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“Tournament Theory:
Problem Areas of Rank-Order Tournaments”

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List of Abbreviations

CEO	Chief Executive Officer
cf.	confer
e.g.	exempli gratia
et. al.	et alii
FIFA	Fédération Internationale de Football Association
FOC	first order condition
i.a.	inter alia
IBM	International Business Machines Corporation
NE	Nash-Equilibrium
OLS	Ordinary Least Square
PGA	Professional Golf Association
SFM	Skandia Fund Management

1 Introduction

The objective of this thesis is to call attention to the problem areas of rank-order tournaments. “Incentives are the Essence in Economics” (Lazear: 1986: 2) is a motto that many organizations and firms adopt. An important example is that of Hamburg-Mannheimer International, a German insurance company, today known as ERGO, which rewarded the best salesmen and sponsored a “pleasure trip” to Budapest in 2007. After such incentive for good work, people were aware of the fact that companies offer incentives to their employees. Rank-order tournaments seemed to be a useful tool to increase the performance of employees and, therefore, the output of firms. From the pioneer literature of Lazear and Rosen (1981), we know that employees show more willingness to perform when a marginal increase in effort leads to a proportional increase in utility. For years now, well-known companies such as General Electric, Johnson & Johnson, and IBM rely on rank-order tournaments to improve profitability. Nevertheless, rank-order tournaments also bear problems and disadvantages for all participants. Participants, in this context, are known as agent and principal. A desirable outcome for the principal is to construct a tournament that motivates the agents to exert the optimal level of effort that increases his output. This thesis describes four main problems of rank-order tournaments that could obviously distort the optimum level of effort of the agents: Teamwork & Horizontal Collusion, Risk-Taking Behavior, Sabotage & Mobbing, and the Presence of a Superstar. The basic pioneer model of Lazear and Rosen has been complemented by several approaches in order to demonstrate the four potential risks of principals implementing rank-order tournaments. The purpose of this essay is to help principals construct an optimal incentive tournament. The disclosure of the disadvantages of the tournament theory identified fundamental but also surprising results. For instance, horizontal collusion is heavily overvalued and the hypothesis of potential collusion between agents can mainly be rejected. Sabotage activities depend heavily on the agents’ characteristics and suffer from the Moral Hazard prob-

lem. However, risky behavior of agents and the employment of a Superstar, or a “high flyer” in a company, create problems in terms of output deterioration. The “right” homogenous mix of agents has the potential to solve all problems immediately. To find this mix, principals have to be aware of the four “negative” peculiarities of tournament theory. The structure of the thesis is divided into six major parts in order to analyze the problem fields of rank-order tournaments. Chapter one briefly defines the basic principles of performance measurement. The brief review is followed by the fundamental economic model of Lazear and Rosen (1981). The model and its assumptions are the framework of this paper, and are explained from the agents’ and principals’ point of view. All upcoming extensions made are based on this framework. With the help of Matthias Kräkel (2012) and his 2x2 collusion matrix I examine the horizontal collusion theory and find empirical evidence for supporting it. Chapter three highlights the agents’ risk-taking behavior and how this behavior reflects the output of the principal. The extension model of Hvide (2002) is the basic theoretical foundation that subsequently has to be proofed by empirical findings of Grund and Gürtler (2005). Furthermore, I discuss a questionable mediocre solution by Hvide to avoid risky behavior of the participants. Risky behavior activities are followed in chapter four by sabotaging agents. Harbring and Irlenbusch (2008 and 2011) developed a theoretical model that includes sabotage behavior of agents. In consequence of this model, both authors evaluated a laboratory study to find evidence for their hypotheses. Further research findings i.a. by Garciano and Palacios-Huerta (2005) with results in the Spanish National Soccer League conclude this chapter. The final chapter deals with the superstar phenomenon of Tiger Woods, a topic that recently arose by Jennifer Brown (2011) after the pioneer work of Rosen and her *The Economics of Superstars* in 1981. This chapter examines the inferiority of the opponents of the superstar and the effects of competing with a “high flyer”. Findings are supported by Tanaka and Ishino (2012) and their data from the Japan Golf Tour, which deals with the superstar Masahi Ozaki. The last chapter summarizes the results and concludes my research.

