the favorite or underdog. Results suggest that intermediate results significantly affect sabotaging behavior of the teams and that favorites and underdogs differ in their chosen level of sabotage.

Third, while there is growing evidence on the overall impact of intermediate information on agents' risk-taking behavior, empirical findings offer little insights into the relationship between ex-ante and within-tournament asymmetry regarding risk-taking. Existing studies mainly focus on only one dimension of asymmetry: (ex-ante) heterogeneity relating to ability or asymmetry relating to interim results. Hence, it is not clear, whether favorites and underdogs react differently to the availability of intermediate information. Chapter 4[20] examines the relationship between intermediate information, risk-taking and heterogeneity in order to reduce this research gap. The study exploits data from high-stakes contests, namely the knockout rounds of the European soccer competition 'Champions League'. The empirical analysis focuses on the teams' coaches and uses within-game information on their substitution strategies to measure the risk of their strategy. Results show that interim results (measured by the goal difference at the time of the substitution) have a significant impact on the risk-taking behavior of coaches. Results also indicate that favorites and underdogs partly react differently to within-tournament information.

Fourth, based on Lazear and Rosen's tournament theory, Höffler and Sliwka (2003) develop a theoretical model that deals with within-team competition and a principal's selection choice under incomplete information about agents' abilities. It states that a managerial change can trigger incentives when the within-team competition can be reinvigorated. This is only the case when the composition of the team is rather homogeneous. So far, the theoretical model has not been tested empirically, yet. Chapter 5[21], a joint work with Gerd Mühlheusser and Dirk Sliwka, tests the assumptions made by Höffler and Sliwka (2003) using a large data set on the German Bundesliga. We find that teams

[20] The article "Risk-Taking Behavior of Heterogeneous Contestants and Its Consequences in Dynamic Tournaments", which is based on the study presented in chapter 4, has been submitted to the journal "The Scandinavian Journal of Economics" recently.

[21] Chapter 5 refers to the article "The Impact of Managerial Change on Performance: The Role of Team Heterogeneity", written by Gerd Mühlheusser, Dirk Sliwka and myself, published in "Economic Inquiry" (2016, volume 54, number 2).

who have replaced their coach significantly increase their performance - but only when the team is sufficiently homogeneous prior to the dismissal.

In addition to incentives economic research refers to another important factor for the performance of a firm: the contribution of managers. Recent empirical work suggests that individual managers at the top of a firm significantly affect a firm's performance.[22] The empirical study presented in chapter 6[23] , which is a joint work with Gerd Mühlheusser, Dirk Sliwka, and Niklas Wallmeier, adds to the growing literature by using data from professional soccer, namely the German Bundesliga. By estimating OLS regressions that include both team and manager fixed effects, we find that coaches have a significant effect on a teams' success and playing style, as prior results confirm. Hence, not only incentive structures are important determinants for the performance of firms or teams, but the person at the top of an organization.

The empirical analysis of incentives and the contribution of coaches all base on data from sporting contests. As explained before, sports data offer several advantages, especially concerning empirical research about incentive effects resulting from relative compensation systems. Manifold theoretical articles offer numerous testable implications on incentive effects of rank order tournaments but only few industrial sectors provide opportunities to test these predictions, "largely since reliable measures of relative performance are usually difficult to obtain [...]. In sports competitions, relative performance measures are typically all that matters and they are well defined" (Szymanski, 2003, p. 468). Performance of sports teams or individual athletes are closely monitored by media, fans and sports journalists. Detailed statistics on a team's and individual player's performance are (publicly) available. Hence, the sport sector is perfectly suitable for economic research on factors influencing performance.

Sports data are not only suitable for the investigation of internal questions such as incentive problems but also for questions relevant from a market perspective, for instance people's demand. The topic of demand for sport has become a very popular field of

[22]See e.g. Bertrand and Schoar (2003); Lazear et al. (2015); Graham et al. (2012).

[23]The chapter is based on the article "The Contribution of Managers to Organizational Success - Evidence from German Soccer" by Gerd Mühlheusser, Dirk Sliwka, Niklas Wallmeier and myself, published (online) in "Journal of Sports Economics".

economic research recently. Borland and MacDonald (2003) refer to two reasons for the growing literature on determinants of demand in sports: First, the demand for sport is characterized by certain peculiarities.

> "Where else, for example, would you find consumers (fans who attend matches) who then become part of a product that is bought by other consumers (fans who watch on TV)? Or a situation where consumers do not necessarily like the idea of unfettered competition between participants on the other side of the market?" (Borland and MacDonald, 2003, p. 478).

The decision to attend a sporting match is affected by various determinants. Usually demand mostly depends on economic factors such as the price and income. But in sports further - rather unusual - aspects are relevant, e.g. the presence of another supplier or the contest's uncertainty of outcome (Villar and Guerrero, 2009). Second, due to the rising economic importance of professional sports knowledge on factors influencing attendance becomes more and more important for manifold stakeholders, e.g. club managers or government (Borland and MacDonald, 2003, p. 478). Although there is a large body of work analyzing determinants of demand in sports, few studies exist that focus on the impact of "superstars" on attendance. In order to add to the empirical work on demand we - Christian Deutscher and myself - examine in chapter 7 to what extent the attendance of hockey matches in Germany and the Czech Republic is affected by the presence of international stars, namely players from the National Hockey League (NHL).[24] We find that the impact of stars significantly differs between the Czech and the German hockey league: While in the Czech Republic the assumption that superstars matter is supported, we find only a negligible impact for the German league.

In the following chapters, the empirical studies mentioned are presented. First, I present empirical work on the impact of intermediate information and heterogeneity on effort exerted by agents. After that, my focus shifts from effort to sabotage: Do agents adjust their sabotaging behavior to interim results and heterogeneity? Third, I examine the risk-taking behavior of agents and how this is affected by both ex-ante and within-tournament asymmetry. In the subsequent chapter I illustrate the effect of

[24]This chapter is a revised version of the research article "The effect of stars on attendance: NHL-players in the German and Czech hockey league" by Christian Deutscher and Sandra Schneemann, published in the book "Breaking the Ice: The Economics of Hockey" by Bernd Frick (2017).

within-team heterogeneity on a team's performance after a managerial change. Then empirical research on the contribution of coaches on a team's success is pointed out. The final empirical analysis of this dissertation refers to the impact of stars on attendance. Eventually, my dissertation concludes with a short summary and an outlook for future research.

2 Intermediate Information, Loss Aversion and Effort: Empirical Evidence from German Soccer

Lazear and Rosen (1981) argue that under certain conditions relative compensation systems provide optimal incentives in order to induce agents to elicit effort. However, disparities in ability or the availability of intermediate information about contestants' performance or relative rankings might reduce these incentive effects (McLaughlin, 1988). In asymmetric contests the less able agent (underdog) is likely to decrease its effort in order to avoid effort costs as he knows that the probability of losing the competition is very high. The more capable competitor (favorite) anticipates this reduction and decreases its effort as well. Accordingly, asymmetric contests are associated with weak incentive effects (see Introduction).

The following sections of the chapter refer to the published article:

Schneemann, S. and Deutscher, C. (2017). Intermediate information, loss aversion, and effort: Empirical evidence. *Economic Inquiry*, 55(4):1759–1770. doi:10.1111/ecin.12420

3 The Impact of Intermediate Information on Sabotage in Tournaments with Heterogeneous Contestants

Many daily activities are characterized by relative performance evaluations that reward the better or best performer with the largest prize. In various contests, two or more individuals or teams compete for a sports championship, job promotion, or sales bonuses. Extensive research into tournaments and their effects on contestants' performance thus has emerged in recent decades, mostly based on theoretical work by Lazear and Rosen (1981), who describe the fundamental incentive and selection effects induced by rank-order tournaments.

Theoretical models that analyze players' behavior in rank-order tournaments typically focus on the effort or investment decisions: The more input a player chooses relative to her or his opponents, the higher her or his probability of winning the contest (Knoeber and Thurman, 1994; Kräkel, 2008). Yet tournaments might do more than induce agents to exert effort; they also can lead to unintended (predominantly) negative effects such as sabotage (see Introduction).

The following sections of the chapter refer to the published article:

Deutscher, C. and Schneemann, S. (2017b). The impact of intermediate information on sabotage in tournaments with heterogeneous contestants. *Managerial and Decision Economics*, 38(2):222–237. doi: 10.1002/mde.2771

4 Risk-Taking Behavior of Heterogeneous Contestants and Its Consequences in Dynamic Tournaments

Rank order tournaments are used in order to induce agents to elicit effort. However, tournaments do not only impact the effort choices of agents but also further aspects of behavior such as sabotage (see chapter 3) or risk-taking (Chowdhury and Gürtler, 2015; Genakos and Pagliero, 2012; Kräkel and Sliwka, 2004; Nieken, 2010).

Sabotage is related to actions taken by one agent to reduce the output of the other agent(s) (Lazear, 1989; Chowdhury and Gürtler, 2015). Risk-taking behavior in turn affects competitors' variance of performance, i.e. a higher risk strategy enlarges both the positive and negative tail of performance distribution (Knoeber and Thurman, 1994). Both sabotage and risk-taking are assessed as negative. While sabotage results in reduced welfare (Balafoutas et al., 2012), risk-taking is associated with lower selection efficiency (Grund and Gürtler, 2005; Hvide and Kristiansen, 2003; Miller, 2008) and effort (Grund and Gürtler, 2005; Hvide, 2002; Nieken, 2010). Risk-taking per se is not inevitably harmful. However, if contestants increase their choices of risk, tournaments become more noisy so that the outcome of a competition might not be decided by contestants' effort but risk factors. Furthermore, marginal gains of effort decrease with increasing noise (Nieken, 2010). Therefore, high risk is typically associated with low effort. As it can be assumed that the organizer's payoff increases with selection efficiency and effort, principals benefit from low risk-taking behavior. Hence, insights into the relationship between different tournament characteristics and contestants' decisions on their risk-taking behavior are of great interest (Genakos and Pagliero, 2012; Grund and Gürtler, 2005).

A major part of risk-taking literature focuses on the relationship between asymme-

try and risk as it is assumed that an agent's decision on their risk strategy depends in particular on the asymmetry between the participating agents. Asymmetry can be classified into two dimensions: the ex-ante differences in ability and the availability of intermediate information on the current score of the tournament (Grund et al., 2013). With reference to ex-ante heterogeneity, a main theoretical prediction is that less able agents (underdogs) typically opt for the risky strategy while more able agents (favorites) avoid high-risk strategies (Bronars, 1987; Grund et al., 2013; Hvide, 2002; Knoeber and Thurman, 1994; Kräkel and Sliwka, 2004). As winning respectively losing a tournament solely depends on the relative performance of the contestants, it doesn't matter whether an agent loses by a little or a lot. Therefore, the less able agent might benefit from increasing the risk of his strategy even though this change in strategy also increases the probability of an even worse performance. The more able contestant on the other hand will avoid risky actions as these might derogate his or her advantageous starting position (Knoeber and Thurman, 1994; Kräkel and Sliwka, 2004).

Most of the literature that focuses on the impact of ex-ante heterogeneity refers to static tournaments, i.e. contestants decide one-time on their (risk-taking) behavior. In reality, though, tournaments often are dynamic in nature. In dynamic contests, competitors are able to adjust their behavior over the course of a tournament, e.g. to interim information. "The release of interim information creates endogenous asymmetries between contestants" (Ederer, 2010, p. 738). Hence, it is assumed that interim information affects behavior similary to ex-ante heterogeneity: Agents lagging behind ('within-tournament' underdogs) tend to increase risk, while leading contestants ('within-tournament' favorites) decrease risk.[25] Several empirical studies confirm this assumption. They show that trailing contestants tend to choose higher risk strategies than those in the lead (e.g. Chevalier and Ellison, 1997; Genakos and Pagliero, 2012; Grund and Gürtler, 2005; Grund et al., 2013).

While there is growing evidence on the overall impact of intermediate information on agents' risk-taking behavior, empirical findings offer little insights into the relationship

[25]Regarding the impact of interim information on effort see e.g. Aoyagi (2010); Ederer (2010); Gershkov and Perry (2009) or chapter 2, with reference to intermediate information and sabotage see e.g. Gürtler et al. (2013) or chapter 3.

between ex-ante and within-tournament asymmetry regarding risk-taking. Existing studies mainly focus on only one dimension of asymmetry: (ex-ante) heterogeneity relating to ability or asymmetry relating to interim results. Hence, it is not clear whether ex-ante favorites and underdogs react differently to the availability of intermediate information.[26]

Furthermore, empirical evidence on the impact of risk-taking on performance is still scarce. To some extent, this can be related to empirical issues; on the one hand it is difficult to distinguish between agents' risk-taking behavior and performance (Genakos and Pagliero, 2012), and on the other hand disentangling risk-taking from sabotage can be problematic (Grund et al., 2013). Previous results suggest that increasing risk does not pay off (Grund and Gürtler, 2005; Grund et al., 2013; Bartling et al., 2015).

In order to add further evidence on contestants' risk-taking behavior within contests, this study exploits data from high-stakes contests, namely the knockout rounds of the European soccer competition 'Champions League', organized by the Union of European Football Associations (UEFA). The empirical analysis at hand focuses on the teams' coaches and uses within-game information on their substitution strategies to measure the riskiness of their strategy. Depending on the tactical position of the outgoing and incoming player, a substitution is assessed as risk-increasing or -reducing. Using this measure, it can be estimated how the risk-taking behavior is affected by intermediate results, namely the particular score at the time of the substitution. Furthermore, data enable us to examine the impact of the chosen risk strategy on the outcome of the match.

The present study contributes to the existing literature in two ways: Firstly, it adds further evidence on the impact of interim results on competitors' risk-taking behavior in dynamic tournaments and how risk affects the outcome of a competition. Secondly, the study's results provide new insights into the relationship between risk, intermediate information and ex-ante heterogeneity.

Results confirm the theoretical prediction that trailing agents tend to choose higher risk strategies whereas the leading competitor chooses a safer strategy. This result holds when analyzing risk-taking behavior for underdogs and favorites separately. However,

[26]To the best of our knowledge, the study conducted by Grund et al. (2013) is the only one that explicitly dwells on risk-taking behavior of favorites and underdogs.

some differences between favorites and underdogs become apparent; while underdogs reduce risk by larger amounts than favorites when in the lead, favorites increase risk by larger amounts when behind with two or more goals. In contrast to intermediate information, ex-ante heterogeneity has no significant effect on risk. Concluding, results suggest that the outcome of a match is not affected by the level of the chosen risk.

This chapter is organized as follows: First, a literature review on existing empirical studies on risk-taking behavior in dynamic tournaments is given (section 4.1). The next section (4.2) offers information on the UEFA Champions League and the dataset used. Afterwards, hypotheses are formulated (section 4.3). Section 4.4 presents variables measuring risk, heterogeneity and intermediate information as well as descriptive statistics, while the following section (4.5) shows the empirical results. The paper concludes with section 4.6.

4.1 Literature Review: Empirical Evidence on Risk-Taking

Even though there is a growing literature on risk-taking behavior of contestants in dynamic tournaments, empirical evidence on that topic is scarce. Existing studies mostly refer to mutual fund managers or sporting contests. Relating to the behavior of mutual fund managers, it is shown that poorly performing funds tend to increase their portfolio risk at the end of a year to a greater degree than better performing funds, which confirms the main theoretical prediction about risk-taking (Brown et al., 1996; Chevalier and Ellison, 1997; Koski and Pontiff, 1999). However, Busse (2001) notes that such behavior depends on the sample structure: Comparing the results of monthly and daily fund returns shows that the tendency of poorly performing funds to increase their risk is apparent only in the monthly data. With daily data, this tendency disappears. Furthermore, Kempf et al. (2009) show that the risk-taking behavior also depends on the employment risk that a mutual fund manager experiences. If the probability of losing the job is low, relatively poorly performing managers tend to increase their risk, whereas risk is decreased when the employment risk is high.

Other empirical studies on that topic analyze the risk-taking behavior of contestants

in dynamic sporting contests. Genakos and Pagliero (2012), for example, study how contestants' behavior, i.e. risk-taking and performance, is affected by the availability of intermediate information on pariticipants' standings. Using manifold data from weightlifting contests they can show that trailing competitors tend to take greater risks than leading competitors. Genakos and Pagliero measure risk as the weight announced by a weightlifter prior to the next attempt. The higher the announcement the riskier the athlete's strategy. However, the positive relationship between rank and risk applies only to athletes in (interim) ranks one to six. After these ranks, weightlifters reduce the riskiness of their strategy with increasing rank. The authors explain this result with the intuition, that the probability to win the contest decreases with increasing deficit, i.e. weightlifters lagging (far) behind give up.

Grund et al. (2013) empirically explore how intermediate scores affect the risk-taking behavior of NBA teams. Using the fraction of three-point attempts as a measure of risk-taking, they find that the intermediate point difference has a significant effect on risk: The more a team is behind, the riskier is its behavior. They also analyze whether ex-ante favorites and underdogs adjust their risk strategy differently to intermediate information. Results reveal that favorites show riskier behavior than underdogs when they are behind. However, the consequences of an increase in risk-taking behavior are mostly negative. That is, increasing risk raises the winning probability only if the team is far behind and in certain time periods.

The study conducted by Mueller-Langer and Andreoli Versbach (2017) also relies on soccer data, namely data from the UEFA Champions League. They investigate whether risk strategies differ over the two stages of the knockout rounds.[27] They hypothesize that teams that are behind in score after the first match choose higher risk strategies in the second match. By comparing the distribution of results and goals of the first and second game, they find that the risk choices do not differentiate significantly between the two matches. However, results suggest that teams playing the second match at home choose higher risk strategies.

Grund and Gürtler (2005) also make use of data from professional soccer (German

[27] In each knockout round of the Champions League the teams have to compete twice against each other.

Bundesliga) but deviate from the methodology of the studies mentioned before. They change the perspective from teams or players to coaches. Grund and Gürtler refer risk to the coaches' substitution strategies. A substitution is assessed as risk-decreasing if a coach exchanges an offensive player (e.g. a forward) for a defensive player (e.g. a defender) and as risk-increasing the other way round. By investigating whether the goal difference at the time of a substitution affects the probability of a risk-increasing or risk-reducing substitution, these authors identify a significant and negative effect on the former but a significant and positive effect on the latter type of substitutions. That is, a negative score leads to riskier behavior, whereas a positive score prompts less risky strategies. They also examine whether the degree of risk-taking affects the score and point advancement of a team, between the time of the first substitution and the end of the match. Switching to a riskier strategy is worse than maintaining the initial strategy though, because increasing risk leads to lower score and point expectations.

Bartling et al. (2015) also use information on the substitution strategy of soccer coaches to operationalize agent's risk-taking behavior. They exploit data from the German Bundesliga and the English Premier League. Focus of their study is the effect of reference points respectively expectations on people's behavior. They analyze to what extent players' and coaches' behavior depend on whether their team is behind expectations or not. They refer players' behavior to the frequency of irregular activities, measured by the number of cards, and coaches' behavior to risk-taking, measured by their substitution strategy (similar to Grund and Gürtler, 2005). Expectations (win, draw or loss) are operationalized using betting odds. They find that coaches substitute significantly more often in an offensive way when their team is behind expectations, i.e. betting odds predict a win but the team is behind in score. Furthermore, results suggest that this behavior has a negative effect on match outcome.

So far, empirical results tend to confirm the theoretical prediction that agents react to within-tournament information revealing heterogeneity by adjusting their risk strategy. It is shown that trailing agents usually switch to riskier strategies, while leading agents tend to reduce risk. Overall, results suggest that risk has no effect or a negative effect on the outcome of a competition. Except for Grund et al. (2013), existing studies consider

only one dimension of asymmetry. In the following, we explicitly focus on both dimensions: ex-ante heterogeneity and within-tournament asymmetry relating to intermediate information.

4.2 The UEFA Champions League

The present dataset covers seven seasons of the UEFA Champions League (from 2009/10 to 2015/16). The UEFA Champions League (CL) is a European soccer club tournament organized by the Union of European Football Associations (UEFA). The competition is played parallel to the national championships and is the most prestigious and profitable contest in Europe.[28] Only the best teams of the national European leagues are allowed to participate in the CL.[29]

The tournament consists of 5 rounds: group stage, round of sixteen, quarterfinal, semifinal and final.[30] In the group stage, four teams play twice against each other (once at the home and once away). Each team gains three points for a win, one for a draw and zero for a loss. The two teams which accumulate most points qualify for the following knockout round.[31] The round of sixteen, the quarterfinal and semifinal consist of two matches against the same opponent.[32] Each team plays one match away and one at its home stadium. The aggregate score after the second leg decides which team advances

[28]Real Madrid, e.g., gained around 57 Mio Euro for winning the Champions League in 2013/14 (http://de.uefa.com/MultimediaFiles/Download/OfficialDocument/uefaorg/Finance/02/11/95/46/2119546_DOWNLOAD.pdf).

[29]The number of teams per league depends on the rank of the respective league in the 5-year-ranking of the UEFA, which depends on the results of the leagues' clubs in the five previous Champions and European League (another European club competition organized by the UEFA) seasons. The leagues or rather associations on ranks 1 to 3 (currently England, Germany and Spain) have 4 starting positions each (3 teams are qualified directly for the group stage + 1 team has to play a qualification round). The ones ranking 4 to 6 have 3 (2+1) and leagues ranking 7 to 12 have 2 (1+1) starting positions. Each of the other associated leagues have one starting position for the qualification.

[30]Prior to the group stage, some teams additionally have to play one to four qualification rounds.

[31]In case two teams have accumulated the same number of points, the results of the two matches in which these two teams competed against each other at the group stage decide on which team qualifies for the next round.

[32]In the round of sixteen, the winner of a group plays against the runner-up of another group. A group winner always plays the first game away and the second at home. The fixtures of the quarter and semi finals are drawn by lot. The first team to be drawn plays the first match at home and the second away.

to the next round. In case the aggregate score is tied, the team that scores more away goals proceeds to the next round. If both teams score the same number of away goals the teams play an extra time and, if necessary, execute a penalty shootout to decide on the overall winner. In contrast to the round of sixteen, quarterfinal and semifinal, the final round consists of a single match only. The venue of the final is determined two years in advance by the UEFA and therefore is neutral in the vast majority of cases.[33]

In the empirical analysis we focus only on those CL matches that are played in the knockout rounds, excluding finals. We exclude the final round of the Champions League because of its peculiarities compared to the other rounds (single match, neutral venue). As there might be matches at the group stage that are meaningless because one or both of the teams are already safely qualified for the next round or have dropped out of the competition, we decided to exclude all matches at the group stage. Using data from the knockout rounds of the Champions League offers one major advantage compared to league data: Each match represents a high-stake competition. While in the course of a season a league match can be of greater or lesser importance for a team, coach or player, each knockout match is of crucial importance for the advancement in the competition. In the course of a season strategies might differ from one match to the other (e.g. strong players could be spared because the opponent is assessed as very weak or more important matches are to come), but in the CL each match counts.

Overall, the dataset contains 196 Champions League matches: 112 last 16 matches, 56 quarterfinals, and 28 semifinals. The present dataset includes detailed within-game information on a minute-by-minute level. For each minute of the match, we know the exact score of the match, the position of each player on the field and, in case of a substitution, the positions of the incoming and outgoing players.

4.3 Hypotheses

In the UEFA Champions League knockout rounds two teams compete against each other for advancing to the next round. A team's success thereby depends crucially on the

[33]Since 1992/93, there was only one final with a participating team being the home team: FC Bayern Munich played (and lost) the final in 2011/12 against Inter Mailand in the Allianz Arena in Munich.

number of goals scored and conceded. As long as a team has scored more goals than the opponent, the team will advance to the next round. In case the score is even[34], an overtime has to be played, i.e. chances to win the round remain, but additional effort has to be exerted. In case a team concedes more goals than it scores it is eliminated from the contest. The probability of scoring and conceding a goal is thereby affected by the chosen risk strategy. The riskier the behavior the higher the probability of scoring and receiving a goal. We therefore expect the goal difference to have a significant effect on the risk-taking behavior of coaches.

In case a team is ahead, scoring another goal does not change the outcome of the match, while receiving one or more goals might lead to the elimination from the contest. Incentives for preventing the opponent from scoring a goal increase, especially when the team is ahead by only one goal. Hence, a coach should tend to reduce the risk strategy when in the lead, even though this also reduces the chances to score another goal. This behavior is expected be most pronounced if a team leads by one goal, because receiving a single goal would change the match outcome from 'winning' to 'overtime', thus teams respectively coaches have much to lose. Previous studies suggest that agents might weigh potential losses more than gains (loss aversion) (see chapter 2 or Brown, 2011; Genesove and Mayer, 2001). Therefore, we assume that the reduction in risk is greatest when the goal difference equals one.

In case a team is behind the argumentation is reverse; in order to prevent the team from losing the round it has to score at least one goal, while conceding another goal does not change the outcome. Hence, the coach should switch to a riskier strategy.

In case of an even score both scoring and conceding affect the outcome. While scoring a goal would result in winning the round, conceding a goal would lead to a team's elimination. Therefore, a coach should be more hesitant to adjust the risk strategy with respect to leading or trailing in a match. This argumentation leads to the following hypotheses:

[34]Please note that we have adjusted the goal differences in such a way that an even score always leads to an overtime to be played. Normally, a draw can also lead to a team's elimination from the competition / advancement to the next round.

Hypothesis 1. Coaches choose less risky strategies when in the lead and increase risk when behind in score.

Hypothesis 2. Coaches opt for the least risky strategy when their teams are ahead by one goal.

Referring to ex-ante heterogeneity, theory assumes that more able agents (ex-ante favorite) choose safer strategies than less able agents (underdog) (Bronars, 1987; Grund et al., 2013; Hvide, 2002; Knoeber and Thurman, 1994; Kräkel and Sliwka, 2004). The next hypothesis to be tested is:

Hypothesis 3. Coaches of favorite teams choose less risky strategies than coaches of underdogs.

Favorites have higher probabilities of scoring and lower probabilities of receiving a goal respectively. This also applies for the case that the favorite is behind in score. Therefore, coaches of favorite teams should be more hesitant to change to a riskier strategy, even in case the score is negative. Underdogs in turn have lower winning probabilities ex-ante. In case the underdog is behind in score, they have nothing to lose and therefore will increase the riskiness of their behavior. In case the favorite is ahead, there is no need to immediately adjust risk-taking behavior as the risk of conceding a goal is still small. In case the underdog manages to score a goal while receiving none, they should be interested in adopting a safer strategy in order to minimize the (high) probability of receiving a goal. Accordingly, we formulate the following hypothesis:

Hypothesis 4. Favorites take lower risks than underdogs when behind and higher risks than underdogs when leading.

Regarding the consequences of risk, we expect that the chosen risk strategy affects both the probability of scoring and of receiving a goal, respectively. The corresponding hypothesis reads as follows:

Hypothesis 5. Increasing risk raises the probabilities to score and to concede a goal.

4.4 Variables and Descriptive Statistics

4.4.1 Risk-Taking, Intermediate Information and Heterogeneity in Soccer

Risk-taking refers to the variance of performance; choosing a higher risk strategy increases the probability of changing the outcome of the tournament both in a positive and negative direction. In soccer, a team's success critically depends on the number of goals scored and conceded. Therefore, a higher risk strategy can be interpreted as a behavior that increases both the probability of scoring and conceding a goal. One possibility to affect a team's performance distribution refers to the coach's substitution strategy: the more offensive (defensive) an incoming player is compared to the outgoing player, the higher (lower) the probability of scoring and of conceding a goal, respectively (see Grund and Gürtler, 2005; Bartling et al., 2015). Therefore, we measure risk-taking by means of considering coaches' substitution strategies.

Defenders	**Midfielders**	**Forwards**
Centre Back	Defensive MF	Centre Forward
Left / Right Defender	Offensive MF	Secondary Striker
	Left / Right MF	
	Central MF	
	Left / Right Wing	

Tab. 4.1 Classification of (Sub)Positions

Depending on the tactical position of a player, he can be considered to be more or less offensive respectively defensive. Overall, four main positions can be differentiated: goalkeepers (G), defenders (DF), midfielders (MF) and forwards (F). Except for goalkeepers, these positions can again be subdivided into further positions (see Table 4.1).

In order to evaluate the offensive potential of a position, Grund and Gürtler (2005) as well as Bartling et al. (2015) assign ordinal values to the main positions in the following order: (goalkeepers,) defenders, midfielders, forwards. Even though it is undoubtful that a midfield player is less offensive than a forward and more offensive than a defender, this classification seems rather rough.[35] Moreover, it is questionable whether the degree of

[35] Grund and Gürtler (2005) exclude goalkeepers. Defenders get the value 0, midfielders the value 1 and forwards the value 2. Bartling et al. (2015) assign the value 1 to goalkeepers, 2 to defenders, 3 to midfielders and 4 to strikers.

offensive play is the same for all kinds of midfield players, as these range from defensive to offensive ones. Therefore, we construct a different kind of offensive measure that relies on a different dataset that comprises information about all players (N = 2,184) who played in the season 2015/16 at least once in one of the four best European leagues 'Premier League' (England), 'Bundesliga' (Germany), 'Primera División' (Spain) and 'Serie A' (Italy). This dataset contains information on the number of average goals and assists[36] per minutes played as well as the exact field position of each player in that season. By means of these data, we can calculate how many goals plus assists (*scorerpoints*) a position[37] scores on average per 90 minutes played. As a more offensive style of play leads to more goals and assists scored on average, we can assign an exact value for its offensive play to each position. Table 4.2 shows the respective values.[38,39]

	Position	**Mean**	**Std. Dev.**	**Obs.**
	Goalkeeper	0.002	0.01	182
Defender	Centre Back	0.068	0.168	374
	Left / Right Defender	0.113	0.09	371
Midfield	Defensive Midfield	0.112	0.086	176
	Central Midfield	0.223	0.147	287
	Left / Right Midfield	0.194	0.117	26
	Offensive Midfield	0.455	0.235	129
	Left / Right Wing	0.456	0.833	305
Forward	Secondary Striker	0.542	0.229	40
	Centre Forward	0.588	0.269	294
	Total	0.231	0.384	2,184

Tab. 4.2 Average Number of Goals plus Assists per 90 Minutes Played and Position

Table 4.2 shows that there are great differences regarding the offensive play of midfield players. While a defensive midfielder scores roughly the same number of scorerpoints like left or right defenders on average, a wing player almost scores four times as much.

[36] An assist constitutes an activity carried out by a player, e.g. a pass, that helps another player to score a goal.

[37] We group right and left defenders as well as midfielders, as the requirements are the same for right and left.

[38] The dataset stems from www.transfermarkt.de.

[39] The average values and overall ranking for the different positions only slightly deviate from league to league.

Overall, the data at hand confirm the common knowledge that goalkeepers are the most defensive players, followed by defenders (mean DF = 0.09) and midfielders (mean MF = 0.31). Forwards represent the most offensive position (0.583). In order to evaluate the coaches' substitution strategies, we compare the positions of the substituted players regarding their offensive values, i.e. we determine the difference between scorerpoints of the incoming and outgoing player as our measure for risk-taking. In case a coach does not substitute a player in a given minute, the change in risk equals zero (no strategic adjustments are made).

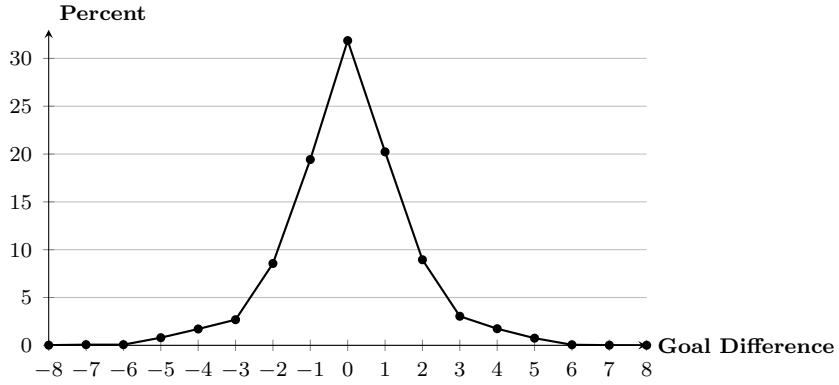


Fig. 4.1 Distribution of (Cumulative) Goal Difference

In order to analyze the effect of intermediate information on coaches' risk-taking behavior, we rely on information on the exact goal difference at the time of a substitution. As the winner of a round depends on the aggregate goal difference of both matches, we use the cumulative score at the time of a substitution as our measure for intermediate information, i.e. the goal difference of the second leg includes goals scored and received in the first game. One problem arises by considering a draw, because at the end of the second game an even score could have different implications for a team: It could lead to an extra time being played, a team's elimination or a team's advancement. Therefore, we treat draws differently: a tie that would result in playing an extra time is treated as a goal difference of zero, whereas a draw that would cause one team to be eliminated from the tournament and the other team to be advanced to the next round is treated as a goal difference of -1 (for the team that would be eliminated) and +1, respectively (for the team that would advance to the next round). Figure 4.1 shows the distribution

of the goal difference. Overall, there is a high percentage of ties. These mainly refer to matches played in the first leg, since these matches all start with a tie (0-0) so that we solely observe draws at the beginning of the first game. As only few observations for absolute goal differences greater than two are available, we pool all goal differences ≥ 3 / $\leq$ -3 together.

In order to analyze whether ex-ante heterogeneity affects the risk-taking behavior of soccer coaches, we generate a heterogeneity variable that relies on information on the playing quality of the competing teams, measured by the players' market values. Existing studies mainly refer to betting odds when it comes to variables indicating the heterogeneity of a contest. However, in the case of the Champions League betting odds seem rather inappropriate, as the odds for the second leg are affected by the outcome of the first leg so that odds for the second match might be biased. We therefore make use of data as to market values. The referring dataset stems from the website www.transfermarkt.de.[40] We have information on the market values of both players in the starting line-up and on the bench. The respective values each refer to the time of the match. For each team we calculate the average value of the whole team (starting line-up + bench players). As market values increase over the seasons, we calculate the relative market value per team.[41] Our measure for *heterogeneity* refers to the difference between the relative market values of both teams.

In order to test whether favorites and underdogs react differently to intermediate information, we classify the team that has a higher average market value as the favorite team (*favorite*).

[40]Transfermarkt provides data on player and team values since 2005. Since then more and more studies make use of this data source, see e.g. Bryson et al. (2013); Franck and Nüesch (2011); Frick (2011); Scelles et al. (2016); Torgler and Schmidt (2007). Salary data from Kicker, the most prominent German soccer magazine, and market values from Transfermarkt have proven to be strongly correlated (see, e.g. Franck and Nüesch, 2011, p. 3041).

[41]First, we calculate the average market value of all teams in the 1/8-finals (per season). Second, we generate the relative market value by dividing each team's value by the average market value.

4.4.2 Control Variables

The riskiness of a coach's strategy is influenced not only by intermediate information but also by other factors such as the current team formation, the 'home-field advantage', or previous match events, e.g. a red card shown to a player leading to a sendoff. In general, a coach might be willing to substitute in a more offensive way when the players on the field are rather defense-orientated. The more offensive the fielded players are, the less likely a risky substitution will be. As we have information about the players of the starting eleven and their respective positions and know the offensive values of the substituted players, we are aware of a team's composition at each minute of the match. Therefore we include a variable that indicates the average offensive value of the players on the field before the substitution (*avg offensive*).[42] Hence, *avg offensive* also includes risk changes prior to the respective substitution.

Empirical results of previous studies indicate a home-field advantage in soccer[43], i.e. the home team wins considerably more often than the away team, resulting in a more defensive style of play by the away team. We thus include the dummy variable *away* to identify whether an observation refers to the home or away team.

In case a red card is shown to a player the respective team has to play the remaining period with one player less. Coaches often react to a player's dismissal by substituting a more offensive player for a more defensive player, especially if the sent off player is a defending one. Therefore we check the number of red cards shown to a team in the period prior to a substitution ($red\ cards_{t-1}$).[44] Furthermore, we consider a dummy variable indicating whether the respective match is the first or second one (*2nd leg*).

[42] In order to account for dismissals due to red cards, we use the average value of scorerpoints in place of the sum of scorerpoints of all field players.

[43] See e.g. Clarke and Norman (1995); Courneya and Carron (1992); Nevill and Holder (1999); Nevill et al. (1996, 2002).

[44] Including information on the position of the dismissed player does not change the main results and therefore are not considered in the later estimations.

4.4.3 Descriptive Statistics

In the 196 knockout matches of the seasons 2009/10 to 2015/16, a total of 1,064 substitutions took place. In approximately 75.1% of the cases, the coaches exploit the maximum number of three substitutions per game, in 20% a coach substitutes twice and in 4.7% once. In only one case, a coach does not substitute at all in a match.[45] As a coach is not allowed to substitute more than three players, intermediate information or other incidences cannot impact a coach's risk strategy after the third substitution. Therefore, we drop all observations followed by the third substitution.

Data on the number and point in time of the substitutions stem from the official score sheets from the UEFA, available at http://de.uefa.com/uefachampionsleague/. Some substitutions typically do not refer to tactical decisions made by the coach but other reasons. These often apply to substitutions executed in the extra- or overtime of a match, or to substitutions of goalkeepers.[46] Therefore, these observations are excluded from the analysis. Overall, the final dataset comprises 196 matches, 1,002 substitutions, and 32,895 minute observations.

	Outgoing		**Incoming**	
Position	**Freq.**	**Percent**	**Freq.**	**Percent**
Centre Back	61	6.09	86	8.58
Left / Right Defender	92	9.18	102	10.18
Defensive Midfield	106	10.58	93	9.28
Central Midfield	154	15.37	143	14.27
Left / Right Midfield	17	1.70	21	2.10
Offensive Midfield	123	12.28	100	9.98
Left / Right Wing	221	22.06	206	20.56
Secondary Striker	52	5.19	36	3.59
Centre Forward	176	17.56	215	21.46
Total	1,002	100	1,002	100

Tab. 4.3 Positions of Substituted Players

Table 4.3 shows the positions of the incoming and outgoing players. Most substituted

[45] Pep Guardiola, FC Barcelona, 23rd Feb 2016 (against Arsenal FC, 1/8 final)

[46] In case a team leads in a match by one goal, coaches often substitute in the extratime in order to waste playing time, thereby reducing the chance of the opposing team to score a goal. In the overtime a substitution is often due to a player's exhaustion. Normally, a goalkeeper is substituted only in case of an injury or a red card shown to the starting goalkeeper.

players are wing players, followed by centre forwards. Altogether, 62% (56%) of the outgoing (incoming) players are midfield players, 22.8% (25%) forwards and 15.3% (18.8%) defenders. Coaches substitute players of the same main position most frequently, as can be seen from Table 4.4. Substituting a very offensive (forward) for a very defensive (defender) player and vice versa rarely occurs (2.5%).