2 Tournament Theory

A rank-order tournament is a contest arranged by the principal where two or more agents with equal or similar duties and responsibilities compete for promotion, bonuses, or other financial benefits. In practice, multiple salesmen from the same hierarchical level compete for promotion to a higher pay level. The relatively best of this competition will be promoted by the management or in this case by the principal. Besides promotion and incentives trips there are plenty of prizes possible. Often, salesmen compete for an extra bonus, which is in the end received by the one who has the best sales volume. A bonus can be any kind of pecuniary compensation (cf. Bull, Schotter/Weigelt 1987: 2).

2.1 Basic Principles of Performance Measurement

To have a better link to the rank-order tournaments that I will briefly explain in the following chapter it is necessary to clarify the difference between absolute and relative performance measurement. Additionally, I will introduce the basic theoretical aspects of the Principal-Agency-Theory, which explains the behavior of the actors in a tournament.

2.1.1 Principal-Agent-Theory

The Principle-Agent-Theory is the analysis framework of the tournament theory. An often quoted definition is by Pratt and Zeckhauser: "Whenever one individual depends on the action of another, an agency relationship arises. The individual taking the action is called the affected. The affected party is the principal." (Pratt and Zeckhauser 1985: 2). Before I explain the tournament theory itself, I briefly describe the principal-agent-relationship to understand the relevance of this paper. The main problem between the principal and the agent is the asymmetric information set. Both parties attempt to maximize their utility in form of known opportunistic actions which can be specified and distinguished as follows:

- Hidden Action – Moral Hazard
- Hidden Characteristics
- Hidden Information
- Hold-Up

Most known is the moral hazard problem. Agents that are acting on behalf of the principal tend to take a higher risk than if they act on their own responsibility. In the case of the tournament theory, the principal has to find such incentives that the agents maximize their own utility and the utility of the principal. Additionally, environmental circumstances must be taken into account.

2.1.2 Performance: Absolute vs. Relative

The differentiation of absolute and relative performance is necessary to explain because each performance measure goes hand in hand with different incentives. The absolute performance assessment measures the performance of the employee in regard to his or her total labor output. Typical examples are piece rates or revenue shares. Here, the wage rises proportionally with the produced number of units or the performed sales volume. Absolute incentive schemes motivate agents to perform in overall terms, whereas relative payment schemes create competition between the agents. Relative performance assessment by contrast compares the output between two or more employees, which have similar assignment to complete (cf. Backes-Gellner, Lazear, and Wolff 2001: 191-192).

2.2 The Rank-Order Tournament Model by Lazear and Rosen

Rank-Order Tournaments as Optimum Labor Contracts is the pioneer work of Edward P. Lazear and Sherwin Rosen and first-time published in 1981. The paper explains why the salary spread between low hierarchical levels is less than between high. The relative performance is crucial for this measurement. Therefore,

the model used differs from the neoclassic models which strictly refer to marginal product compensation. Additionally, Lazear and Rosen make use of the coherence between game theoretical appliances and labor market theory. The model with its assumptions and the terminology in 2.2.1 and 2.2.2 are according to the pioneer work of Lazear and Rosen (cf. Lazear and Rosen 1981: 841-847).