Outgoing		**Incoming**	**Freq.**	**Percent**
Defender	↔	Defender	99	9.88
Defender	↔	Midfield	41	4.09
Defender	↔	Forward	13	1.3
Midfield	↔	Defender	77	7.68
Midfield	↔	Midfield	425	42.42
Midfield	↔	Forward	119	11.88
Forward	↔	Defender	12	1.2
Forward	↔	Midfield	97	9.68
Forward	↔	Forward	119	11.88
Total			1,002	100

Tab. 4.4 Substitution Strategies

With reference to our measure for risk-taking, the three substitution strategies are almost uniformly distributed: 34.33% of the substitutions are risk reducing, 32.34% risk neutral and 33.33% risk increasing, resulting in a mean value of approximately zero (see Table 4.5). Table 4.5 also shows that favorites tend to substitute less offensively respectively risky than underdogs, which is in line with the theoretical assumption.[47]

Variable	**Sample**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
risk	substitution	1,002	-0.003	0.201	-0.520	0.520
risk	overall	32,895	0.000	0.035	-0.520	0.520
	favorite	16,550	-0.0005	0.034	-0.520	0.476
	underdog	16,345	0.0003	0.036	-0.520	0.520

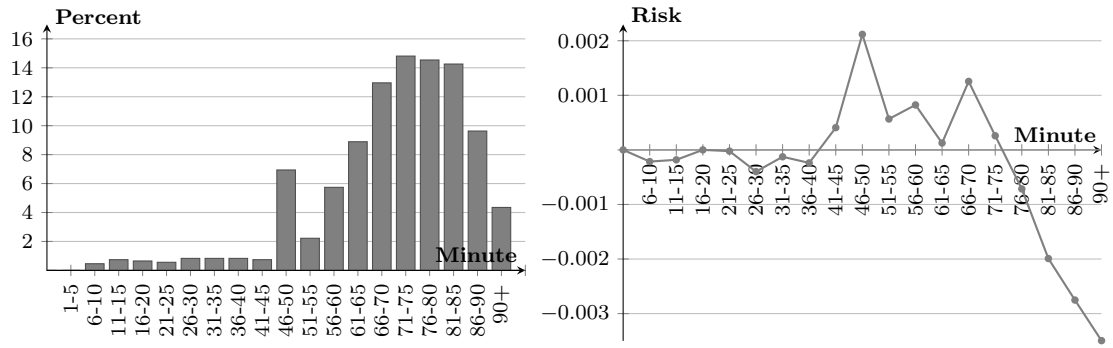
- The substitution sample refers to only those minutes in which a substitution takes place, while the overall sample comprises all observations included in the later regressions.

Tab. 4.5 Descriptive Statistics for Risk

Most substitutions take place in the second half of a match (see left part of Figure 4.2). Overall, only 5.65% of the substitutions are conducted in the first 45 minutes. Coaches substitute most frequently between the 66th and 85th minute (56.6%). In the first 30

[47] A t-test is significant on a 5% level.

minutes of the second half, coaches' strategy adjustments are mainly risk increasing, whereas substitutions after minute 75 are mostly risk reducing ones (see right part of Figure 4.2). The closer it comes to the end of the match, the more defensive is an incoming player compared to the outgoing player.

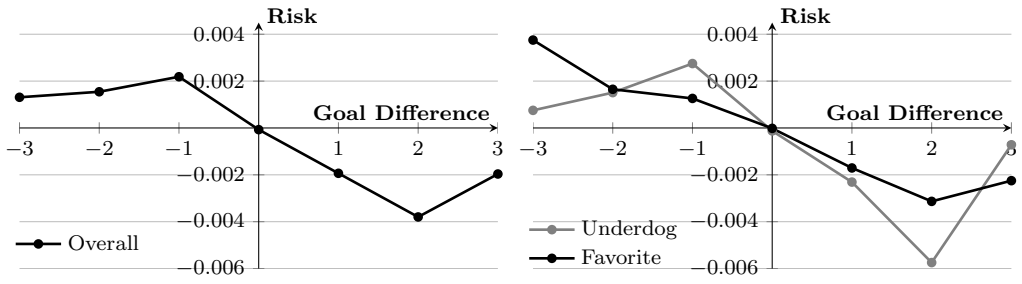


(a) Substitutions per Minute

(b) Point in Time and Risk

Fig. 4.2 Point in Time, Substitutions and Risk

Figure 4.3 confirms theoretical assumptions that lagging contestants tend to chose higher risk strategies than leading contestants. On average, highest risk is taken by a coach when his team trails by one goal. A coach tends to decrease the risk by the largest amount in case his team leads the match by two goals. The right part of Figure 4.3 illustrates the mean risk-taking behavior of favorites and underdogs seperately. Overall, it shows that both favorites and underdogs choose higher risk strategies when they are behind and lower risk strategies when they lead the match. However, underdogs tend to take more risk than favorites when being slightly behind (goal difference =-1) and reduce risk to a larger amount when in the lead.



(a) Overall

(b) Underdogs vs. Favorites

Fig. 4.3 Goal Difference and Risk

Table 4.6 shows descriptive statistics for the control variables considered. On average, the players on the field are as offensive as a central midfield player. About half of the observations refer to away matches and 2nd leg matches. Overall, 3% of all observations take place after a player is sent off the field. A total of 34 players had to leave the field due to a red card. As explained above, most of the observations refer to an even score.

Variable	Obs	Mean	Std. Dev.	Min	Max
heterogeneity	32895	0.006	0.902	-2.305	2.305
avg offensive	32895	0.231	0.020	0.134	0.319
away	32895	0.501	0.500	0	1
red cards$_{t-1}$	32895	0.030	0.172	0	1
2nd leg	32895	0.494	0.500	0	1
goaldifference	32895	0.021	1.630	-8	8
$goaldiff_{\geq+3}$	32895	0.056	0.230	0	1
$goaldiff_{+2}$	32895	0.090	0.286	0	1
$goaldiff_{+1}$	32895	0.202	0.402	0	1
$goaldiff_{0}$	32895	0.319	0.466	0	1
$goaldiff_{-1}$	32895	0.194	0.396	0	1
$goaldiff_{-2}$	32895	0.086	0.280	0	1
$goaldiff_{\leq-3}$	32895	0.053	0.225	0	1

Tab. 4.6 Descriptive Statistics for Independent Variables

4.5 Results

Our empirical analysis first focuses on the overall relationship between intermediate information, heterogeneity and risk. We test whether the current goal difference affects the coaches' risk strategy. The dependent variable *risk* refers to the difference between the average scorerpoints of the outgoing and incoming player. The ordinary least squares (OLS) regression shows that intermediate information significantly impacts coaches' risk-taking behavior, while ex-ante heterogeneity proves to be insignificant (see Table 4.7). The result is robust across the three models which differ in the fixed effects considered. On average, trailing teams increase and leading teams reduce the riskiness of their strategy. Coaches switch to riskiest strategies when their team is behind by one (or two) goals. The increase in risk-taking by trailing teams and reduction by leading teams is in accordance with Hypothesis 1. As coaches choose safest strategies when their team is ahead by two or three goals, Hypothesis 2 has to be rejected.

	Model 1	**Model 2**	**Model 3**
$goaldiff_{\geq+3}$	-0.0037***	-0.0039***	-0.0046***
	(0.0013)	(0.0013)	(0.0014)
$goaldiff_{+2}$	-0.0038***	-0.0047***	-0.0052***
	(0.0008)	(0.0009)	(0.0009)
$goaldiff_{+1}$	-0.0017***	-0.0019***	-0.0023***
	(0.0005)	(0.0006)	(0.0006)
$goaldiff_{-1}$	0.0024***	0.0026***	0.0025***
	(0.0006)	(0.0006)	(0.0006)
$goaldiff_{-2}$	0.0019**	0.0023**	0.0025***
	(0.0009)	(0.0009)	(0.0009)
$goaldiff_{\leq-3}$	0.0018	0.0023	0.0024
	(0.0013)	(0.0014)	(0.0015)
heterogeneity	0.0001	-0.0014	0.0001
	(0.0002)	(0.0010)	(0.0010)
away	-0.0007*	-0.0008**	-0.0008**
	(0.0004)	(0.0003)	(0.0003)
red cards$_{t-1}$	-0.0053***	-0.0053***	-0.0049***
	(0.0019)	(0.0018)	(0.0018)
2nd leg	0.0002	0.0003	0.0004
	(0.0005)	(0.0004)	(0.0004)
avg offensive	-0.0386***	-0.0623***	-0.0793***
	(0.0127)	(0.0161)	(0.0174)
Season dummies	yes	yes	yes
Minute dummies	yes	yes	yes
Team dummies	no	yes	yes
Opponent dummies	no	yes	yes
Coach dummies	no	no	yes
R2	0.009	0.013	0.014
Adj. R2	0.006	0.007	0.007
Obs.	32895	32895	32895

- dependent variable: *risk*
- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01
- Clustered on team-match-level

Tab. 4.7 OLS Regression Results: Impact of Intermediate Information and Heterogeneity on Risk

The theoretical assumption that more able agents choose less risky strategies cannot be confirmed. The variable *heterogeneity* has no significant effect on the dependent variable *risk*. Hence, Hypothesis 3 has to be rejected.[48] As expected, teams are more hesitant to play an offensive style of play when playing away; *away* is significant and negative. Losing a player due to a red card also affects risk negatively. As losing a player leads to an increased probability to concede a goal, coaches seemingly want to reduce

[48]The inclusion of an interaction term *favorite*goaldifference* confirms this result: Both *favorite* and the interaction term are insignificant. See Appendix, Table 4.10.

this probability by substituting a more offensive player for a more defensive one.[49] The formation on the field has a significant effect on the risk strategy, too. The more offensive the current players on the field are the less offensive the incoming player is on average.

In a next step and in order to test whether favorites and underdogs react differently to interim results, we perform the OLS regression of Model 3 separately for favorites and underdogs (see Table 4.8). Overall, underdogs and favorites both react to interim results by adjusting their risk strategy. However, some differences in the risk-taking behavior can be found. In case a team is leading, the decrease in risk-taking is more pronounced for underdogs than favorite teams, which is in line with Hypothesis 4. The coefficients of $goaldiff_{+2}$ and $goaldiff_{+1}$ are twice as high for underdogs as for favorites. Underdogs might adjust their risk strategy to a larger extent when in the lead in order to compensate the ex-ante larger likelihood to concede a goal. The fact that $goaldiff_{\geq+3}$ is insignificant could be due to the small fraction of underdogs leading a match by three or more goals. [50] Differences between favorites and underdogs are also apparent when the goal difference is negative. Regarding the coefficient of $goaldiff_{-1}$ underdogs and favorites react as expected: Underdogs choose riskier strategies than favorites to increase their chances to score a goal. Again the coefficient is almost twice as high compared to the coefficient of favorites. This again is consistent with Hypothesis 4. However, our assumption regarding trailing favorites does not hold for goal differences $\leq$ -2. In case the team is behind by two or more goals, the increase in risk is more pronounced for favorites than for underdogs. Regarding favorite teams, risk increases with the intermediate goal difference; the larger the deficit the more risks the coach of the favorite team takes. Underdogs in turn do not react to a high deficit by adjusting risk. $goaldiff_{\leq-3}$ proves to be insignificant. Some coaches of underdogs trailing far behind might realize that the goal difference is too large to have any chance to catch up and therefore might switch from a risky to a defensive strategy in order to prevent the team from disgrace.

Interestingly, coaches of favorite teams do not distinguish between home and away

[49] Results remain the same when including a variable capturing the position of the dismissed player into the regression.

[50] Only 380 observations (2.3%) refer to an underdog leading a match by three or more goals.

matches. Playing away does not affect favorite's risk strategy while underdogs adjust risk to the venue. Furthermore, underdogs tend to increase their risk-taking behavior in the second leg while favorites do not differentiate between the first and second match.

	Model 1 Underdog	**Model 2** Favorite
$goaldiff_{\geq+3}$	-0.0034	-0.0046**
	(0.0024)	(0.0019)
$goaldiff_{+2}$	-0.0080***	-0.0041***
	(0.0021)	(0.0013)
$goaldiff_{+1}$	-0.0032***	-0.0016*
	(0.0011)	(0.0009)
$goaldiff_{-1}$	0.0031***	0.0019**
	(0.0009)	(0.0009)
$goaldiff_{-2}$	0.0022*	0.0039**
	(0.0012)	(0.0018)
$goaldiff_{\leq-3}$	0.0007	0.0076***
	(0.0021)	(0.0025)
away	-0.0012**	-0.0004
	(0.0005)	(0.0005)
2nd leg	0.0011*	0.0003
	(0.0007)	(0.0006)
$red\ cards_{t-1}$	-0.0064***	-0.0059**
	(0.0024)	(0.0029)
avg offensive	-0.1142***	-0.0738***
	(0.0250)	(0.0279)
Season dummies	yes	yes
Minute dummies	yes	yes
Team dummies	yes	yes
Opponent dummies	yes	yes
Coach dummies	yes	yes
R2	0.021	0.016
Adj. R2	0.010	0.005
Obs.	16345	16550

- dependent variable: *risk*
- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01
- Clustered on team-match-level

Tab. 4.8 OLS Regression Results: Favorite vs. Underdog

Overall, risk-taking behavior of favorites and underdogs show similar tendencies: trailing teams tend to choose riskier strategies and leading teams take fewer risks. While underdogs maximize risk when the deficit is small, favorites increase risk the most when they are trailing with a clear deficit. The latter is in support of Bartling et al. (2015) who find that teams that are unexpectedly behind increase risk to a larger extent than teams not being unexpectedly behind. They explain this behavior with pressure, nervousness

or frustration which might lead to irrationality (Bartling et al., 2015, p. 2650).

In order to analyze the impact of risk on the winning probability, we have performed several logit and OLS regressions. As the winning probability crucially depends on the probability to score and to concede a goal, we estimate the impact of risk on goals scored and conceded in a given minute respectively. Because of the incidental parameters' problem of fixed effects in nonlinear models with limited time periods, we use OLS instead of logit when including team and opponent fixed effects (Haas and Nüesch, 2012, p. 3110).

As our measure for risk we use a team's average offensive in the given minute of the match.[51] The higher *avg offensive* the more likely it should be to score and receive a goal respectively as the coach takes more risks by fielding more offensive players. Furthermore, we control for the goal difference prior to and match events in the particular minute. Those match events refer to incidences that consumes time and therefore reduce the probability of scoring and conceding a goal respectively, e.g. the number of substitutions in t ($substitutions_t$) or whether the other team has scored a goal in t ($goal_t$ / $goal\ against_t$). In addition we control for the minute played (*minute*) and include a dummy indicating the 45th minute because this minute includes the extratime of the 1st half and therefore takes longer than the other minutes.[52] As a player's dismissal might derogate a team's scoring probability, we account for the number of sentoffs of the two teams prior to the given minute ($red\ cards_{t-1}$ / $red\ cards_{t-1}$ *opponent*). In case a team scored a goal shortly before t, it might rest on this success, or the opponent might even fight harder for a goal of their own. Therefore, we include dummy variables accounting for the event of a goal scored and received in the 5 minutes prior to t respectively. Finally, we include a dummy variable indicating the favorite team and control for being the away team.

To sum up, the results all suggest that risk does not affect the probability of scoring and receiving a goal respectively (see Table 4.9). In none of the models the risk variable *avg offensive* is significant. This result does not change when including team and opponent

[51] Using two variables measuring the offensive of the starting eleven and the cumulative value of the risk variable separately does not change the main results.

[52] This problem only arises for the 1st half, for the second half we have information for each minute of the extratime.

	logit		OLS			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
dep. Variable:	Goal	Goal against	Goal	Goal against	Goal	Goal against
avg offensive	1.1964	-0.2120	-0.0015	0.0120	0.0006	0.0129
	(2.1342)	(1.9084)	(0.0332)	(0.0360)	(0.0336)	(0.0357)
goal difference$_{t-1}$	0.0283	-0.0282	-0.0007	0.0007	-0.0037	-0.0005
	(0.0306)	(0.0296)	(0.0005)	(0.0005)	(0.0039)	(0.0037)
*goal difference * offensive*					0.0130	0.0050
					(0.0170)	(0.0162)
substitutions$_t$	-1.0304***	-1.0300***	-0.0106***	-0.0106***	-0.0106***	-0.0106***
	(0.3096)	(0.3096)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
goal against$_t$	-1.3736*		-0.0105***		-0.0105***	
	(0.7123)		(0.0027)		(0.0027)	
goal$_t$		-1.3727*		-0.0105***		-0.0105***
		(0.7124)		(0.0027)		(0.0027)
minute 45	0.8317***	0.8295***	0.0177**	0.0177**	0.0176**	0.0177**
	(0.2919)	(0.2917)	(0.0088)	(0.0088)	(0.0088)	(0.0088)
minute	0.0064***	0.0064***	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0015)	(0.0015)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
red cards$_{t-1}$	-0.5265*	0.5314***	-0.0054*	0.0134***	-0.0055*	0.0134***
	(0.2937)	(0.1654)	(0.0030)	(0.0039)	(0.0030)	(0.0039)
red cards$_{t-1}$ *opponent*	0.5336***	-0.5385*	0.0133***	-0.0054*	0.0133***	-0.0054*
	(0.1602)	(0.2955)	(0.0039)	(0.0030)	(0.0039)	(0.0030)
goal scored last 5 min	-0.3415**	0.0794	-0.0070***	-0.0002	-0.0070***	-0.0002
	(0.1651)	(0.1694)	(0.0021)	(0.0023)	(0.0022)	(0.0023)
goal conceded last 5 min	-0.0105	-0.3402**	-0.0013	-0.0070***	-0.0013	-0.0070***
	(0.1773)	(0.1681)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
favorite	0.4769***	-0.4787***	-0.0006	0.0007	-0.0007	0.0007
	(0.0929)	(0.0931)	(0.0024)	(0.0024)	(0.0024)	(0.0024)
away	-0.3878***	0.3914***	-0.0061***	0.0062***	-0.0062***	0.0062***
	(0.0921)	(0.0907)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Constant	-4.8515***	-4.4440***				
	(0.5124)	(0.4387)				
Team dummies	no	no	yes	yes	yes	yes
Opponent dummies	no	no	yes	yes	yes	yes
Pseudo-R2	0.021	0.021				
R2			0.006	0.006	0.006	0.006
Adj. R2			0.004	0.004	0.004	0.004
Obs.	38200	38200	38200	38200	38200	38200

- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01
- Clustered on team-match-level

Tab. 4.9 Regression Results: Impact of Risk on Goals Scored and Conceded

fixed effects (Model 3-6) or an interaction term for risk and goal difference (Model 5-6). Further regressions with an alternative risk variable (e.g. the cumulative value of *risk*), additional control variables and interaction terms or using different sub samples (favorites and underdogs, trailing or leading teams, only even matches) confirm this result.[53] In neither of the regressions does risk affect the dependent variable significantly. Thus, Hypothesis 5 has to be rejected.

In contrast to risk, most of the other controls affect the likelihood of changing the

[53]Detailed regression results are provided upon request.

match outcome significantly in all of the models (except for *goal difference*$_{t-1}$ and in part *favorite*). Whether a team is behind or ahead has no effect on the probability of scoring or receiving another goal. Match events taking place in t in turn significantly reduce the scoring probability while in the course of the match (*minute*) and especially in the 45th minute significantly more goals are scored. Suffering a sentoff has – as expected – a negative and (slightly) significant effect on the likelihood of scoring. The argument is reversed for sentoffs of the opponent. In case a team has scored a goal shortly before t, the probability of scoring another goal is significantly reduced while conceding a goal has no effect on scoring, and vice versa. Being the away team has a significant and negative effect on scoring a goal and a significant and positive impact on conceding a goal respectively. The favorite team in turn scores more and concedes fewer goals, but *favorite* is significant only when team and opponent fixed effects are not included (Model 3-6). Results are robust across the different models.

As the risk strategy has no effect on the match outcome, it is questionable why coaches adjust their risk strategy in the common way. Picking up on the argument of Grund et al. (2013), the coaches' behavior may be based on an overestimation of risk-taking and / or public pressure. Although a coach may be aware that choosing a riskier strategy may not change the situation and reducing risk does not increase chances to win *on average* respectively, he could still believe that in particular cases a strategic adjustment leads to success. Furthermore, spectators may think that a coach gives up, if he sticks to the initial strategy even though his team trails behind. As a coach may want to signal that everything possible is being done in order to change the match outcome, he may increase risk-taking even though he knows that this does not change anything. Another explanation is that pressure and stress lead to irrational behavior (Grund et al., 2013).

4.6 Conclusion

The present study provides evidence on the risk-taking behavior of contestants. Results show that both trailing and leading teams adjust risk. While coaches of teams that are behind take more risks, coaches of leading teams decrease the risk strategy. Favorites

take more risks than underdogs when trailing by more than one goal, whereas underdogs decrease risk by a larger amount when leading in a match. Ex-ante heterogeneity does not affect the choice of risk significantly. Both increasing and reducing risk prove to have no effect on the match outcome. Neither does the likelihood of receiving a goal decrease by less risk-taking nor do teams score more goals by increasing risk. As higher risk-taking typically results in less effort exerted by agents, insights into the relationship between different contest designs and the risk-taking behavior of contestants are of high importance. This study therefore focuses on the relationship between interim results and the risk strategy of heterogeneous agents on the one hand, and on the consequences of risk regarding the outcome of the competition on the other hand. In case of asymmetric contests, handicaps are often mentioned in order to increase homogeneity and therefore effort levels. Results show that handicaps have to be chosen very carefully, as these might result in higher risks and hence lower effort, i.e. trailing contestants might increase their risk strategy which in turn reduces effort exerted.

Although our analysis confirms existing results, some limitations have to be mentioned. First, we can only observe coaches' substitution strategies but have no information on potential tactical changes besides substitutions. It could be the case that in the course of a match a player who starts as a right or left defender more and more plays like a left or right midfield player. Unfortunately, changes in the style of play independent of substitutions are unobservable for us. Our measure for risk relies on the coaches' behavior but those who implement the respective risk strategy are the players. But the actual behavior of the players cannot be observed so that our measure for risk is rather rough.

Second, the ruling that away goals are more valuable than home goals might lead to under- or overestimated coefficients. In case a team is behind by one goal, scoring a single goal can lead to all three possible outcomes: elimination, overtime or winning the round. Therefore the coefficients of $goaldiff_{+1}$, $goaldiff_{0}$ and $goaldiff_{-1}$ can be biased.

Third, we cannot differentiate between substitutions due to tactical changes and substitutions due to other reasons, e.g. injuries, bad performance, threat of being sent off etc. In case a coach has to substitute a player based on other reasons, his risk adjustments

might be different compared to tactical substitutions.

Therefore, further research is necessary to add supplementary evidence on the relationship between interim results and risk-taking behavior of heterogeneous contestants in dynamic tournaments. Furthermore, it is assumed that risk and effort choices affect each other (Nieken, 2010) but empirical evidence on that assumption is very rare. Future (empirical) research may focus on the interrelation between effort and risk-taking behavior of contestants. It could also be interesting to test whether certain tournament designs that have an impact on contestants' effort choices (e.g. prize spread, number of participants) also affect agents' risk strategy.

4.7 Appendix

	Model 1	**Model 2**	**Model 3**
goaldifference	-0.0011***	-0.0012***	-0.0013***
	(0.0002)	(0.0002)	(0.0002)
*heterogeneity*goaldiff*	-0.0002	-0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0002)
heterogeneity	0.0001	-0.0016	-0.0002
	(0.0002)	(0.0010)	(0.0011)
away	-0.0005	-0.0006*	-0.0007**
	(0.0004)	(0.0003)	(0.0003)
red cards$_{t-1}$	-0.0052***	-0.0052***	-0.0047**
	(0.0019)	(0.0019)	(0.0019)
2nd leg	0.0001	0.0001	0.0002
	(0.0004)	(0.0003)	(0.0003)
avg offensive	-0.0360***	-0.0605***	-0.0787***
	(0.0127)	(0.0162)	(0.0175)
Season dummies	yes	yes	yes
Minute dummies	yes	yes	yes
Team dummies	no	yes	yes
Opponent dummies	no	yes	yes
Coach dummies	no	no	yes
R2	0.008	0.012	0.013
Adj. R2	0.005	0.006	0.006
Obs.	32895	32895	32895

- dependent variable: *risk*
- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01
- Clustered on team-match-level

Tab. 4.10 Determinants of Risk: Interacting Goal Difference and Heterogeneity

5 The Impact of Managerial Change on Performance: The Role of Team Heterogeneity

This chapter refers to the published article:

Mühlheusser, G., Schneemann, S., and Sliwka, D. (2016). The impact of managerial change on performance: The role of team heterogeneity. *Economic Inquiry*, 54(2): 1128–1149. doi:10.1111/ecin.12285

6 The Contribution of Managers to Organizational Success: Evidence from German Soccer

This chapter refers to the published article:

Mühlheusser, G., Schneemann, S., Sliwka, D., and Wallmeier, N. (2016). The Contribution of Managers to Organizational Success: Evidence from German Soccer. *Journal of Sports Economics*, forthcoming. doi:10.1177/1527002516674760

7 The Effect of Stars on Attendance: NHL-Players in the German and Czech Hockey League

Labor disputes between team owners and players' associations are a common phenomenon in North American sports. In case a new collective bargaining agreement (CBA) has to be negotiated and owners and players cannot come to an agreement, the following season is at stake. As negotiations often last for some time it is not unusual that the upcoming season is shortened. However, it is also possible that the entire season is canceled, as has happened in the 2004/05 National Hockey League (NHL) lockout. When the CBA of the NHL expired in 2012 and it became clear that team owners and the National Hockey League Players' Association (NHLPA) could not agree on the conditions of the new CBA[54], many players left the NHL prior to the 2012/13 season in order to play professional hockey in Europe. The uncertainty about the season's beginning respectively the threat of cancellation of the whole season prompted 170 players to close temporary contracts with European teams by November 2012. Since most of the European leagues restrict the number of foreign players per team, the majority of NHL-players joined teams in their home country. The fact that many NHL-players got involved with European clubs caused high media attention in America. ESPN, a major American sports channel, even broadcasted games from Europe during the NHL lockout. Following successful negotiations between the National Hockey League and its players' association on January 6th, 2013, the players returned to North America in order to

[*] This chapter is a revised version of the research article "The effect of stars on attendance: NHL-players in the German and Czech hockey league" by Christian Deutscher and Sandra Schneemann, published in the book "Breaking the Ice: The Economics of Hockey" by Bernd Frick (2017).

[54] There were major conflicts regarding financial determinants, namely the scope and distribution of hockey-related revenues, a fixed salary cap, the contract length and free agency rules. Mediation by the Federal Mediation and Conciliation Service discontinued after a few days in November due to unsuccessful discussions with the negotiating parties. The league repeatedly canceled games as negotiations continued to fail throughout the month of December.

prepare for the shortened season that started on January 19th, 2013 - more than three month after its original start.

While sports economists have comprehensively investigated the impact of the NHL lockout on North American demand, little to nothing is known about its consequences for hockey and its demand in Europe. This is surprising since this situation serves as a rare chance to determine the effect of stars on attendance. As the NHL is appraised to be the best hockey league worldwide, NHL-players can be considered as being of superior ability - or stars - in minor leagues, such as the German DEL (Deutsche Eishockey Liga) or the Czech Extraliga. A total of 28 (12) NHL-players signed contracts with Czech (German) clubs during lasting negotiations between the NHL and the NHLPA. The players stayed on average for 18 matches in Europe. Hence, it is possible to analyze whether the arrival of NHL-players affected attendance in the Czech and German highest hockey league. This chapter examines the relationship between demand and the presence of NHL-players by using game level data from the two European leagus. In order to have sufficient observations for matches with and without stars, we include information about the season before the lockout (2011/12) as well as during the lockout (2012/13) into our analysis. We find that 'stars' affect demand differently in the Czech Republic and Germany: While NHL-players attracted significantly more spectators in the Extraliga, especially if they played for the away team, we only find a negligible effect of stars playing for the home team in the DEL. Stars who played for the away team did not increase demand for DEL matches at all. As the obligation of NHL-players was very costly for European clubs[55], it is questionable whether German teams could benefit from signing a NHL-player.

The chapter starts with a review of literature on the demand for sports and hockey. In section 7.2 we describe the two European leagues under consideration in more detail. Section 7.3 presents the data at hand and the empirical approach. In section 7.4 we illustrate the results of our estimations. Finally, we summarize the insights of the chapter and offer implications in section 7.5.

[55]Depending on age, contract value and injury history, teams had to pay insurance fees between $20,000 and $70,000 per player for the two month span plus individual salaries (http://www.espn.com/nhl/story/_/id/8403261/playing-europe-russia-easy-accomplish-locked-players).

7.1 Literature Review

This section offers an overview on the related literature in order to provide a basis for the empirical analysis in section 7.3. We start with studies that investigate determinants of demand for sports in general and hockey in particular. As we focus on the effect of stars on attendance subsequently, we also present empirical evidence on this topic.

7.1.1 Surveys on Determinants of Attendance in Sports

Borland and MacDonald (2003) as well as Villar and Guerrero (2009) survey literature on determinants of demand for sporting contests. First, Borland and MacDonald (2003) discuss the product of professional sport to suggest five categories which determine the demand for sporting competitions: consumer preferences, economic factors, the quality of viewing, characteristics of the contest and the supply capacity (p. 481ff.). Borland and MacDonald (2003) argue that consumer preferences for sporting goods are more complex than preferences for other goods, as team loyalty, bandwagon effects and the striving for prestige determine the demand for sports contests. Regarding economic factors the authors expect ticket prices, opportunity and travel costs, income of potential fans, the market size, unemployment rate and substitutes to affect attendance. The quality of viewing is influenced by the conditions of viewing, time and day of the contest, weather conditions and the existence of adequate food and sanitary facilities. Borland and MacDonald (2003) refer the characteristics of a contest to the qualities of the respective teams, the presence of star players, relevance of a match, winning probability of the home team and uncertainty of outcome. The supply capacity can also affect demand as it constrains match attendance. After presenting the main determinants of demand, the authors give a review of existing literature on these determinants. Borland and MacDonald show that findings concerning the impact of star players on attendance are mixed: while some studies find a positive effect of stars on demand, others reject the assumption that stars affect attendance.[56] They conclude that various factors affect attendance and have to be considered in empirical analyses respectively.

[56]See e.g. Schofield (1983); Kahn and Sherer (1988); Hausman and Leonard (1997).

Villar and Guerrero (2009) also overview (mostly empirical) research on demand in the field of sports economics. In contrast to Borland and MacDonald (2003), they put stronger emphasis on methods and variables used in the empirical literature. The authors review different definitions of attendance, e.g. average attendance, logarithm of attendance or proportion of tickets sold, and criticize that some studies do not consider the problem of restricted capacity as they apply simple OLS regression although more appropriate econometric methods are at hand, e.g. Tobit models. Afterward, distinct factors that have proven to determine the attendance of a sporting contest are considered: economic factors, the quality of the contest, uncertainty of outcome, opportunity costs and other aspects. Villar and Guerrero identify economic indicators comparable to those presented by Borland and MacDonald: ticket price, complementary and substitute goods, income, unemployment, market size, stadium capacity and strikes. The same is true for the quality of a contest. Villar and Guerrero suggest that the winning probability of the home team, the expected quality of both teams, presence of superstars, rivalry between the teams and recent performance of the home team affect the quality of a match. Regarding the uncertainty of outcome, the authors distinguish between match, seasonal and long-term uncertainty. They present evidence for a negative effect of a low long-term uncertainty on attendance. Finally, Villar and Guerrero illustrate that opportunity costs and other factors such as weather, TV broadcasting, day and time of the contest, parallel competitions of other sports, the distance between the cities of the home and away team, advertising and the racial composition of the teams also affect the demand for sporting contests.

7.1.2 Analyzing Determinants of Attendance in Hockey

Studies that examine attendance in hockey often refer to the NHL. Most of these studies focus on the impact of violence on demand (Jones et al., 1993; Coates et al., 2012; Stewart et al., 1992; Paul, 2003; Paul and Weinbach, 2011). However, other determinants are also tested. Coates and Humphreys (2012), for example, analyze the effect of uncertainty of outcome while both Jones and Ferguson (1988) and Cocco and Jones (1997) examine whether demand depends on a team's (re)location. Furthermore, Leadley and Zygmont

(2006) determine the impact of new arenas on attendance and Winfree and Fort (2008) as well as Rascher et al. (2009) study the impact of the NHL Lockout 2004/05 on fan behavior. The following presents these studies in more detail.

Studies with a focus on violence mostly find a positive effect of fighting on demand for hockey matches, e.g. Jones et al. (1993), Stewart et al. (1992) and Paul (2003). Jones et al. (1993) find that violence and match attendance are positively related to each other and therefore confirm the 'blood sport' hypothesis. The positive relationship between violence and attendance is confirmed for NHL matches both in the USA and Canada. However, a negative relationship between attendance and extreme forms of violence is found for matches that are hosted in Canada. On the contrary, major penalties increase attendance in matches that take place in the US. Stewart et al. (1992) present another study on demand for hockey. They assess teams as profit maximizers that offer the product 'sporting competition'. Violence can be considered as an important component of this product. The authors assume that violence influences demand directly as well as indirectly. They argue that violence is a major determinant of attendance and hence, affects demand directly. Furthermore, Stewart et al. state that violence may have a positive impact on a team's winning probability. As the prospect of a home win is positively related to attendance, violence can increase demand indirectly. The authors present empirical results which confirm the previous assumptions. They show that violence affects attendance both directly and indirectly.

Paul (2003) investigates the impact of certain policy changes concerning fighting and scoring on demand for NHL games. Policy changes were introduced in order to reduce the amount of exercised violence and to increase the probability of scoring. League organizers hoped that less violence and more goals would result in higher attractiveness of the play which in turn should attract more fans. However, the empirical analysis shows that fighting is positively and scoring negatively related to attendance. Teams that exercise a higher amount of violence attract more fans, especially in the USA, while the average number of previously scored goals is negatively related to attendance. Hence, Paul (2003) confirms that violence positively affects demand for hockey matches. In contrast to Jones et al. (1993), Stewart et al. (1992), Paul (2003), the studies of Paul and Weinbach (2011)

and Coates et al. (2012) find that fighting does not affect attendance significantly.

Paul and Weinbach apply data from the Quebec Major Junior Hockey League (QMJHL) while Coates et al. use information on the German Hockey League (DEL), the Finnish SM-liiga and the NHL. Results of the QMJHL indicate that the win percentage of the home team increases attendance significantly, while scoring and fighting do not attract more fans. Coates et al. (2012) find that both success and attendance are not related to violence. In an additional study, Coates and Humphreys (2012) focus on another determinant of attendance: the uncertainty of outcome. Using data from the NHL, regression results indicate that fans prefer matches in which the home team is expected to win over even matches. The authors attribute this result to loss aversion. Furthermore, they show that attendance is positively affected by scoring and negatively affected by receiving goals and penalties. Coates and Humphreys conclude that the negative relationship between penalties and attendance justifies policies released by the NHL to curb violence.

Leadley and Zygmont (2006) focus on the quality of viewing, namely the impact of an arena's modernity, on demand. Data from the NHL show that an arena attracts approximately 15 to 20 percent more fans in the first year after opening, confirming that the age / modernity of an arena is an important factor for attendance. The length of this so-called 'honeymoon effect' lasts between five to eight years and depends on the considered period (Miller, 2009; Büschemann and Deutscher, 2011).

Jones and Ferguson (1988) and Cocco and Jones (1997) focus on the impact of the location of a NHL team on team demand. Jones and Ferguson (1988) find a strong relationship between locational attributes, i.e. the country in which the match takes place (Canada vs. US), the population and income of inhabitants, and attendance. Their results also indicate positive effects of fighting, the number of stars playing for the respective teams, a team's qualification for the playoffs, matches played at the weekend and team standings on attendance. No effect is found for the uncertainty of a match. The authors conclude that locational factors, league rules and team success significantly influence the decision of fans to attend a match.

Cocco and Jones (1997) investigate the viability of Canadian small market franchises.

They examine the relationship between team demand and locational factors as well as team quality for Canadian NHL teams. Locational factors are captured by the population and per capita income of the city a team is located in. The authors also control for the teams' rankings, match uncertainty, the relevance of a match for reaching the playoffs, the day of a match (weekend) and the playing style of a team (fighting, skating or both). Regression results show that population is negatively correlated with attendance while income and team quality of both the home and away team positively affect attendance.

Winfree and Fort (2008) as well as Rascher et al. (2009) focus on the impact of the NHL lockout 2004/05 on attendance of minor and junior hockey leagues respectively the National Basketball Association (NBA). Both studies suggest that the NHL lockout has a positive effect on attendance of the other leagues. Winfree and Fort (2008) find that attendance of junior and minor league hockey teams increases by about 5% during the lockout. However, the lockout variable is only significant for minor league teams. In addition, the authors show that team quality significantly raises the league's demand. Rascher et al. (2009) focus on the impact of the NHL lockout on minor hockey leagues and the NBA. The results indicate that the respective leagues exhibit a significant increase in demand by about 2% during the lockout. Moreover regression results show that team specific factors as well as team quality also attract fans, while population only is significant and positive for the NBA.

7.1.3 Determining the Impact of Stars on Attendance

Although some of the above mentioned studies control for the presence of superstars, they provide few insights into the importance of stars for the demand for sporting competitions. The following describes several studies which explicitly focus on the relationship between superstars and demand.

Hausman and Leonard (1997), for instance, test the effect of certain NBA superstars, namely Michael Jordan, Larry Bird, 'Magic' Johnson, Isiah Thomas and Shaquille O'Neal, on television ratings and gate attendance. Depending on the chosen period (1989/90 vs. 1991/92) results show a significant and positive effect of superstars on local cable ratings, regardless of whether the stars play for the home or the visiting team.

By analyzing data from TNT[57], Hausman and Leonard (1997) find that the presence of Magic Johnson has the greatest effect. His appearance raises TNT's ratings by approximately 38%. Another analysis is conducted with a dataset from NBC[58]. Estimation results confirm the positive impact of superstars on demand. Relating to gate attendance, Hausman and Leonard examine if away teams with a superstar in their squad attract more fans than (visiting) teams without such a superstar. Results point to a major influence of superstars on road attendance.

Berri et al. (2004) present different estimation models in order to analyze the effect of superstars on fan interest in the NBA. The authors use information on gate revenue to operationalize fan interest. Depending on the model, superstars have a significant and positive or no effect at all on fan interest. They include distinct variables to control for a superstar effect. On the one hand, they take a variable into account that refers to a team's overall star attraction. They measure this attraction by calculating the sum of All-Star Game votes per team. On the other hand, they include dummy variables for four superstars: Michael Jordan, Shaquille O'Neal, Grant Hill and Charles Barkley. As control variables, Berri et al. use the team performance / quality, certain franchise characteristics (stadium capacity and age, expansion team, roster stability) and market characteristics (competitive balance, population, income). The authors estimate a double-logged model as well as linear models to examine the relationship between the different determinants and attendance. The effect of the star variables depends on the model considered: the All-Star votes have significant and positive effect on gate revenue in the double-logged model (which tends to be the more appropriate one) while they are insignificant in the linear model. In contrast to the results of Hausman and Leonard (1997), none of the four superstar players has a significant impact on gate revenue. Closing, Berri et al. compare the effect of superstars with the impact of wins on gate revenue. As gate revenue turns out to be more affected by wins and stadium capacity, the authors conclude that "it is performance on the court, not star power, that attracts the fans in the NBA" (Berri et al., 2004, p. 44).

[57]TNT (Turner Network Television) is an American TV channel.

[58]NBC is another US TV channel respectively a broadcast network with several radio and TV stations.

Based on Hausman and Leonard (1997), Berri and Schmidt (2006) examine the externality of superstars on road attendance in the NBA. The authors extend the work of Hausman and Leonard by using a larger data set (1992/93 - 1995/96) and identifying a larger number of superstars. Similar to the study of 2004, Berri and Schmidt (2006) rather focus on an aggregate measure of star power than individual star players. The star attraction of a team is again captured by the sum of All-Star game votes of its players. Control variables are the market size, the expansion status of a team, roster stability, competitive balance and the racial composition of a team. Results show that road attendance is significantly affected by team wins, star power and racial composition. Following this analysis, Berri and Schmidt also examine the effect of individual star players on road attendance and to what extent this effect is based on a player's star appeal or his on-court productivity. Results suggest that productivity is more important for road attendance than star appeal, confirming the results of the previous study by Berri et al. (2004). Nevertheless, the authors conclude that stars attract fans and generate revenue, especially when they play for the visiting team.

The most recent empirical study on the effect of superstars on attendance is conducted by Brandes et al. (2008). In contrast to prior studies the authors do not use data from the NBA but the major German soccer league 'Bundesliga'. Brandes et al. distinguish between "local heroes" and superstars and estimate their effect separately for home and away attendance. Brandes et al. regard a superstar as a player whose market value belongs to the league's top 2% quantile. A local hero is defined as "the most valued player of a particular team that has no superstars" (Brandes et al., 2008, p. 267). The authors use several control variables to isolate the star and local hero effect from other influences: team factors such as reputation (average ranking in the last 20 years) and stadium capacity as well as market characteristics (male population, unemployment rate and competitive balance). Fixed effects regressions show that superstars increase attendance both at home and in away matches while local heroes only attract fans in home matches.