2.2.1 View of the Agent

Keeping things simple, the time horizon of the model by Lazear and Rosen relies on a single period. Therefore, sequential and dynamic effects are eliminated. The game considers two agents that are ex-ante homogenous, rational and risk neutral. The prize distribution is simply that the winner, the one with the highest output level, receives the fixed prize W_1 and the loser receives the fixed prize W_2 , where $W_1 > W_2$. According to that the tournament-prize-difference is $\Delta W = W_1 - W_2$. The spread is the main incentive to increase investment by the agents as we will see later in this paper. The contest in the model is rank-order and the margin does not affect the winning. Also, agents do not communicate with each other, no collusion occurs at this moment and prizes as well as rules are set up before and are completely known. The performance of both is equal to the following lifetime productivity function:

$$q_i = \mu_i + \varepsilon_i \text{ with } i \in \{j, k\} \quad (2.1)$$

The agents output is controlled by μ_i and ε_i , the individual input factor and the random luck component. The level of investment is chosen by the agents prior to a realization of the luck component which is beyond anyone's control. Furthermore, the ε_i are stochastically independent from each other with expected value of $E(\varepsilon_i) = 0$ and a variance of $Var(\varepsilon_i) = 0$. The employment of labor μ_i causes identical disutility of labor for both agents of $C(\mu_i)$, with $C'(\mu_i), C''(\mu_i) > 0$. Agents are expected to maximize their utility with the identical cost function and behavior.

The probability of winning this tournament is $P(\mu_i, \epsilon_i)$ and the maximum wealth for each agent is thus:

$$E[\pi_i] = P(\mu_i)W_1 + (1 - P(\mu_i))W_2 - C(\mu_i) \text{ with } i \in \{j, k\} \quad (2.2)$$

The agent j wins the tournament when $q_j > q_k$ and the probability of winning can be written as

$$\begin{aligned} P(\mu_i, \epsilon_i) &= \text{prob}(q_j > q_k) \\ P(\mu_i, \epsilon_i) &= \text{prob}(\mu_j + \epsilon_j > \mu_k + \epsilon_k) \\ P(\mu_i, \epsilon_i) &= \text{prob}(\epsilon_j - \epsilon_k > \mu_k - \mu_j) \\ P(\mu_i, \epsilon_i) &= G(\mu_j - \mu_k) \end{aligned} \quad (2.3)$$

where $G(\cdot)$ reflects the distribution function of the random variable $\epsilon_k - \epsilon_j$. Its derivative in respect to μ_i gives the density function $g(\cdot)$. Using this assumption, we can modify our target function of each player if both agents maximize their utility function:

$$\begin{aligned} E[\pi_j] &= W_2 + (W_1 - W_2)G(\mu_j - \mu_k) - C(\mu_j) \\ E[\pi_k] &= W_2 + (W_1 - W_2)[1 - G(\mu_j - \mu_k)] - C(\mu_k) \end{aligned} \quad (2.4)$$

Due to the independence of both target functions, Lazear and Rosen adopt the Nash-Cournot assumptions. Each agent simply assumes that he can not change the opponent's decision of the degree of investment. The solution is to optimize against the optimal investment level of the opponent (cf. Breyer 2011: 106-109).

$$\frac{\partial E[\pi_j]}{\partial \mu_j} = (W_1 - W_2)g(\mu_j - \mu_k) - C'(\mu_j) = 0 \quad (2.5)$$

$$\frac{\partial E[\pi_k]}{\partial \mu_k} = (W_1 - W_2)g(\mu_j - \mu_k) - C'(\mu_k) = 0 \quad (2.6)$$

As a result, we obtain two symmetrical reaction functions in which the marginal earnings are equal to the marginal costs. Based on the symmetry, both agents choose the identical input factor level in the Nash-Equilibrium, $\mu_j - \mu_k = 0$ and $P(\mu_i, \varepsilon_i) = G(0) = \frac{1}{2}$, "...so the outcome is purely random in equilibrium." (Lazear and Rosen 1981: 845). The only chance to increase the probability of winning is to influence the individual skills ex-ante. In the equilibrium equations (2.5) and (2.6) reduce to (cf. Hvide (2002): 882-883):

$$\begin{aligned} C'(\mu_j) &= (W_1 - W_2)g(\mu_j - \mu_k) \\ C'(\mu_k) &= (W_1 - W_2)g(\mu_j - \mu_k) \end{aligned} \quad (2.7)$$

The implications of the equilibrium equations:

1. The employment of labor increases with the raise in the tournament-prize-difference $\Delta W = W_1 - W_2$.
2. If the luck component is irrelevant, then $\varepsilon_k - \varepsilon_j$ has a high probability of being equal to 0. The more the luck component is relevant for the result of the tournament, the less is the employment of labor of the agents. Conversely, the agent's employment of labor increases, if a reduction of the luck component is observable. The principal then needs to increase the prize spread to prevent the decline in the work input (cf. Backes-Gellner, Lazear and Wolff 2001: 173-174).