So far, empirical research refers to superstars by using measures of popularity or salary. The study at hand takes a different approach and makes use of the presence of

NHL-players in minor hockey leagues, namely in the Czech Extraliga and the German DEL. We regard NHL-players playing for European hockey clubs as star players and analyze whether these stars affect attendance in the two leagues. We use various control variables that have proven to be important determinants for demand in previous studies (see section 7.3.3).

7.2 Professional Hockey in Germany and the Czech Republic

In the Czech Republic hockey and soccer are the most popular and successful sports in terms of attracting attention from both the media and supporters. With respect to hockey, Germany is somewhat different: Although the DEL is one of the more popular leagues, it is ranked far behind the major soccer league (Bundesliga) and competes with basketball and handball for the second place on the popularity scale. Total revenue of the DEL was about 86 Million Euro in 2011/12[59] or four percent of the Bundesliga's revenue in 2011/12 (2.08 Billion Euro)[60].[61]

The Czech major hockey league 'Extraliga' was founded following the political breakup of the Czechoslovakia in 1993. Its antecessor, the 'Czechoslovak First Ice Hockey League', started in 1931. The Extraliga organized its inaugural championship season in 1993/94. HC Kladno was the first team to win the Czech championship. A total of 22 different teams have played in the Extraliga ever since. Only six clubs have been permanent members of the league.[62] In the initial two seasons only 12 teams competed for the national championship. In 1995/96 the Extraliga expanded to 14 teams. VHK Vsetín won the most titles, namely six, but withdrew from competition due to financial problems later on. Participation in the Extraliga is regulated by a promotion and relegation system. Until 2012/13 the four teams at the bottom of the standings had to play a relegation round with the loser playing a best-of-seven series against the winner of the

[59] www.handelsblatt.com/sport/sonstige-sportarten/handball-basketball-eishockey-profi-ligen-kaempfen-um-den-silberrang/7369336.html

[60] www.bundesliga.de/de/liga/news/2012/dfl-stellt-bundesliga-report-2013-vor-bundesliga-bestaetigt-nachhaltiges-wachstum_0000238084.php

[61] Data on total revenue of the Extraliga are not available.

[62] Litvínov, Pardubice, Plzen, Sparta Prag, Vítkovice and Zlín.

First League. Since 2012/13 the two worst teams of the play-outs play against the play-off winners of the First League.

In contrast to the Extraliga, the DEL is a closed league without a relegation system. The DEL was established in 1994 following a period of financial distress for many hockey clubs. Hence, the league organizers aimed at offering an attractive competition combined with financial security of the clubs. In the inaugural season 1994/95, 18 teams participated in the competition for the German championship. Kölner Haie was the first club that won the German championship. In the following seasons, the number of teams varied between 18 and 14. Since 2010/11 there were only two changes in the field of participants: In the year 2013 Hannover Scorpions sold their licence to Schwenninger Wild Wings, and in 2016 Hamburg Freezers could not afford to pay the licence fee and hence withdrew from the DEL. Fischtown Pinguins moved up and made their debut in the season 2016/17. Apart from that, the same set of (14) teams competes in the DEL since 2010/11. Overall 31 different teams have participated in the DEL. There are only six teams which have been permanent members of the DEL.[63] The most successful club is Eisbären Berlin, winning a total of seven titles.

Both the DEL and Extraliga seasons are divided into a regular and a postseason. In the regular season, each of the 14 teams plays four times against each other team (twice at each team's arena), resulting in 52 matches per team and 364 matches per league and season. In both leagues eight teams qualify for the postseason which consists of three rounds (best-of-seven series). The top six teams of the regular season directly qualify for the play-offs. The teams on rank seven to ten have to play a preliminary round.[64] Both leagues restrict the number of foreign players that are allowed to play for a team. Currently, each DEL team is allowed to contract nine foreign players[65], while only six foreign players per team are permitted in the Extraliga.

[63] Adler Mannheim, Kölner Haie, Eisbären Berlin, Ice Tigers Nürnberg, Krefeld Pinguine, Augsburger Panther

[64] In the Extraliga the preliminary round is played in a best-of-five series, in the DEL in a best-of-three series.

[65] Prior to the 2012/13 season ten foreign players were allowed to play for a given team of the DEL (www.welt.de/sport/article12541845/DEL-senkt-Auslaenderquote-in-der-kommenden-Saison.html).

7.3 Data Description and Empirical Approach

The dataset at hand covers information on all DEL and Extraliga matches of the *regular seasons* 2011/12 and 2012/13.[66] Overall we have information on 728 matches per league. However, we exclude 18 matches because of certain peculiarities or missing data: First, we exclude five matches as they are hosted in unusual settings. These refer to two DEL and three Extraliga matches. The 'DEL winter game' 2011/12 took place in a soccer stadium and in front of 50,000 spectators. The match EHC München against Augsburger Panther was relocated to another arena in Munich. In 2012/13 three home games by Rytíři Kladno were held at an arena in Prague.[67] These games and venues exhibit particular features for which we cannot control and hence, they are not included in our analysis. Another observation has to be excluded because information on betting odds is missing.[68] As we control for the rank of the teams prior to a match, we also have to exclude all matches played on the first matchday as no rank prior to the first match of a season is available. The final dataset comprises 710 matches per league.[69]

Data stems from a variety of sources. Game related data derives from the leagues' official websites www.del.org and www.hokej.cz as well as from the hockey website www.hockeydb.com. The dataset includes information on the teams, the day and time of the match, the number of spectators and the respective region and arena. Information on further influencing factors, such as the number of inhabitants and unemployment rates stems from the websites of the Federal Employment Agency of Germany (www.statistik.arbeitsagentur.de), the German Federal Statistical Office (www.destatis.de), the Czech Statistical Office (www.czso.cz) and the Ministry of the Interior of the Czech Republic (www.mvcr.cz/mvcren).

[66] Play-off matches are not considered in our analysis since all NHL-players left the DEL and Extraliga prior to the play-offs. Hence, we cannot compare play-off matches with stars with play-off matches without them. As play-off matches usually attract more fans than regular season matches, including these games would distort the results.

[67] Against Pardubice, Brno and Slavia Prag.

[68] Vitkovice HC - Mlada Boleslav, October 9th, 2011

[69] 356 observations per league relate to the season 2011/12 and 354 to the season 2012/13.

7.3.1 Descriptive Statistics - Attendance Overall

Villar and Guerrero describe several possibilities to define the demand for sporting contests. While some studies use the number of tickets or the proportion of tickets sold, others refer to the number of unsold seats or the ratio of attendance and capacity. In the subsequent analysis we apply the *attendance/capacity-ratio* as our dependent variable. Welki and Zlatoper (1999) prefer to use a proportion over the absolute number of spectators because it adjusts for varying stadium capacities. "The larger the stadium capacity, the greater the number attending if the inclination to attend is equal across ticketholders in the various cities" (Welki and Zlatoper, 1999, p. 287). Considering the *attendance/capacity-ratio* helps to avoid this issue.

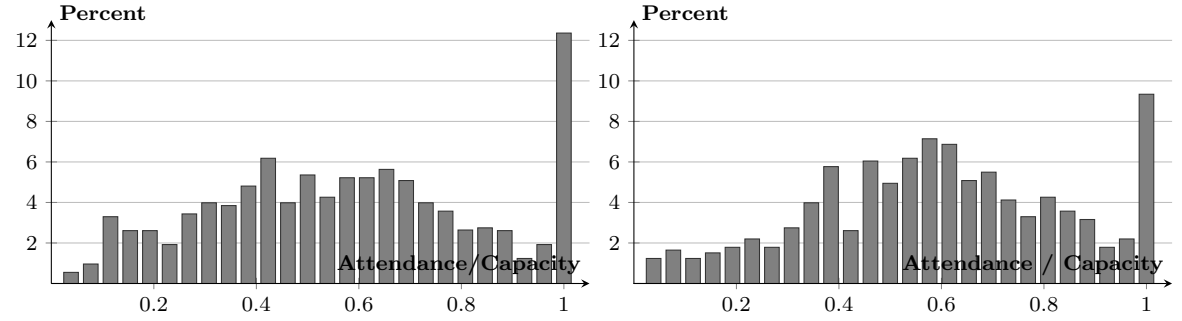
Variable	League	Obs	Mean	Std. Dev.	Min	Max
attendance	DEL	710	6,022.88	3,662.21	1503	18,500
	Extraliga	710	4,948.08	1,899.08	1801	14,175
attendance/capacity-ratio	DEL	710	0.641	0.217	0.187	1
	Extraliga	710	0.629	0.216	0.131	1

Tab. 7.1 Descriptive Statistics of Attendance and the Ratio of Attendance and Capacity

Table 7.1 shows that hockey matches attract on average 6,000 spectators in Germany and 5,000 in the Czech Republic in the seasons 2011/12 and 2012/13. The majority of matches of the DEL and Extraliga are not sold out: in only about 15% of the matches the *attendance/capacity-ratio* is above 90% (see Figure 7.1). This eases the interpretation of the results as a high number of sold out matches would raise the question of how many tickets could have been sold given a larger arena.

The standard deviation of attendance in the DEL is twice as large as in the Extraliga. This is not surprising as the German teams are located in cities that differ considerably with reference to inhabitants. The differences between the Czech cities are considerably smaller than those between the German cities. There are teams from Germany's largest cities, namely Berlin, Hamburg and Munich, with more than a million inhabitants as well as teams from rather small cities, such as Villingen-Schwenningen, Straubing or Iserlohn, with less than 100,000 inhabitants (see also Table 7.7). Figure 7.1 reports the distribution of the *attendance/capacity-ratio* for both leagues. As some matches are

sold out, the data is slightly right censored. Hence, we estimate the impact of stars on attendance by applying Tobit regression models later on.



(a) DEL (b) Extraliga

Fig. 7.1 Distribution of *attendance/capacity-ratio* per League

Further statistics on a team-level show that the average number of spectators depends on the individual club (see Figure 7.2). Eisbären Berlin is the most popular club in the DEL with an average attendance of 14,000 spectators. The majority of matches of Eisbären Berlin is sold out, the average *attendance/capacity-ratio* is 98%. Nine German clubs attract on average less than 5,000 spectators.

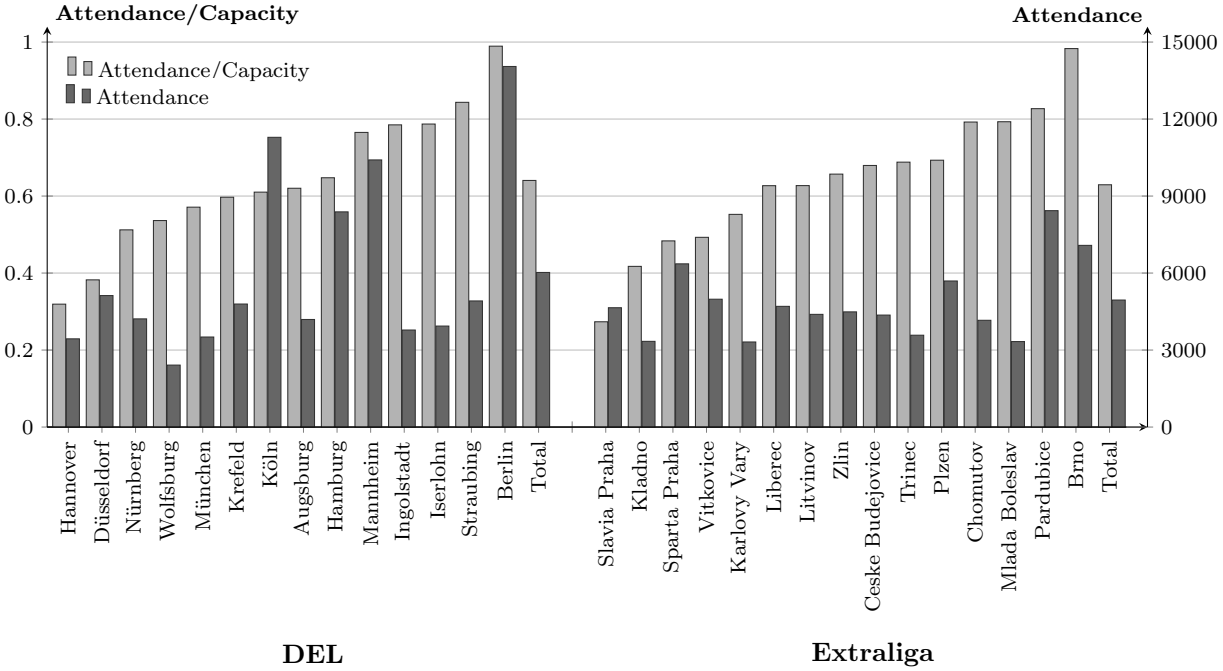


Fig. 7.2 Average Attendance and *attendance/capacity-ratio* per Club

In the Extraliga, the most popular club is Pardubice with on average about 8,500

spectators. Overall, the Czech clubs seem to be more homogenous regarding attendance, although the *attendance/capacity-ratio* varies almost as much as in the DEL.

7.3.2 Descriptive Statistics - NHL-Players and Attendance

Overall, 40 NHL-players signed (temporary) contracts with Czech or German hockey clubs. 28 players decided to play in the Extraliga and twelve in the DEL (see Table 7.2).

DEL		**Extraliga**	
	NHL-Players		**NHL-Players**
Hannover	1	Slavia Praha	1
Düsseldorf	0	Kladno	5
Nürnberg	0	Sparta Praha	1
Wolfsburg	0	Vitkovice	2
München	2	Karlovy Vary	1
Krefeld	1	Liberec	4
Köln	0	Litvinov	0
Augsburg	0	Zlin	0
Hamburg	1	Ceske Budejovice	5
Mannheim	4	Trinec	2
Ingolstadt	0	Plzen	1
Iserlohn	1	Chomutov	3
Straubing	0	Pardubice	3
Berlin	2	Brno	0
Total	12	Total	28

Tab. 7.2 Number of NHL-Players per Team and League

We have information on the identity of each of these players, the date of arrival and departure, their nationality and the number of all-star games these players appeared in as well as information on the clubs they previously have played for. The NHL-players are distributed over seven German and eleven Czech teams. While the DEL team Adler Mannheim contracted a maximum of four NHL-players, seven German teams forwent signing a NHL-player. The Extraliga clubs Kladno and Ceske Budejovice[70] even signed five NHL-players. The majority of Czech clubs engaged at least one NHL-player, contrary to German teams.[71]

[70] Ceske Budejovice signed five different NHL-players, but only four were with the team at the same time. One player (Martinek Radek) had already left the team after a few days.

[71] The player's names are shown in Table A in the appendix.

		DEL		Extraliga	
		Freq.	**Percent**	**Freq.**	**Percent**
NHL_{home}	0	633	89.15	560	78.87
	1	77	10.85	150	21.13
	Total	710	100	710	100
NHL_{away}	0	629	88.59	554	78.03
	1	81	11.41	156	21.97
	Total	710	100	710	100
$NHL_{overall}$	0	579	81.55	506	71.27
	1	131	18.45	204	28.73
	Total	710	100	710	100

Tab. 7.3 Number of Matches with at least one NHL-Player

There are 131 (204) matches in the DEL (Extraliga) in which at least one NHL-player belongs to either the squad of the home or the away team (see $NHL_{overall}$ in Table 7.3).[72] All of these matches relate to the season 2012/13 in which the NHL-lockout took place, i.e. we can observe at least one 'star' in 37% (57%) of all regular season matches of the DEL (Extraliga) in 2012/13. There are only 18 DEL matches in which more than two NHL-players are on the field (Table 7.4). In the Extraliga, the total number of NHL-players is considerably larger. There is even a match in which eight NHL-players can be observed.

		DEL			Extraliga		
		Freq.	**Percent**	**Cum.**	**Freq.**	**Percent**	**Cum.**
Total Number of NHL-players	0	579	81.55	81.55	506	71.27	71.27
	1	71	10	91.55	63	8.87	80.14
	2	42	5.92	97.46	48	6.76	86.9
	3	12	1.69	99.15	29	4.08	90.99
	4	1	0.14	99.3	24	3.38	94.37
	5	5	0.7	100	23	3.24	97.61
	6	0	0	100	9	1.27	98.87
	7	0	0	100	7	0.99	99.86
	8	0	0	100	1	0.14	100
	Total	710	100		710	100	

Tab. 7.4 Total Number of NHL-Players per Match

Most of the players from the NHL returned to their home country during the lockout.

[72] NHL_{home} *(*NHL_{away}*)* is a dummy variable that indicates if at least one NHL-player belongs to the home (away) team.

Table 7.5 provides respective information on the nationalities of the NHL-players. Because of the restriction on the number of foreign players in both leagues and the insecurity about the length of the lockout, most clubs only contracted native NHL-players. Half of the NHL-players playing in the DEL were German, in the Extraliga even 75% of the NHL-players were Czech.

DEL				**Extraliga**			
Nation	**Freq.**	**Percent**	**Cum.**	**Nation**	**Freq.**	**Percent**	**Cum.**
CAN	3	25.00	25.00	*CAN*	5	17.86	17.86
GER	6	50.00	75.00	*CZE*	21	75.00	92.86
US	1	8.33	83.33	*FIN*	1	3.57	96.43
US CAN	2	16.67	100	*SK*	1	3.57	100
Total	12	100		Total	28	100	

Tab. 7.5 Nationality of NHL-Players

Table 7.6 reports descriptive statistics of further characteristics of the NHL-players. In Germany every third NHL-player already had played for the respective team in the DEL, in the Extraliga almost half of the NHL-players went back to a club they have played for in the past (*teamexperience*). The previous stint with the team was usually at the beginning of the players' careers and prior to their first NHL experience. It seems that players preferred to play in a known setting rather than in an unknown city.

Variable	**League**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
teamexperience (dummy)	DEL	12	0.33	0.49	0	1
	Extraliga	28	0.46	0.51	0	1
matches played in 2012/13	DEL	12	16.33	8.02	6	32
	Extraliga	28	19.14	8.80	4	34
age	DEL	12	28.84	3.73	23.18	35.25
	Extraliga	28	29.08	4.81	24.07	40.60
All Star (dummy)	DEL	12	0.33	0.49	0	1
	Extraliga	28	0.14	0.36	0	1
years played in NHL	DEL	12	7.67	3.87	3	15
	Extraliga	28	8.29	4.35	3	19
matches played in NHL	DEL	12	422.75	244.96	38	813
	Extraliga	28	470.32	299.27	102	1346
draft pick	DEL	12	67.67	51.05	5	172
	Extraliga	28	83.93	80.60	4	241

Tab. 7.6 Descriptive Statistics of NHL-Player Characteristics

The NHL-players played on average 16 matches for DEL clubs and 19 games for Extraliga teams during the NHL lockout. Some players even stayed for more than 30

matches.[73] The players were on average 29 years old and most of them had not played an All-Star game prior to their engagement in the DEL or Extraliga. Only four players in both the DEL and Extraliga already had experienced an All-Star game. Most of the NHL-players who signed a contract with a German or Czech club previously had played several years in the NHL. 15 players were selected in the first round of the annual NHL draft. Rostislav Klesla (pick number 4), Jaromir Jagr (5) and Blake Wheeler (5) were among the first to be selected. Klesla (Trinec) and Jagr (Kladno) played for Czech teams, Wheeler (München) for a German one.

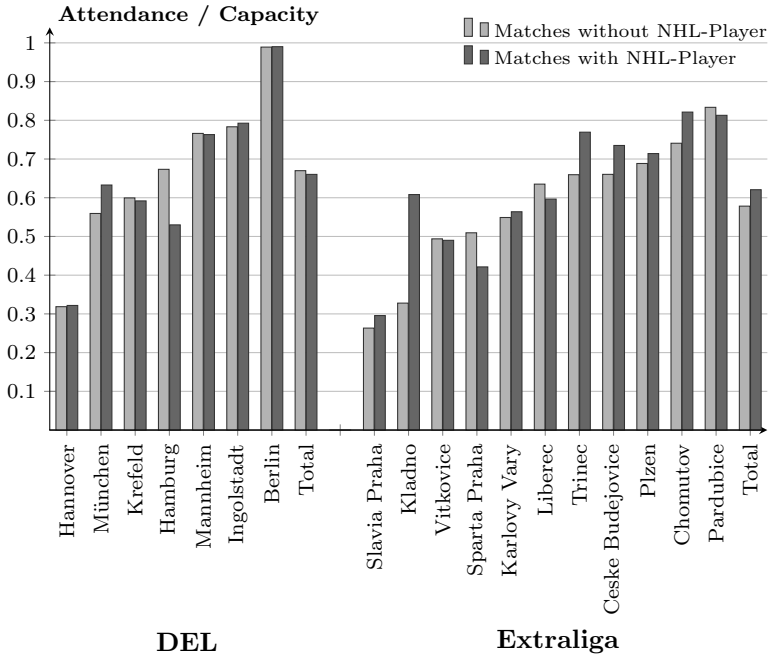


Fig. 7.3 *attendance/capacity-ratio* of Teams with and without NHL-Player

Figure 7.3 compares the *attendance/capacity-ratio* of matches with and without NHL-players for the respective teams. Surprisingly, the attendance of DEL matches with NHL-players is lower than without NHL-players. When we consider attendance per DEL club, there are only marginal differences between matches with and without NHL-players, except for the team from Hamburg. On average 8,700 fans attended a match of the Hamburg Freezers in 2011/12 and 2012/13, but only about 6,900 spectators attended a match after the club contracted the Canadian NHL-player Jamie Benn. In general, the

[73] Jaromir Jagr (Kladno) and Vladimir Sobotka (Slavia Praha) stayed the longest in the Czech Republic, namely 111 days. Christian Ehrhoff (Krefeld) stayed for the longest period in Germany (105 days).

average attendance of Hamburg decreased from 9,200 in 2011/12 to 7,700 in 2012/13. Among other things, this could be due to free tickets that had been given away in an attempt to increase tickets in 2011/12.[74] If we exclude Hamburg from the comparison, there are slightly more spectators at matches with NHL-players than without. Most of the Czech clubs that signed a NHL-player could increase attendance figures, especially Kladno: Kladno almost doubled its *attendance/capacity-ratio* after several NHL-players joined the team.[75] Overall, matches with NHL-players could attract slightly more spectators than matches without NHL-players in the Extraliga, even when we exclude Kladno from the analysis.

7.3.3 Control Variables

Besides the appearance of star players, further factors affect demand and therefore need to be controlled for. Borland and MacDonald (2003) point out that consumer preferences, economic aspects, the quality of viewing, characteristics of the sporting contest and the supply capacity are important determinants of attendance (see section 7.1.1). Hence, we control for most of these determinants. We assume that consumer preferences such as loyalty and habit depend on the respective team and are constant over the two considered seasons. Therefore we control for these factors by including team fixed effects in some of the models. Concerning economic aspects, we make use of data on the market size, measured by the number of inhabitants (*inhabitants*), the unemployment rate of the respective cities (*unemployment*) and the availability of substitutes, measured by the distance between a given team and the nearest other first division hockey team (*distancehockey*). Ticket prices are unavailable for both leagues.[76] Table 7.7 reports descriptive statistics on these variables as well as on further control variables. The German clubs are located in larger cities than the Czech teams. The number of inhabitants is

[74] www.taz.de/!107131/

[75] This could be due to the fact that Jaromir Jagr, the most popular hockey player in the Czech Republic, was amongst the NHL-players who joined Kladno's team.

[76] Even in case data on prices were available, it would be problematic to include prices into the analysis. Empirical analysis of the impact of ticket prices on attendance often lacks meaningful results because it is not obvious how to deal with the different categories of tickets and prices (Villar and Guerrero, 2009).

almost twice as high. The unemployment rates of the clubs' cities range between 3.3% (Ingolstadt) and 16% (Litvinov). On average the unemployment rate is higher in Czech than in German cities. As the area of the Czech Republic is smaller than the area of Germany the distances between hockey opponents are shorter for Czech hockey teams.

An important factor for the quality of viewing at a sporting event is the age and the modernity of an arena. In order to control for this kind of quality, we collected data on the age of an arena (*arenaage*) and the year of the most recent renovation (*arenarenovation*). Table 7.7 shows that Czech arenas are almost twice as old as the arenas in Germany. Furthermore, Czech arenas are modernized less often than German ones. The quality of viewing also depends on the atmosphere of an arena. An arena exclusively build for hockey is expected to have a better atmosphere than multifunctional arenas. In the Extraliga, 10 out of 15 arenas are multifunctional while 9 out of 14 arenas are multifunctional in Germany. We control for the different kinds of arenas by including a dummy variable that indicates if an arena is multifunctional or not (*multifunctional*).

Variable	**League**	**Level**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
inhabitants (Mio)	DEL	team	14	0.74	0.93	0.05	3.44
	Extraliga	team	15	0.26	0.41	0.03	1.24
unemployment	DEL	team	14	7.05	2.35	3.3	11.95
	Extraliga	team	15	8.60	3.57	4.24	15.80
distancehockey	DEL	team	14	94.00	55.27	27	240
	Extraliga	team	15	62.57	39.38	1	135
arenaage	DEL	team	14	20.35	9.87	12.58	44.84
	Extraliga	team	15	39.32	11.39	21.15	51.71
arenarenovation	DEL	team	14	6.69	2.56	3.22	12.45
	Extraliga	team	15	11.06	5.64	6.73	26.17
multifunctional	DEL	team	14	0.64	0.50	0	1
	Extraliga	team	15	0.67	0.49	0	1
6pm (dummy)	DEL	match	710	0.64	0.48	0	1
	Extraliga	match	710	0.58	0.49	0	1
Christmas (dummy)	DEL	match	710	0.03	0.16	0	1
	Extraliga	match	710	0.02	0.15	0	1
distance	DEL	match	710	408.22	199.94	27	791
	Extraliga	match	710	237.55	138.79	1	530
heterogeneity	DEL	match	710	0.12	0.15	-0.30	0.55
	Extraliga	match	710	0.14	0.15	-0.30	0.52
capacity	DEL	match	710	9468.74	4236.63	4500	18500
	Extraliga	match	710	8401.41	3206.06	4200	17000

Tab. 7.7 Descriptive Statistics of Control Variables

The time and day of a match is another important factor influencing the quality of viewing. Most of the games of both leagues take place on either Friday or Sunday (see

Table 7.8). Because of the high share of these days we include a dummy variable that indicates whether a match takes place on one of these main days or not (*mainday*). The majority of games starts after 5pm except for Sunday games of the DEL. Here, more than 30% start at 2.30pm and more than 50% at 4.30pm. We assume that games that start in the evening attract a larger crowd than matches that started earlier in the day. Hence, we control for matches that starts at or after 6pm (*6pm*). Finally, we also control for holidays. As several studies find that attendance is higher when matches are played on holidays (Borland and MacDonald, 2003, p. 488; Villar and Guerrero, 2009, p. 146) we include a respective variable (*Christmas*). *Christmas* indicates if a match is played between December 23rd and January 2nd, the usual time frame for Christmas holidays. About 2 to 3 percent of the matches are played during Christmas holidays.

	DEL			**Extraliga**		
	Freq.	**Percent**	**Cum.**	**Freq.**	**Percent**	**Cum.**
Monday	13	1.83	1.83	11	1.55	1.55
Tuesday	79	11.13	12.96	128	18.03	19.58
Wednesday	23	3.24	16.2	64	9.01	28.59
Thursday	6	0.85	17.04	37	5.21	33.8
Friday	299	42.11	59.15	222	31.27	65.07
Saturday	6	0.85	60	2	0.28	65.35
Sunday	284	40	100	246	34.65	100
Total	710	100		710	100	

Tab. 7.8 Weekdays of matches

Characteristics of the sporting contest refer, among others, to the quality and significance of a match as well as to the uncertainty of outcome. The quality of a match can be proxied by the sum of abilities of the respective teams. In the subsequent analysis, the teams' skills are represented by the ranking of the teams prior to the respective match (*rank*). Rivalry has been shown to impact attendance as well. The rivalry between two teams mostly refers to geographical closeness of the teams. Hence, we include the variable *distance* that measures the distance in kilometers between the home and away team.[77] The distance between the two cities can also be considered as an economic factor: the longer the distance, the higher the travel costs for fans of the away team. Therefore we expect a negative impact of *distance* on attendance. In addition, we include the match

[77]We calculated the differences between the cities by using Google Maps.

day and its squared value into our analysis (*matchday*, $matchday^2$) since we expect that the importance or attractiveness of games varies over the course of a season.[78] Another characteristic of a sporting contest relates to the uncertainty of outcome. Fans might be more interested in 'uncertain' matches than in matches that seem to be decided in advance (see e.g. Rottenberg, 2000; Zimbalist, 2002). We measure the uncertainty of outcome as the difference between the home team's and away team's winning probabilities (*heterogeneity*). We calculate winning probabilities by means of betting odds that stem from the website www.betexplorer.com. Table 7.7 shows that matches of the Extraliga seem to be slightly less balanced than games of the DEL (0.14 vs. 0.12).

Finally, Borland and MacDonald (2003) declare that the capacity of an arena is an important factor for the demand of sporting contests. Therefore we also control for the capacity of an arena (*capacity*). The German arenas have a slightly higher capacity than the ones in the Czech Republic. The German arenas hold on average more than 9,500 spectators, while the Czech arenas have an average capacity of about 8,500.

7.4 Empirical Analysis

As there are teams with up to five NHL-players at the same time, we use two different variables to test the impact of 'stars' on attendance: First, we use a dummy variable that indicates if there is at least one NHL-player in the home respectively away team (NHL_{home}/NHL_{away}). Second, we control for the number of NHL-Players of the home respectively away team ($Number\ NHL_{home}/Number\ NHL_{away}$). For each league we estimate regressions with both alternatives. As explained above, the *attendance/capacity-ratio* of a match by home team i against away team j at matchday t is our dependent variable. As this ratio is right censored we estimate Tobit models in the subsequent analysis. For each league we estimate Tobit models of the following basic form:

[78] We assume that matches at the begin and the end of a season attract more fans than matches in the middle of an ongoing season. Hockey fans often long for the start of the season as they have to do without during summer. Hence, the demand for hockey matches should be higher in the first matches of a season. Whether a team achieves to qualify for the postseason often is decided in the last matches of the regular season. Therefore, matches at the end of the season often are more important and attractive respectively.

$$
\begin{aligned}
att./cap. - ratio_{ijt} = \beta_0 &+ \beta_1 \cdot NHL_i + \beta_2 \cdot NHL_j + \beta_3 \cdot inhabitants_i + \beta_4 \cdot unemployment_i \\
&+ \beta_5 \cdot distancehockey_i + \beta_6 \cdot arenarenovation_i + \beta_7 \cdot arenarenovation_i^2 \\
&+ \beta_8 \cdot multifunctional_i + \beta_9 \cdot mainday_{ijt} + \beta_{10} \cdot 6pm_{ijt} + \beta_{11} \cdot Christmas_{ijt} \\
&+ \beta_{12} \cdot rank_i + \beta_{13} \cdot rank_j + \beta_{14} \cdot distance_{ij} + \beta_{15} \cdot heterogeneity_{ijt} \\
&+ \beta_{16} \cdot matchday_{ijt} + \beta_{17} \cdot matchday_{ijt}^2 + \beta_{17} \cdot capacity_i + \epsilon_{ijt}
\end{aligned}
$$

Furthermore, we run estimations without team- and time-constant variables but home and away team fixed effects. Tables 7.9 and 7.10 show the results of the presence and the number of NHL-players on attendance in matches of the DEL (Model 1 and 2, 5 and 6) and the Extraliga (Model 3 and 4, 7 and 8).

Results illustrate that the impact of stars on attendance depends on the league and the model specification. Model 1 and 2 indicate that stars do not affect attendance in the DEL, neither if a star is playing for the home nor the away team. In contrast to the DEL, the presence of stars increases fan interest significantly in the Extraliga (Model 3 and 4). However, if we do not include home and away team fixed effects, stars only attract more Czech fans if they play for the away team (Model 3). Once team fixed effects are included stars of both home and away team increase attendance significantly. The coefficient of NHL_{home} is considerably larger than the coefficient of NHL_{away} (0.05 vs. 0.03). Stars on a home team's roster raise the demand for hockey matches by more than 5%, i.e. a home team can increase attendance by about 420 spectators per match when they sign a star player.

We obtain similar results when we replace the dummy variables NHL_{home} and NHL_{away} by the number of NHL-players that play for the home respectively away team (*Number* NHL_{home}, *Number* NHL_{away}). Table 7.10 confirms that the star effect depends on the considered league and model. Again, star effects are negligible for the German DEL. The star variable is only significant in Model 5, i.e. when we exclude home and away team fixed effects. In case we control for time-invariant team effects, results show that German hockey fans do not react to the presence of NHL-players.

	DEL		Extraliga	
	Model 1	**Model 2**	**Model 3**	**Model 4**
NHL_{home}	0.0311	0.0065	0.0096	0.0520***
	(0.0231)	(0.0158)	(0.0219)	(0.0157)
NHL_{away}	0.0031	0.0076	0.0717***	0.0330**
	(0.0215)	(0.0152)	(0.0216)	(0.0162)
inhabitants	0.1199***		0.2368***	
	(0.0110)		(0.0443)	
unemployment	0.0018		0.0061**	
	(0.0050)		(0.0029)	
distancehockey	0.0006***		0.0023***	
	(0.0001)		(0.0003)	
arenarenovation	-0.0081*	-0.0104	-0.0093***	0.0103
	(0.0043)	(0.0191)	(0.0029)	(0.0160)
$arenarenovation^2$	-0.0002	0.0000	0.0002***	-0.0003
	(0.0002)	(0.0007)	(0.0001)	(0.0004)
multifunctional	-0.0672***		0.0388**	
	(0.0210)		(0.0183)	
$rank_{home}$	-0.0117***	-0.0037***	-0.0048***	-0.0052***
	(0.0012)	(0.0009)	(0.0009)	(0.0007)
$rank_{away}$	-0.0037***	-0.0011	-0.0035***	-0.0022***
	(0.0012)	(0.0009)	(0.0009)	(0.0007)
distance	-0.0002***	-0.0002***	-0.0004***	-0.0003***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
heterogeneity	0.0653	0.0293	0.1220**	0.0110
	(0.0814)	(0.0664)	(0.0612)	(0.0542)
Christmas	0.1394***	0.1368***	0.0730*	0.0838***
	(0.0398)	(0.0263)	(0.0413)	(0.0281)
mainday	0.0775***	0.0649***	0.0682***	0.0650***
	(0.0162)	(0.0107)	(0.0132)	(0.0091)
6pm	0.0136	-0.0130	0.0107	-0.0265***
	(0.0130)	(0.0087)	(0.0139)	(0.0099)
matchday	-0.0008	0.0001	-0.0015	-0.0015
	(0.0018)	(0.0012)	(0.0018)	(0.0012)
$matchday^2$	0.0001**	0.0001**	0.0000	0.0000*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
capacity	-0.0139***		-0.0474***	
	(0.0025)		(0.0044)	
season2012	-0.0105	-0.0130	-0.0115	-0.0231
	(0.0138)	(0.0134)	(0.0175)	(0.0143)
Constant	0.9187***	0.8714***	0.9208***	0.8573***
	(0.0533)	(0.0962)	(0.0579)	(0.0427)
hometeam dummies	No	Yes	No	Yes
awayteam dummies	No	Yes	No	Yes
Observations	710	710	710	710
McKelvey & Zavoina's R2	0.551	0.806	0.502	0.779

- dependent variable: *attendance/capacity-ratio*
- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

Tab. 7.9 Tobit Results for NHL_{home} / NHL_{away}

Similar to the previous estimation, demand of Czech fans significantly increases once stars play for the competing teams. In contrast to Model 4, Model 8 suggests that the presence of stars has a stronger effect when they play for the away teams. The more stars belong to the teams' squads the more Czech fans can be attracted. Overall, analysis shows that stars have no universal effect on demand. While star players attract significantly more spectators in the Czech league, German hockey teams hardly benefit

from such players. Underlying conditions tend to affect the impact of stars and hence, have to be taken into account.

	DEL		Extraliga	
	Model 5	**Model 6**	**Model 7**	**Model 8**
Number NHL$_{home}$	0.0309**	0.0142	0.0109	0.0276***
	(0.0142)	(0.0097)	(0.0085)	(0.0063)
Number NHL$_{away}$	0.0063	0.0092	0.0540***	0.0465***
	(0.0140)	(0.0099)	(0.0085)	(0.0067)
inhabitants	0.1211***		0.2394***	
	(0.0110)		(0.0438)	
unemployment	0.0015		0.0066**	
	(0.0050)		(0.0029)	
distancehockey	0.0005***		0.0023***	
	(0.0001)		(0.0003)	
arenarenovation	-0.0079*	-0.0069	-0.0105***	0.0044
	(0.0043)	(0.0190)	(0.0028)	(0.0152)
arenarenovation^2	-0.0002	-0.0001	0.0002***	-0.0002
	(0.0002)	(0.0007)	(0.0001)	(0.0003)
multifunctional	-0.0675***		0.0345*	
	(0.0208)		(0.0177)	
rank$_{home}$	-0.0117***	-0.0037***	-0.0046***	-0.0050***
	(0.0012)	(0.0009)	(0.0009)	(0.0007)
rank$_{away}$	-0.0034***	-0.0010	-0.0043***	-0.0031***
	(0.0012)	(0.0009)	(0.0009)	(0.0007)
distance	-0.0002***	-0.0002***	-0.0003***	-0.0003***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
heterogeneity	0.0535	0.0273	0.1818***	0.0878
	(0.0822)	(0.0664)	(0.0631)	(0.0602)
Christmas	0.1408***	0.1361***	0.0912**	0.1034***
	(0.0396)	(0.0262)	(0.0404)	(0.0267)
mainday	0.0773***	0.0649***	0.0676***	0.0624***
	(0.0161)	(0.0107)	(0.0129)	(0.0086)
6pm	0.0136	-0.0131	0.0114	-0.0269***
	(0.0130)	(0.0087)	(0.0136)	(0.0094)
matchday	-0.0012	-0.0003	-0.0026	-0.0029**
	(0.0018)	(0.0012)	(0.0018)	(0.0012)
matchday^2	0.0001**	0.0001***	0.0001**	0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
capacity	-0.0140***		-0.0469***	
	(0.0024)		(0.0043)	
season2012	-0.0142	-0.0188	-0.0284*	-0.0425***
	(0.0134)	(0.0131)	(0.0160)	(0.0127)
Constant	0.9284***	0.8474***	0.9233***	0.8744***
	(0.0534)	(0.0961)	(0.0567)	(0.0406)
hometeam dummies	No	Yes	No	Yes
awayteam dummies	No	Yes	No	Yes
Observations	710	710	710	710
McKelvey & Zavoina's R2	0.553	0.806	0.526	0.802

- dependent variable: *attendance/capacity-ratio*
- Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

Tab. 7.10 Tobit Results for Number NHL$_{home}$ / Number NHL$_{away}$

Several control variables also have a significant effect on the dependent variable. Similar to the NHL variables, the impact of the controls depend on the model specification, e.g. *arenarenovation* is significant negative and *arenarenovation*^{2} significant positive in Model 3, but insignificant in Model 4. Including team fixed effects tend to reduce the

significance of the (time-varying) explanatory variables while the proportion of explained variance increases. This suggests that team specific effects account for a major part of demand for hockey matches.

In almost all models the coefficients of *mainday*, *distance* and *Christmas* are highly significant. The demand for hockey significantly increases, when a match takes place on a Friday or Sunday and especially during (*Christmas*) holidays. The greater the distance between the competing teams, the fewer spectators attend a match since the degree of rivalry decreases and travel costs for the fans of the away team increase.