2.2.2 View of the Principal

Usually, the principal also wants to maximize his expected utility. In this case he maximizes his expected gain. The expected gain is equal to the gross return

minus the cost in form of prize money to the agent. Under the constraint of equation (2.1) follows that the expected value of q_i is equal to μ_i and in the equilibrium equal to μ ($\mu_j=\mu_k=\mu$):

$$E[\pi] = \mu - \frac{(W_1 + W_2)}{2} \quad (2.8)$$

expected gain for the firm. The target function above is still subject to the constraint that compensation is at least as high as the marginal costs (input factor) to fulfill the participation constraint:

$$\frac{(W_1 + W_2)}{2} = C(\mu) \quad (2.9)$$

costs for each agent in equilibrium ($\mu_j=\mu_k=\mu$). Replacing the constraints in the target functions $E[\pi] = \mu - C(\mu)$ and building the first order conditions for the firm over its costs of $W_1 + W_2$ for each agent leads to:

$$\begin{aligned} \frac{\partial E[\pi_1]}{\partial W_1} &= (1 - C'(\mu)) \frac{\partial \mu}{\partial W_1} \\ \frac{\partial E[\pi_2]}{\partial W_2} &= (1 - C'(\mu)) \frac{\partial \mu}{\partial W_2} \end{aligned} \quad (2.10)$$

A maximization of μ leads to the same result, but it is not possible for the principal to control the input directly and consequently the principal can not control the output either. Corresponding to (2.10), the agents choose the employment of labor such as $1=C'(\mu)$ in the Nash-Equilibrium. This means that agents increase their effort until it equals one unit of input. Back to the assumptions of Backes-Gellner, Lazear and Wolff: They discovered that the employment of labor in the equilibrium is high when the luck component is relatively small (cf. Backes-Gellner, Lazear and Wolff 2001: 173). Using the fact that $1=C'(\mu)$, it is possible to construct with the help of (2.7) the optimum "prize-spread-function":

$$\frac{1}{g(\mu_j - \mu_k)} = (W_1 - W_2) \quad (2.11)$$

Equation (2.11) is the evidence for the assumption above. The reverse effect of $g(\mu_j - \mu_k)$ in regard to the tournament-prize-difference is obvious. This means that high wages in high positions or hierarchical levels are not just due to the fact of high performance. High wages should give the other co-workers an incentive to reach that hierarchical level itself. Wages therefore have the incentive to motivate co-workers to obtain a higher working position. Level of wages in the tournament theory are explained throughout the salary structure of the company and a random luck component (cf. Backes-Gellner, Lazear and Wolff 2001: 207).

2.3 Extension of the Model by Lazear and Rosen

The result of the original model by Lazear and Rosen refers to an optimal "prize-spread-function" as of 2.11. But usually, in a competitive or perfect market companies maximize their profit while minimizing wages, on a constant level of effort. So in reality, a company is not a standalone in the market and has several competitors. Therefore, the "zero profit condition" applies in the long term: revenues have to meet the costs. This means that all generated profits have to be distributed as wages to the employees. For the afore mentioned model the revenues, R return per unit, and the "zero profit condition" are as follows:

$$R(q_j + q_k) \text{ with } E[\epsilon_i] = 0 \text{ leads to } R(\mu_j + \mu_k) \quad (2.12)$$

$$R(\mu_j + \mu_k) = (W_1 - W_2) \quad (2.13)$$

From 2.8, in the equilibrium the investment level is $\mu_j = \mu_k = \mu$ and the equation 2.13 reduces to

$$R_\mu = \frac{W_1 + W_2}{2} \quad (2.14)$$

A fixed μ always refers to a constant optimal "prize-spread-function". In the perfect market the μ is variable and depends on the profit. Hence, the sum of the prizes has to be equal to the expected revenues and optimal prizes are as follows:

$$W_1 = R_\mu + \frac{C'(\mu)}{2g(\mu_j + \mu_k)} = R_\mu + \frac{R}{2g(\mu_j + \mu_k)} \quad (2.15)$$

$$W_2 = R_\mu - \frac{C'(\mu)}{2g(\mu_j + \mu_k)} = R_\mu + \frac{R}{2g(\mu_j + \mu_k)} \quad (2.16)$$

Additionally, 2.15 and 2.16 find evidence that $R = C'(\mu)$.

2.4 Introduction to the Problem Areas of Rank-Order Tournaments

The sad end of a qualification trial in the U.S. for the Olympic games in 1994 went down in history. The husband of famous figure skater Tonya Harding attempted to get rid of her competition by hiring someone to take out figure skater Nancy Kerrigan with a metal bar. Kerrigan was seriously injured and could not finish the qualification tournament (cf. STERN 2007). Within the implementation of a tournament, it is necessary to keep in mind the potential uncooperative behavior of the participants. This inappropriate behavior has a negative effect on the overall result. The next four chapters deal with the obvious problem areas of rank-order tournaments that affect the principals' output and to some extent, the agents'. I focus on Teamwork & Horizontal Collusion, Risk-Taking Behavior, Sabotage & Mobbing, and the Superstar Effect and on how these problems occur and affect the participants.

3 Teamwork and Horizontal Collusion

After the differentiation between absolute and relative performance measurements in 2.2.2, it is possible to anticipate that teamwork might also create problems for the principal. Of course, the overall output in a firm depends not only on teamwork, but rather a certain degree of teamwork within a firm is mandatory and helpful. However, the characteristics of tournaments are the exact opposite of teamwork; complementary effects are nowhere to be found in practice. Kräkel differentiates between two sets of problems:

1. The main objective of teamwork is cooperation, which contradicts tournament theory. Cooperative behavior is self-destructive because it increases the player's own workload and helps the other participants or competitors to improve in the rank-order at the same time.
2. The second argument is that, in general, teamwork aggregates specialists (employees with special abilities), whereas each of them is responsible for a specific task. But this behavior does not allow for comparison between the contestants, which is crucial for a rank-order tournament.

Aside from teamwork, horizontal collusion between the agents and principles is also a problem of performance tournaments and the focus of this section. Again, the most detailed and preferential quote comes from Kräkel, who examines both a static and dynamic view. Horizontal collisions are agreements between employees of the same hierarchical level in a company. If the performance measure depends on relative payment, agents have the incentive to cooperate or to minimize their working burden. Agreements in a tournament with a high number of agents are unlikely to happen if the agents do not know their competitors. To prevent the minimization of the input, companies recruit skilled workers from the external labor market; they set an example to show that they do not only depend upon their own employees. Recruiting an external worker once in a while makes

internal agreements more risky (cf. Backes-Gellner, Lazear, and Wulff 2001: 197-198). The following two subsections describe the static and dynamic effects of horizontal collusion within a rank-order tournament and refer to Kräkel (2012).