In Germany fans prefer ice hockey arenas to multifunctional arenas: The dummy variable *multifunctional* is significant and negative (Model 1 and 5). In the Czech Republic it is the other way round: *multifunctional* is significant and positive. Models without team dummies show further differences between the DEL and Extraliga: The unemployment rate in Germany is insignificant while it is significant and positive in the Czech Republic. Existing literature argues that unemployment can have both a positive and negative effect on attendance. Some authors assume that unemployment is negatively related to attendance, because less people can afford to buy tickets with increasing unemployment. Other authors share the opinion that unemployment can have a positive effect on attendance as sports can help people to "manage personal frustrations" (Villar and Guerrero, 2009, p. 135). The results confirm both positions.

Similar effects for DEL and Extraliga matches are shown for the number of inhabitants and the teams' ranks on attendance: The more inhabitants live in the respective cities, the more spectators attend to a match. The rank of the home and away team prior to a match has a negative and significant impact on attendance. Hence, the assumption that the quality of the two teams is an important determinant of attendance is confirmed.

7.5 Conclusion

In contrast to previous studies on the impact of stars on attendance, we do not focus on players who stay in the league for an entire season but players who come and go over the course of a season. We make use of the NHL lockout in 2012/13 and analyze whether the

appearance of NHL-players affect attendance in other hockey leagues, namely the Czech Extraliga and the German DEL. Results show that stars attract significantly more fans in the Czech Extraliga while the impact of stars mostly is insignificant in the German DEL.

At first sight the differences between the leagues are difficult to explain. However, at second glance there is some reasoning behind the results: First, hockey is of considerably higher significance in the Czech Republic than it is in Germany. While average attendance of Extraliga games is comparable to that of DEL matches, the number of German inhabitants is more than seven times higher than the number of Czech inhabitants. Therefore it can be assumed that hockey awareness is substantial higher in the Czech Republic. Second, the NHL is considerably more popular in the Czech Republic than in Germany as a high share of Czech hockey players is active in the NHL.[79] Furthermore, the Czech national hockey team is quite successful while the German team is rather unsuccessful.[80] International success of a national team is an important determinant for attracting interest for the respective sport in the public. Hence, there is substantially greater attention to hockey in the Czech Republic than in Germany. In consideration of these two facts the results are not surprising. Concluding, the results suggest that the presence of popular players only leads to an increase in attendance if the respective sport is popular in the relevant country. In the Extraliga, more fans were attracted and hence, more tickets could be sold. It can be assumed that Czech clubs could benefit economically from the star players. On the contrary, we suggest that signing NHL-players did not pay off for German clubs. German teams had to pay high insurance fees while they could not increase fan interest.

Future research could replicate our analysis with data from other leagues, e.g. the Russian or Swedish league. In these countries hockey is of high importance. Hence, we expect that NHL-players could also increase attendance significantly, similar to the

[79]So far, a total of 220 Czech players - six times as many as German hockey players (37) - have been playing in the NHL ever since. www.quanthockey.com/nhl/nationality-totals/nhl-players-career-stats.html

[80]The Czech Republic respectively Czechoslovakia has won 10 Olympic medals until today. Germany could win a medal only once. While the Czech Republic could celebrate their most recent Olympic medal in 2012, the Germans are waiting for the next hockey medal since 1953.

Extraliga. It also would be interesting to examine whether such star effects depend on the considered sport. However, as lockouts in other leagues, e.g. in the NBA or NFL, rarely cause players to play in other leagues such comparisons seem to be difficult.

7.6 Appendix

	Extraliga			DEL	
	Player	**Team**		**Player**	**Team**
1	Polak, Roman	Vitkovice HC	1	Seidenberg, Dennis	Adler Mannheim
2	Kuba, Filip	Vitkovice HC	2	Goc, Marcel	Adler Mannheim
3	Klesla, Rostislav	Trinec Ocelari HC	3	Pominville, Jason	Adler Mannheim
4	Hudler, Jiri	Trinec Ocelari HC	4	Hecht, Jochen	Adler Mannheim
5	Neuvirth, Michal	Sparta Praha	5	Wheeler, Blake	EHC Red Bull München
6	Sobotka, Vladimir	Slavia Praha HC	6	Stastny, Paul	EHC Red Bull München
7	Rask, Tuukka	Plzen HC	7	Giroux, Claude	Eisbären Berlin
8	Kindl, Jakub	Pardubice HC	8	Briere, Daniel	Eisbären Berlin
9	Hemsky, Ales	Pardubice HC	9	Sulzer, Alexander	ERC Ingolstadt
10	Krejci, David	Pardubice HC	10	Benn, Jamie	Hamburg Freezers
11	Pavelec, Ondrej	Liberec Bili Tygri HC	11	Greiss, Thomas	Hannover Scorpions
12	Smid, Ladislav	Liberec Bili Tygri HC	12	Ehrhoff, Christian	Krefeld Pinguine
13	Simmonds, Wayne	Liberec Bili Tygri HC			
14	Stewart, Chris	Liberec Bili Tygri HC			
15	Jagr, Jaromir	Kladno			
16	Plekanec, Tomas	Kladno			
17	Zidlicky, Marek	Kladno			
18	Tlusty, Jiri	Kladno			
19	Kaberle, Tomas	Kladno			
20	MacDonald, Andrew	Karlovy Vary HC			
21	Frolik, Michael	Chomutov Pirati			
22	Jurcina, Milan	Chomutov Pirati			
23	Chimera, Jason	Chomutov Pirati			
24	Radek, Martinek	Ceske Budejovice HC			
25	Ference, Andrew	Ceske Budejovice HC			
26	Hanzal, Martin	Ceske Budejovice HC			
27	Michalek, Milan	Ceske Budejovice HC			
28	Prospal, Vaclav	Ceske Budejovice HC			

Tab. 7.11 Name and Team of NHL-Players Playing in the Extraliga or DEL

8 Summary and Outlook

The present work empirically analyzes different aspects of economic theory: The first part concentrates on distinct implications drawn from tournament theory. *First*, the research focuses on tournaments and their effect on effort, sabotage and risk-taking. Overall, the results indicate that the availability of intermediate information significantly affects contestants' behavior. Effort, the willingness to sabotage the opponent as well as risk-taking are adjusted to interim results. In contrast to information on within-tournament asymmetry, ex-ante heterogeneity has proven to be insignificant (except for the case of sabotage). With reference to effort (chapter 2), we make use of extensive performance statistics recently available for players of the German Bundesliga. In a new approach we relate effort to running data such as the distance run or the number of sprints and intensive runs performed by an individual player per match. The results indicate that effort is greatest when a player's team leads by one goal. As players weigh potential losses more than gains these results are in line with the concept of loss aversion. In case intermediate information points at an increasing within-contest asymmetry, effort of both participating teams decline.

In order to test whether agents' willingness to sabotage depends on interim information (chapter 3), we also rely on soccer data on team-level. Teams tend to be more prone to engage in sabotage when they are slightly behind (by one goal) or the ex-ante underdogs. While favorites sabotage most when they trail by one goal, underdogs show most of their destructive activities when slightly ahead (by one goal). The least sabotage is to be observed when the (absolute) goal difference equals three or more goals. Further estimations indicate that engaging in sabotage has no or even negative effect on the match-outcome, especially for favorites.

Chapter 4 focuses on agent's risk strategy and its impact on performance. The analysis refers to coaches and their substitution strategy and exploits data from the UEFA

Champions League. Depending on the tactical position of the outgoing and incoming player, a substitution is assessed as risk-increasing or -reducing. Empirical results show that coaches adjust their risk strategy to the current score of a match: lagging contestants tend to increase risk in the course of a match while leading agents change to a safer strategy. Further tests suggest that favorites and underdogs react differently to within-match information: While underdogs reduce risk by larger amounts than favorites when in the lead, favorites increase risk by larger amounts when behind with two or more goals. Similar to sabotage, the chosen risk strategy does not affect the outcome of a match.

Second, we test Höffler and Sliwka's theoretical implication that managerial changes can generate new incentives in case the respective agent*s* are rather homogeneous (chapter 5). The theoretical model by Höffler and Sliwka (2003) is based on tournament theory's assumption that asymmetric contests provide weak incentive effects to exert effort. By using a large data set on the German Bundesliga, we can analyze whether the team composition prior to a within-season dismissal affects its performance under a new manager. Results indicate that the team composition is an important factor for the success of a managerial change: homogeneous teams perform significantly better than heterogeneous teams following a dismissal.

The second part of the thesis deals with another important factor influencing organizational performance: the individual at the top of the organization (chapter 6). By means of an extensive dataset on the German Bundesliga and in an innovative approach we examine the impact of individual coaches on the performance of their teams. The soccer industry is well-suited for this kind of analysis. Since managerial changes occur very frequently within an ongoing season, it is possible to separate the managerial effect from team influences and other aspects. Results indicate that coaches have a significant impact on team performance. We illustrate that there is a considerable variation between coaches contributions. Furthermore, our analysis shows that managers also affect team's style of playing and that once famous and successful players do not necessarily make good managers.

Finally, the perspective changes from the inside of an organization to the outside.

From a market perspective we focus on the determinants of demand for sporting events (chapter 7). We make use of the NHL Lockout in 2012/13 that led many NHL-players to affiliate with teams overseas, e.g. in Germany and Czech. We consider NHL-players to be international hockey stars and hence analyze whether the presence of stars affect the demand for hockey matches in the German hockey league 'DEL' and the Czech counterpart 'Extraliga'. While we find only negligible effects of stars on attendance for matches of the DEL, results indicate that superstars attract considerably more spectators in the Extraliga, especially if stars play for the away team.

The focus of the work at hand lies on tournament theory. I present different studies that analyze certain theoretical implications. Although empirical results provide some new insights into tournament theory, there are still open questions with respect to the effect of contests on participants' behavior. For instance, theoretical literature on the relationship between effort and risk assumes that high risks typically lead to low effort. To the best of my knowledge, this assumption has never been tested empirically so far. Furthermore it would be interesting to investigate whether effort, sabotage and risk-taking interact with each other. Until now research only focuses on one of these factors.

In contrast to previous years, the modern world is addicted to data. Everywhere data on individual behavior are collected, be it in sports, social media, consumer behavior, organizations, traffic or other fields of interest. Hence, more and more data become available so that more detailed empirical analysis may be possible for future studies on tournaments and further economic research questions. So far, many of the empirical pieces of evidence rely on sports data as data on performance in other industries are hardly available. Szymanski (2003) points out that sports are not to be equated with natural experiments within the scope of empirical research on moral hazard or adverse selection since the theoretical assumption that monitoring agents is costly or not possible is not true for sporting contests. With improving data availability it may be possible to find even better settings for this kind of investigations in future. Nevertheless, sports data provide a well-suited setting for economic research and helps to better understand individual's behavior and economic relationships.

Bibliography

Abowd, J. M., Kramarz, F., and Margolis, D. N. (1999). High wage workers and high wage firms. *Econometrica*, 67(2):251–333.

Allen, M. P., Panian, S. K., and Lotz, R. E. (1979). Managerial succession and organizational performance: A recalcitrant problem revisited. *Administrative Science Quarterly*, 24(2):167–180.

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press, Princeton, NJ.

Aoyagi, M. (2010). Information feedback in a dynamic tournament. *Games and Economic Behavior*, 70(2):242–260.

Arrow, K. J. (1985). The economics of agency. In Zeckhauser, R. J. and Pratt, J. W., editors, *Principals and agents: The structure of business*, pages 37–51. Harvard Business School Press Boston, Boston.

Ashenfelter, O. (1978). Estimating the effect of training programs on earnings. *The Review of Economics and Statistics*, 60(1):47–57.

Audas, R., Dobson, S., and Goddard, J. (1999). Organizational performance and managerial turnover. *Managerial and Decision Economics*, 20(6):305–318.

Audas, R., Dobson, S., and Goddard, J. (2002). The impact of managerial change on team performance in professional sports. *Journal of Economics and Business*, 54(6):633–650.

Audas, R., Goddard, J., and Dobson, S. (1997). Team performance and managerial change in the English football league. *Economic Affairs*, 17(3):30–36.

Azmat, G. and Iriberri, N. (2010). The importance of relative performance feedback information: Evidence from a natural experiment using high school students. *Journal of Public Economics*, 94(7):435–452.

Bach, N., Gürtler, O., and Prinz, J. (2009). Incentive effects in tournaments with heterogeneous competitors - An analysis of the Olympic rowing regatta in Sydney 2000. *management revue*, 20(3):239–253.

Backes-Gellner, U. and Pull, K. (2013). Tournament compensation systems, employee heterogeneity, and firm performance. *Human Resource Management*, 52(3):375–398.

Baik, K. (1994). Effort levels in contests with two asymmetric players. *Southern Economic Journal*, 61(2):367–378.

Balafoutas, L., Lindner, F., and Sutter, M. (2012). Sabotage in tournaments: Evidence from a natural experiment. *Kyklos*, 65(4):425–441.

Bamber, L. S., Jiang, J., and Wang, I. Y. (2010). What's my style? The influence of top managers on voluntary corporate financial disclosure. *The Accounting Review*, 85(4):1131–1162.

Barros, C., Frick, B., and Passos, J. (2009). Coaching for survival: The hazards of head coach careers in the German 'Bundesliga'. *Applied Economics*, 41(25):3303–3311.

Bartling, B., Brandes, L., and Schunk, D. (2015). Expectations as reference points: Field evidence from professional soccer. *Management Science*, 61(11):2646–2661.

Becker, B. E. and Huselid, M. A. (1992). The incentive effects of tournament compensation systems. *Administrative Science Quarterly*, 37(2):336–350.

Berger, J. and Nieken, P. (2016). Heterogeneous contestants and the intensity of tournaments: An empirical investigation. *Journal of Sports Economics*, 17(7):631–660.

Berger, J. and Pope, D. (2011). Can losing lead to winning? *Management Science*, 57(5):817–827.

Bergerhoff, J. and Vosen, A. (2015). Can being behind get you ahead? Reference dependence and asymmetric equilibria in an unfair tournament. Econ Discussion Papers No. 03/2015, University of Bonn, Germany.

Berri, D. J. and Schmidt, M. B. (2006). On the road with the National Basketball Association's superstar externality. *Journal of Sports Economics*, 7(4):347–358.

Berri, D. J., Schmidt, M. B., and Brook, S. L. (2004). Stars at the gate - The impact of star power on NBA gate revenues. *Journal of Sports Economics*, 5(1):33–50.

Bertrand, M. and Schoar, A. (2003). Managing with style: The effect of managers on firm policies. *Quarterly Journal of Economics*, 118(4):1169–1208.

Borland, J. and MacDonald, R. (2003). Demand for sport. *Oxford Review of Economic Policy*, 19(4):478–502.

Brandes, L., Franck, E., and Nüesch, S. (2008). Local heroes and superstars: An empirical analysis of star attraction in German soccer. *Journal of Sports Economics*, 9(3):266–286.

Breuer, C. and Singer, R. (1996). Trainerwechsel im Laufe der Spielsaison und ihr Einfluss auf den Mannschaftserfolg. *Leistungssport*, 26(4):41–46.

Bronars, S. (1987). Risk taking in tournaments. Working paper, University of Texas, Austin.

Brown, J. (2011). Quitters never win: The (adverse) incentive effects of competing with superstars. *Journal of Political Economy*, 119(5):982–1013.

Brown, K. C., Harlow, W. V., and Starks, L. T. (1996). Of tournaments and temptations: An analysis of managerial incentives in the mutual fund industry. *Journal of Finance*, 51(1):85–110.

Brown, M. C. (1982). Administrative succession and organizational performance: The succession effect. *Administrative Science Quarterly*, 27(1):1–16.

Bruinshoofd, A. and ter Weel, B. (2003). Manager to go? Performance dips reconsidered with evidence from Dutch football. *European Journal of Operational Research*, 148(2):233–246.

Bryson, A., Frick, B., and Simmons, R. (2013). The returns to scarce talent: Footedness and player remuneration in European soccer. *Journal of Sports Economics*, 14(6):606–628.

Bull, C., Schotter, A., and Weigelt, K. (1987). Tournaments and piece rates: An experimental study. *Journal of Political Economy*, 95(1):1–33.

Buraimo, B., Frick, B., Hickfang, M., and Simmons, R. (2015). The economics of long-term contracts in the footballers' labour market. *Scottish Journal of Political Economy*, 62(1):8–24.

Büschemann, A. and Deutscher, C. (2011). Did the 2005 collective bargaining agreement really improve team efficiency in the NHL? *International Journal of Sport Finance*, 6(4):298–306.

Busse, J. A. (2001). Another look at mutual fund tournaments. *Journal of Financial and Quantitative Analysis*, 36(1):53–73.

Carmichael, F. and Thomas, D. (1995). Production and efficiency in team sports: An investigation of rugby league football. *Applied Economics*, 27(9):859–869.

Carpenter, J., Matthews, P. H., and Schirm, J. (2010). Tournaments and office politics: Evidence from a real effort experiment. *The American Economic Review*, 100(1):504–517.

Casas-Arce, P. and Martínez-Jerez, F. A. (2009). Relative performance compensation, contests, and dynamic incentives. *Management Science*, 55(8):1306–1320.

Chevalier, J. A. and Ellison, G. D. (1997). Risk taking by mutual funds as a response to incentives. *Journal of Political Economy*, 105(6):1167–1200.

Chowdhury, S. M. and Gürtler, O. (2015). Sabotage in contests: A survey. *Public Choice*, 164(1-2):135–155.

Clark, D. J. and Riis, C. (2000). Allocation efficiency in a competitive bribery game. *Journal of Economic Behavior & Organization*, 42(1):109–124.

Clarke, S. R. and Norman, J. M. (1995). Home ground advantage of individual clubs in English soccer. *The Statistician*, 44(4):509–521.

Coase, R. H. (1937). The nature of the firm. *Economica*, 4(16):386–405.

Coates, D., Battré, M., and Deutscher, C. (2012). Does violence in professional ice hockey pay? Cross country evidence from three leagues. In Jewell, R. T., editor, *Violence and Aggression in Sporting Contests*, pages 47–63. Springer, New York.

Coates, D. and Humphreys, B. R. (2012). Game attendance and outcome uncertainty in the National Hockey League. *Journal of Sports Economics*, 13(4):364–377.

Cocco, A. and Jones, J. (1997). On going south: The economics of survival and relocation of small market NHL franchises in Canada. *Applied Economics*, 29(11):1537–1552.

Conyon, M. J., Peck, S. I., and Sadler, G. V. (2001). Corporate tournaments and executive compensation: Evidence from the U.K. *Strategic Management Journal*, 22(8):805–815.

Courneya, K. S. and Carron, A. V. (1992). The home advantage in sport competitions: A literature review. *Journal of Sport & Exercise Psychology*, 14(1):13–27.

Dato, S. and Nieken, P. (2014). Gender differences in competition and sabotage. *Journal of Economic Behavior & Organization*, 100(c):64–80.

Dawson, P. and Dobson, S. (2002). Managerial efficiency and human capital: An application to English association football. *Managerial and Decision Economics*, 23(8):471–486.

Dawson, P., Dobson, S., and Gerrard, B. (2000a). Estimating coaching efficiency in professional team sports: Evidence from English association football. *Scottish Journal of Political Economy*, 47(4):399–421.

Dawson, P., Dobson, S., and Gerrard, B. (2000b). Stochastic frontiers and the temporal structure of managerial efficiency in English soccer. *Journal of Sports Economics*, 1(4):341–362.

De Paola, M. and Scoppa, V. (2012). The effects of managerial turnover: Evidence from coach dismissals in Italian soccer teams. *Journal of Sports Economics*, 13(2):152–168.

Del Corral, J., Prieto-Rodriguez, J., and Simmons, R. (2010). The effect of incentives on sabotage: The case of Spanish football. *Journal of Sports Economics*, 11(3):243–260.

Deutscher, C., Frick, B., Gürtler, O., and Prinz, J. (2013). Sabotage in tournaments with heterogeneous contestants: Empirical evidence from the soccer pitch. *Scandinavian Journal of Economics*, 115(4):1138–1157.

Dohmen, T. J. (2008). The influence of social forces: Evidence from the behavior of football referees. *Economic Inquiry*, 46(3):411–424.

Dye, R. A. (1984). The trouble with tournaments. *Economic Inquiry*, 22(1):147–149.

Dyreng, S. D., Hanlon, M., and Maydew, E. L. (2010). The effects of executives on corporate tax avoidance. *The Accounting Review*, 85(4):1163–1189.

Ederer, F. (2010). Feedback and motivation in dynamic tournaments. *Journal of Economics & Management Strategy*, 19(3):733–769.

Ehrenberg, R. G. and Bognanno, M. L. (1990a). Do tournaments have incentive effects? *Journal of Political Economy*, 98(6):1307–1324.

Ehrenberg, R. G. and Bognanno, M. L. (1990b). The incentive effects of tournaments revisited: Evidence from the European PGA tour. *Industrial & Labor Relations Review*, 43(3):74–88.

Eriksson, T. (1999). Executive compensation and tournament theory: Empirical tests on Danish data. *Journal of Labor Economics*, 17(2):262–280.

Fabianic, D. (1994). Managerial change and organizational effectiveness in Major League Baseball: Findings for the eighties. *Journal of Sport Behavior*, 17(3):139–152.

Falk, A., Fehr, E., and Huffman, D. (2008). The power and limits of tournament incentives. Working paper, University of Bonn, Germany.

Feess, E., Mühlheusser, G., and Walzl, M. (2008). Unfair contests. *Journal of Economics*, 93(3):267–291.

Fernie, S. and Metcalf, D. (1999). It's not what you pay it's the way that you pay it and that's what gets results: Jockeys' pay and performance. *LABOUR*, 13(2):385–411.

Fizel, J. L. and D'Itry, M. P. (1997). Managerial efficiency, managerial succession and organizational performance. *Managerial and Decision Economics*, 18(4):295–308.

Franck, E. and Nüesch, S. (2010). The effect of talent disparity on team productivity in soccer. *Journal of Economic Psychology*, 31(2):218–229.

Franck, E. and Nüesch, S. (2011). The effect of wage dispersion on team outcome and the way team outcome is produced. *Applied Economics*, 43(23):3037–3049.

Frick, B. (2011). Performance, salaries and contract length: Empirical evidence from German soccer. *International Journal of Sport Finance*, 6(2):87–118.

Frick, B., Gürtler, O., and Prinz, J. (2008). Anreize in Turnieren mit heterogenen Teilnehmern - Eine empirische Untersuchung mit Daten aus der Fussball-Bundesliga. *ZFBF: Schmalenbachs Zeitschrift für Betriebswirtschaftliche Forschung*, 60(4):385–405.

Frick, B. and Prinz, J. (2007). Pay and performance in professional road running: The case of city marathons. *International Journal of Sport Finance*, 2(1):25–35.

Fullerton, R. and McAfee, R. P. (1999). Auctioning entry into tournaments. *Journal of Political Economy*, 107(3):573–605.

Gamson, W. A. and Scotch, N. A. (1964). Scapegoating in baseball. *American Journal of Sociology*, 70(1):69–72.

Garicano, L. and Palacios-Huerta, I. (2014). Sabotage in tournaments: Making the beautiful game a bit less beautiful. In Palacios-Huerta, I., editor, *Beautiful Game Theory: How Soccer Can Help Economics*, pages 124–150. Princeton University Press.

Genakos, C. and Pagliero, M. (2012). Interim rank, risk taking, and performance in dynamic tournaments. *Journal of Political Economy*, 120(4):782–813.

Genesove, D. and Mayer, C. (2001). Loss aversion and seller behavior: Evidence from the housing market. *The Quarterly Journal of Economics*, 116(4):1233–1260.

Gershkov, A. and Perry, M. (2009). Tournaments with midterm reviews. *Games and Economic Behavior*, 66(1):162–190.

Gielen, A. C., Kerkhofs, M. J., and Van Ours, J. C. (2010). How performance related pay affects productivity and employment. *Journal of Population Economics*, 23(1):291–301.

Gill, D. and Stone, R. (2010). Fairness and desert in tournaments. *Games and Economic Behavior*, 69(2):346–364.

Goodall, A. H., Kahn, L. M., and Oswald, A. J. (2011). Why do leaders matter? A study of expert knowledge in a superstar setting. *Journal of Economic Behavior & Organization*, 77(3):265–284.

Gradstein, M. (1995). Intensity of competition, entry and entry deterrence in rent seeking contests. *Economics & Politics*, 7(1):79–91.

Graham, J. R., Li, S., and Qiu, J. (2012). Managerial attributes and executive compensation. *Review of Financial Studies*, 25(1):144–186.

Greene, W. H. (1997). *Econometric analysis*. Prentice Hall, Upper Saddle River.

Grund, C. and Gürtler, O. (2005). An empirical study on risk-taking in tournaments. *Applied Economics Letters*, 12(8):457–461.

Grund, C., Höcker, J., and Zimmermann, S. (2013). Incidence and consequences of risk-taking behavior in tournaments: Evidence from the NBA. *Economic Inquiry*, 51(2):1489–1501.

Grusky, O. (1963). Managerial succession and organizational effectiveness. *American Journal of Sociology*, 69(1):21–31.

Gürtler, O. and Harbring, C. (2010). Feedback in tournaments under commitment problems: Experimental evidence. *Journal of Economics & Management Strategy*, 19(3):771–810.

Gürtler, O., Münster, J., and Nieken, P. (2013). Information policy in tournaments with sabotage. *The Scandinavian Journal of Economics*, 115(3):932–966.

Haas, H. and Nüesch, S. (2012). Are multinational teams more successful? *The International Journal of Human Resource Management*, 23(15):3105–3113.

Hall, S., Szymanski, S., and Zimbalist, A. (2002). Testing causality between team performance and payroll: The cases of Major League Baseball and English soccer. *Journal of Sports Economics*, 3(2):149–168.

Harbring, C. (2006). The effect of communication in incentive systems: An experimental study. *Managerial and Decision Economics*, 27(5):333–353.

Harbring, C. and Irlenbusch, B. (2011). Sabotage in tournaments: Evidence from a laboratory experiment. *Management Science*, 57(4):611–627.

Hausman, J. A. and Leonard, G. K. (1997). Superstars in the National Basketball Association: Economic value and policy. *Journal of Labor Economics*, 15(4):586–624.

Heckman, J. J., Lalonde, R. J., and Smith, J. A. (1999). The economics and econometrics of active labor market programs. In Ashenfelter, O. C. and Card, D., editors, *Handbook of Labor Economics*, volume 3, part A, pages 1865 – 2097. Elsevier, Amsterdam.

Höffler, F. and Sliwka, D. (2003). Do new brooms sweep clean? When and why dismissing a manager increases the subordinates' performance. *European Economic Review*, 47(5):877–890.

Hofler, R. A. and Payne, J. E. (2006). Efficiency in the National Basketball Association: A stochastic frontier approach with panel data. *Managerial and Decision Economics*, 27(4):279–285.

Hvide, H. K. (2002). Tournament rewards and risk taking. *Journal of Labor Economics*, 20(4):877–898.

Hvide, H. K. and Kristiansen, E. G. (2003). Risk taking in selection contests. *Games and Economic Behavior*, 42(1):172–179.

Jones, J., Ferguson, D. G., and Stewart, K. G. (1993). Blood sports and cherry pie. *American Journal of Economics and Sociology*, 52(1):63–78.

Jones, J. C. H. and Ferguson, D. G. (1988). Location and survival in the National Hockey League. *The Journal of Industrial Economics*, 36(4):443–457.

Kahane, L. H. (2005). Production efficiency and discriminatory hiring practices in the National Hockey League: A stochastic frontier approach. *Review of Industrial Organization*, 27(1):47–71.

Kahn, L. M. (2000). The sports business as a labor market laboratory. *Journal of Economic Perspectives*, 14(3):75–94.

Kahn, L. M. and Sherer, P. D. (1988). Racial differences in professional basketball players' compensation. *Journal of Labor Economics*, 6(1):40–61.

Kempf, A., Ruenzi, S., and Thiele, T. (2009). Employment risk, compensation incentives, and managerial risk raking: Evidence from the mutual fund industry. *Journal of Financial Economics*, 92(1):92–108.

Klein, P. G. (2000). New institutional economics. In Bouckeart, B. and DeGeest, G., editors, *Encyclopedia of Law and Economics*, pages 456–489. Edward Elgar, Cheltenham, UK.

Knoeber, C. R. and Thurman, W. N. (1994). Testing the theory of tournaments: An empirical analysis of broiler production. *Journal of Labor Economics*, 12(2):155–179.

Koning, R. H. (2003). An econometric evaluation of the effect of firing a coach on team performance. *Applied Economics*, 35(5):555–564.

Koski, J. L. and Pontiff, J. (1999). How are derivatives used? Evidence from the mutual fund industry. *The Journal of Finance*, 54(2):791–816.

Kräkel, M. (2008). Optimal risk taking in an uneven tournament game with risk averse players. *Journal of Mathematical Economics*, 44(11):1219–1231.

Kräkel, M. and Sliwka, D. (2004). Risk taking in asymmetric tournaments. *German Economic Review*, 5(1):103–116.

Kuper, S. and Szymanski, S. (2009). *Soccernomics*. Nation Books, New York, NY.

Laffont, J.-J. and Martimort, D. (2002). *The Theory of Incentives: The Principal-Agent Model*. Princeton University Press.

Lallemand, T., Plasman, R., and Rycx, F. (2008). Women and competition in elimination tournaments: Evidence from professional tennis data. *Journal of Sports Economics*, 9(1):3–19.

Lambert, R. A., Larcker, D. F., and Weigelt, K. (1993). The structure of organizational incentives. *Administrative Science Quarterly*, 38(3):438–461.

Lazear, E. and Rosen, S. (1981). Rank-order tournaments as optimum labor contracts. *Journal of Political Economy*, 89(5):841–864.

Lazear, E. P. (1989). Pay equality and industrial politics. *Journal of Political Economy*, 97(3):561–580.

Lazear, E. P. (2000). Performance pay and productivity. *American Economic Review*, 90(5):1346–1361.

Lazear, E. P., Shaw, K. L., and Stanton, C. T. (2015). The value of bosses. *Journal of Labor Economics*, 33(4):823–861.

Leadley, J. C. and Zygmont, Z. X. (2006). When is the honeymoon over? National Hockey League attendance, 1970-2003. *Canadian Public Policy/Analyse de Politiques*, 32(2):213–232.

Lien, D. D. (1990). Corruption and allocation efficiency. *Journal of Development Economics*, 33(1):153–164.

Ludwig, S. and Lünser, G. K. (2012). Observing your competitor - The role of effort information in two-stage tournaments. *Journal of Economic Psychology*, 33(1):166–182.

Lynch, J. (2005). The effort effects of prizes in the second half of tournaments. *Journal of Economic Behavior and Organization*, 57(1):115–129.

Lynch, J. G. and Zax, J. S. (2000). The rewards to running: Prize structure and performance in professional road racing. *Journal of Sports Economics*, 1(4):323–340.

Main, B. G. M., O'Reilly, C. A., and Wade, J. (1993). Top executive pay: Tournament or teamwork? *Journal of Labor Economics*, 11(4):606–628.

Maloney, M. T. and McCormick, R. E. (2000). The response of workers to wages in tournaments: Evidence from foot races. *Journal of Sports Economics*, 1(2):99–123.

McLaughlin, K. J. (1988). Aspects of tournament models: A survey. *Research in Labor Economics*, 9(1):225–256.

McPherson, B. (1976). Involuntary turnover: A characteristic process of sport organizations. *International Review for the Sociology of Sport*, 11(4):5–16.

McTeer, W., White, P. G., and Persad, S. (1995). Manager coach mid-season replacement and team performance in professional team sport. *Journal of Sport Behavior*, 18(1):58–68.

Ménard, C. and Shirley, M. M. (2008). Introduction. In Ménard, C. and Shirley, M. M., editors, *Handbook of New Institutional Economics*, pages 1–12. Springer, Berlin Heidelberg.

Miller, G. J. (2008). Solutions to principal-agent problems in firms. In Ménard, C. and Shirley, M. M., editors, *Handbook of New Institutional Economics*, pages 349–370. Springer, Berlin Heidelberg.

Miller, P. A. (2009). Facility age and ownership in major American team sports leagues: The effect on team franchise values. *International Journal of Sport Finance*, 4(3):176–191.

Moldovanu, B. and Sela, A. (2006). Contest architecture. *Journal of Economic Theory*, 126(1):70–97.

Moschini, G. (2010). Incentives and outcomes in a strategic setting: The 3-points-for-a-win system in soccer. *Economic Inquiry*, 48(1):65–79.

Mueller-Langer, F. and Andreoli Versbach, P. (2017). Leading-effect, risk-taking and sabotage in two-stage tournaments: Evidence from a natural experiment. *Jahrbücher für Nationalökonomie und Statistik*, 237(1):1–28.

Nalebuff, B. and Stiglitz, J. (1983). Prizes and incentives: Towards a general theory of compensation and competition. *The Bell Journal of Economics*, 14(1):21–43.

Nevill, A. M., Balmer, N. J., and Mark Williams, A. (2002). The influence of crowd noise and experience upon refereeing decisions in football. *Psychology of Sport and Exercise*, 3(4):261–272.

Nevill, A. M. and Holder, R. L. (1999). Home advantage in sport. *Sports Medicine*, 28(4):221–236.

Nevill, A. M., Newell, S. M., and Gale, S. (1996). Factors associated with home advantage in English and Scottish soccer matches. *Journal of Sports Sciences*, 14(2):181–186.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, 49(6):1417–1426.

Nieken, P. (2010). On the choice of risk and effort in tournaments – Experimental evidence. *Journal of Economics & Management Strategy*, 19(3):811–840.

Nieken, P. and Stegh, M. (2010). Incentive effects in asymmetric tournaments – Empirical evidence from the German hockey league. SFB/TR 15 Discussion Paper No. 305, University of Bonn, Germany.

Nti, K. (1999). Rent-seeking with asymmetric valuations. *Public Choice*, 98(3):415–430.

Nüesch, S. (2009). Are demographic diversity effects spurious? *Economic Analysis & Policy*, 39(3):379.

O'Keeffe, M., Viscusi, W., and Zeckhauser, R. (1984). Economic contests: Comparative reward schemes. *Journal of Labor Economics*, 2(1):27–56.

Orrison, A., Schotter, A., and Weigelt, K. (2004). Multiperson tournaments: An experimental examination. *Management Science*, 50(2):268–279.

Orszag, J. M. (1994). A new look at incentive effects and golf tournaments. *Economics Letters*, 46(1):77–88.

Paul, R. J. (2003). Variations in NHL attendance: The impact of violence, scoring, and regional rivalries. *American Journal of Economics and Sociology*, 62(2):345–364.

Paul, R. J. and Weinbach, A. P. (2011). Determinants of attendance in the Quebec Major Junior Hockey League: Role of winning, scoring, and fighting. *Atlantic Economic Journal*, 39(3):303–311.

Pope, D. G. and Schweitzer, M. E. (2011). Is Tiger Woods loss averse? Persistent bias in the face of experience, competition, and high stakes. *American Economic Review*, 101(1):129–157.

Porter, P. K. and Scully, G. W. (1982). Measuring managerial efficiency: The case of baseball. *Southern Economic Journal*, 48(3):542–550.

Pratt, J. W. and Zeckhauser, R. J. (1985). Principals and agents: An overview. In Zeckhauser, R. J. and Pratt, J. W., editors, *Principals and agents: The structure of business*, pages 1–36. Harvard Business School Press Boston, Boston.

Prendergast, C. (1999). The provision of incentives in firms. *Journal of Economic Literature*, 37(1):7–63.

Rascher, D. A., Brown, M. T., Nagel, M. S., and McEvoy, C. D. (2009). Where did National Hockey League fans go during the 2004-2005 lockout? An analysis of economic competition between leagues. *International Journal of Sport Management and Marketing*, 5(1):183–195.

Rosen, S. (1982). Authority, control, and the distribution of earnings. *The Bell Journal of Economics*, 13(2):311–323.

Rosen, S. (1986). Prizes and incentives in elimination tournaments. *The American Economic Review*, 76(1):701–715.

Rottenberg, S. (2000). Resource allocation and income distribution in professional team sports. *Journal of Sports Economics*, 1(1):11–20.

Rowe, W. G., Cannella, A. A., Rankin, D., and Gorman, D. (2005). Leader succession and organizational performance: Integrating the common-sense, ritual scapegoating, and vicious-circle succession theories. *The Leadership Quarterly*, 16(2):197–219.

Scelles, N., Helleu, B., Durand, C., and Bonnal, L. (2016). Professional sports firm values: Bringing new determinants to the foreground? A study of European soccer, 2005-2013. *Journal of Sports Economics*, 17(7):688–715.

Schofield, J. (1983). The demand for cricket: The case of the John Player League. *Applied Economics*, 15(3):283–296.

Schotter, A. and Weigelt, K. (1992). Asymmetric tournaments, equal opportunity laws, and affirmative action: Some experimental results. *Quarterly Journal of Economics*, 107(2):511–539.

Schwartz, B. and Barsky, S. F. (1977). The home advantage. *Social Forces*, 55(3):641–661.

Scully, G. (1994). Managerial efficiency and survivability in professional team sports. *Managerial and Decision Economics*, 15(5):403–411.

Shearer, B. (2004). Piece rates, fixed wages and incentives: Evidence from a field experiment. *The Review of Economic Studies*, 71(2):513–534.

Stewart, K. G., Ferguson, D. G., and Jones, J. (1992). On violence in professional team sport as the endogenous result of profit maximization. *Atlantic Economic Journal*, 20(4):55–64.

Sunde, U. (2009). Heterogeneity and performance in tournaments: A test for incentive effects using professional tennis data. *Applied Economics*, 41(25):3199–3208.

Sutter, M. and Kocher, M. G. (2004). Favoritism of agents: The case of referees' home bias. *Journal of Economic Psychology*, 25(4):461–469.

Sutter, M. and Strassmair, C. (2009). Communication, cooperation and collusion in team tournaments – An experimental study. *Games and Economic Behavior*, 66(1):506–525.

Szymanski, S. (2003). The assessment: The economics of sport. *Oxford Review of Economic Policy*, 19(4):467–477.

Szymanski, S. and Smith, R. (1997). The English football industry: Profits, performance and industry structure. *International Review of Applied Economics*, 11(1):135–153.

Szymanski, S. and Valletti, T. (2005). Incentive effects of second prizes. *European Journal of Political Economy*, 21(2):467–481.

Taylor, B. A. and Trogdon, J. G. (2002). Losing to win: Tournament incentives in the National Basketball Association. *Journal of Labor Economics*, 20(1):23–41.

Taylor, C. (1995). Digging for golden carrots: An analysis of research tournaments. *American Economic Review*, 85(4):872–890.

Tena, J. d. D. and Forrest, D. (2007). Within-season dismissal of football coaches: Statistical analysis of causes and consequences. *European Journal of Operational Research*, 181(1):362–373.

Theberge, N. and Loy, J. (1976). Replacement processes in sport organizations: The case of professional baseball. *International Review for the Sociology of Sport*, 11(2):73–93.

Torgler, B. and Schmidt, S. L. (2007). What shapes player performance in soccer? Empirical findings from a panel analysis. *Applied Economics*, 39(18):2355–2369.

Vandegrift, D. and Yavas, A. (2010). An experimental test of sabotage in tournaments. *Journal of Institutional and Theoretical Economics*, 166(2):259–285.

Villar, J. G. and Guerrero, P. R. (2009). Sports attendance: A survey of the literature 1973-2007. *Rivista di Diritto e di Economia dello Sport*, 5(2):112–151.

Welki, A. M. and Zlatoper, T. J. (1999). US professional football game-day attendance. *Atlantic Economic Journal*, 27(3):285–298.

Wicker, P., Prinz, J., Weimar, D., Deutscher, C., and Upmann, T. (2013). No pain, no gain? Effort and productivity in professional soccer. *International Journal of Sport Finance*, 8(2):124–139.

Winfree, J. A. and Fort, R. (2008). Fan substitution and the 2004-05 NHL lockout. *Journal of Sports Economics*, 9(4):425–434.

Zimbalist, A. S. (2002). Competitive balance in sports leagues. *Journal of Sports Economics*, 3(2):111–121.