3.1 Static Collusion

Backes-Gellner, Lazear, and Wulff see horizontal collusion as a risk for principals that appears when rewards depend on the relative performance of employees (cf. Backes-Gellner, Lazear and Wulff 2001: 197). However, Matthias Kräkel mostly shares their opinion but argues that the risk of horizontal collusion is only present when collisions are profitable and stable for the agents (cf. Kräkel 2012: 226). In the following, I consider the approach of a static collusion game by Kräkel to confirm or reject the afore mentioned assumption (cf. Kräkel 2012: 226-229). As an extension to the model in 2.2, the game consists of two agents, a homogenous as well as a risk neutral principal. Furthermore, the output and cost functions and their characteristics remain the same.

$$q_i = \mu_i + \varepsilon_i \text{ with } i \in \{j, k\} \quad (3.17)$$

The levels of investment of each agent are observable among themselves and the error term difference $\varepsilon_j - \varepsilon_i$ follows a symmetric density function with a distribution function $G(\cdot)$. Moreover, both agents j and k can only choose from a set of strategies consisting of two different effort levels. Either they can choose the effort level μ_{Nash} or μ_{Coll} whereas

$$\mu_{Nash} > \mu_{Coll} \quad (3.18)$$

The notation μ_{Nash} refers to a Nash-Equilibrium strategy for each agent. If both agents communicate with each other and agree on horizontal collusive behavior

they can choose an effort level μ_{Coll} . This effort level reduces their costs and therefore their working burden. This burden would then reduce to

$$C(\mu_{Nash}) - C(\mu_{Coll}) \text{ with } C(\mu_{Nash}) > C(\mu_{Coll}) \quad (3.19)$$

without a change of the winning probabilities. Thus, the choice of horizontal collusion would be Pareto-Efficient and dominate the Nash-Equilibrium strategy (μ_{Nash}, μ_{Nash}) . Due to the simplified restrictions made, it is possible to draw the strategy set and its potential outcome in a 2x2 matrix for player j and k (see below in Table 1).

j / k	μ_{Nash}	μ_{Coll}
μ_{Nash}	$\frac{W}{2} - C(\mu_{Nash}),$ $\frac{W}{2} - C(\mu_{Nash})$	$(\frac{1}{2} + \tau) \cdot W - C(\mu_{Nash}),$ $(\frac{1}{2} - \tau) \cdot W - C(\mu_{Coll})$
μ_{Coll}	$(\frac{1}{2} - \tau) \cdot W - C(\mu_{Coll}),$ $(\frac{1}{2} + \tau) \cdot W - C(\mu_{Nash})$	$\frac{W}{2} - C(\mu_{Coll}),$ $\frac{W}{2} - C(\mu_{Coll})$

Table 1: Static Collusion Game

Source: cf. Kräkel 2012: 227, Figure IV.1.

The content of the arrays displays the expected net income or utility of both players. Whereby, the upper fields represent the values for player j and the lower fields the ones for player k. The winning probability of both players is equal to $\frac{1}{2}$ as long as both play the same strategy. If they chose different sets of strategies, then μ_{Nash} dominates μ_{Coll} and the probability of winning for the player who chose μ_{Nash} is greater than $\frac{1}{2}$. Thus, winning probabilities behave like

$$\begin{aligned}
 P(j \text{ wins}) &= P(q_j > q_k) = P(\mu_j + \varepsilon_j > \mu_k + \varepsilon_k) \\
 P(j \text{ wins}) &= P(\varepsilon_j - \varepsilon_k > \mu_k - \mu_j) = G(\mu_k - \mu_j) = G(\Delta\mu) \text{ and} \\
 P(k \text{ wins}) &= 1 - P(\mu_j \text{ wins}) = 1 - G(\Delta\mu).
 \end{aligned} \quad (3.20)$$

Due to the symmetric density function it is obvious that

$$\begin{aligned} G(0) &= \frac{1}{2} \text{ as well as } G(\Delta\mu) = 1 - G(-\Delta\mu) \\ G(\mu_{Nash} - \mu_{Coll}) &> \frac{1}{2} \text{ and } G(\mu_{Coll} - \mu_{Nash}) < \frac{1}{2}. \end{aligned} \quad (3.21)$$

To simplify matters, the winning probability in the 2x2 matrix are determined as

$$P(j \text{ wins}) = \begin{cases} \frac{1}{2} - \tau, & \text{if } \mu_j = \mu_{Coll} \text{ and } \mu_k = \mu_{Nash} \\ \frac{1}{2} + \tau, & \text{if } \mu_j = \mu_{Nash} \text{ and } \mu_k = \mu_{Coll} \end{cases} \text{ with } \tau \in \left(0, \frac{1}{2}\right). \quad (3.22)$$

The 2x2 matrix clearly supports Kräkel's assumption. Horizontal collusion seems to be optimal for both agents. The set of strategies where both agents arrange a common strategy result in a higher net income or utility due to equation 3.19. However, it is necessary to find evidence that the negotiations between the agents are stable. But does (μ_{Coll}, μ_{Coll}) also build a Nash-Equilibrium? Only when it is likely that horizontal collusion poses a serious risk to a firm. Note that from the initial assumption (μ_{Nash}, μ_{Nash}) is a Nash-Equilibrium which means that μ_{Nash} is the best answer to μ_{Nash} and not μ_{Coll} which again implies:

$$\frac{W}{2} - C(\mu_{Nash}) > \left(\frac{1}{2} - \tau\right) \cdot W - C(\mu_{Coll}) \Leftrightarrow \tau > \frac{[C(\mu_{Nash}) - C(\mu_{Coll})]}{W} \quad (3.23)$$

But equation 3.23 also states that μ_{Nash} is the best answer of μ_{Coll} which means that μ_{Nash} is a dominant strategy in this collusive game. Furthermore, this collusive game can be interpreted as the prisoners' dilemma in which (μ_{Nash}, μ_{Nash}) is the only Nash-Equilibrium. Concluding, collusive behavior would be profitable for both agents but each agent should be aware that deviating from the collusive strategy is likely. The principal therefore does not need to fear horizontal collusion as a risky behavior in a static tournament. The following subsection briefly examines whether this outcome is also valid for an infinite game.

3.2 Dynamic Collusion

A dynamic collusion refers to multiple interactions between the agents during the tournament, which are more likely to happen in a firm (cf. Gürtler 2010: 265). This subsection describes the dynamic collusion theory by Kräkel (cf. Kräkel 2012: 229-232). Here, two different kinds of repetitious games exist. First, there is a repetition game with a fixed ending and second an infinite game where the time horizon has not been defined by the principal. The former situation is a replicate of the static collusion game. An endless game can be easily solved by backwards induction, and a subgame perfect equilibrium can be derived. The reason is clear: the last round of the game is a replicate situation of the static game, and therefore the agents will play their dominant strategy (μ_{Nash}, μ_{Nash}). In the penultimate round, the result of the final round can already be anticipated, so agents happen to be in the same situation as before. Again the best response is the dominant strategy set (μ_{Nash}, μ_{Nash}). Going step by step backwards explains the subgame perfect equilibrium; the situation only changes if the principal does not tell the agents the exact end of the competition. This explains a more likely real-life situation, as promotion contests within a firm are never fixed on a certain date. A few days, or even hours may be sufficient enough for an agent to deviate from his strategy and claim an advantage against his competitor. This occurrence describes an infinite tournament, also known as a supergame, which cannot be solved by backwards induction. Agents are not aware of how and when the tournament might end and, therefore, are not able to deviate in the last round. As agents do not know the end of the tournament, the probability of a potential next round is described by a subjective discount parameter d . This parameter should reflect the time horizon and calculate the present value of the net income. Agents might have an incentive to deviate from a strategy due to a different preference for the present. In order to solve this infinite game, Kräkel assumes a trigger strategy by Grim. The trigger strategy is determined by collusive behavior with the strategy set (μ_{Coll}, μ_{Coll}) until one agent deviates to set μ_{Nash} . From that moment

on, the other agent plays μ_{Nash} independently what the opponent is doing. Table 2 shows the potential incomes of player j with $\beta > \delta > \alpha > \gamma$. To find evidence whether or not the infinite game has a stable outcome, it is necessary to calculate the present values of these four possible net incomes.

j	μ_{Nash}	μ_{Coll}
μ_{Nash}	$\alpha := \frac{W}{2} - C(\mu_{Nash})$	$\beta := (\frac{1}{2} + \tau) \cdot W - C(\mu_{Nash})$
μ_{Coll}	$\gamma := (\frac{1}{2} - \tau) \cdot W - C(\mu_{Coll})$	$\delta := \frac{W}{2} - C(\mu_{Coll})$

Table 2: Potential Incomes of Player j

Source: cf. Kräkel 2012: 231.

As long as both agents perfectly negotiate with each other and respect their arrangement, both receive the outcome δ . If one agent deviates to a certain point in time, he receives β for one round and the α the Nash-Equilibrium from that moment on. With the help of the characteristics of geometric series, the present value of δ for an endless period of time is

$$\lim_{T \rightarrow \infty} \Sigma = \lim_{T \rightarrow \infty} \left(\frac{\delta \cdot d - \delta \cdot d^{T+1}}{1 - d} \right) = \frac{\delta \cdot d}{1 - d} \quad (3.24)$$

The agent who chooses to deviate from the collusive strategy receives, from the moment of deviation, β for one period and α for the upcoming periods. Discounted values are as follows:

$$\beta \cdot d + \alpha \cdot d^2 + \dots + \alpha \cdot d^T = \beta \cdot d + \frac{\alpha \cdot d^2}{1 - d} \quad (3.25)$$

Now, one can solve both equations towards d and receive the stable-outcome-condition

$$\frac{\delta \cdot d}{1 - d} = \beta \cdot d + \frac{\alpha \cdot d^2}{1 - d} \Leftrightarrow d \geq \frac{\beta - \delta}{\beta - \alpha} \quad (3.26)$$

As a result, a stable outcome in a dynamic game (tournament) is possible and more or less depends solely on the discount parameter d . The insertion of the real values of α , β , and δ into equation 3.26 leads to

$$d \geq \frac{\tau \cdot W - [C(\mu_{Nash}) - C(\mu_{Coll})]}{\tau \cdot W} \quad (3.27)$$

For agents with a high preference for the present equation, 3.27 is enforced because the agent might break the arrangement very soon. Furthermore, the arrangement might break due to a high τ and W , as the equation increases in both parameters. A low difference in $[\mu_{Nash} - \mu_{Coll}]$ could also create non-compliance of the collusion. In conclusion, horizontal collusion is a problem that can directly be influenced and therefore avoided by the principal (cf. Kräkel 2012: 233). That agents prioritize competitive behavior rather than collusive has been the theoretical approach and research. Does the theory also hold in reality? The next subsection examines horizontal collusion in praxis.

3.3 Collusion: From Theory to Practice

In *Turning Up The Volume: An Experimental Investigation Of The Role Of Mutual Monitoring In Tournaments*, Hannan, Towry, and Zhang (2011) investigate how the agent's effort changes in rank-order tournaments when mutual monitoring is present. From the assumption of static and dynamic collusion we know that horizontal collusion, here mutual monitoring, is supposed to be negatively correlated to the principals output. Although the theoretical approach by Kräkel refutes this assumption, I take a closer look at the current experimental study by Hannan, Towry, and Zhang. This paper should either find evidence for the static and dynamic collusion effects or show that the theoretical perspective is not applicable in practice.

Q_1 : Is it possible to find empirical evidence for the static and dynamic collusion game?

3.3.1 Experimental Model & Procedure

In their experimental approach, the authors attempt to examine "whether and by what processes mutual monitoring affects effort in tournaments." (Hannan, Towry, and Zhang 2011: 2). The basic setting of this laboratory study remunerates agents on a performance scheme similar to 2.2.1. The lifetime productivity function in its structure remains the same. By adding an independent variable that controls for mutual monitoring, it is possible to measure these effects directly. The prize structure also consists of a winner prize W_1 and a consolation prize W_2 with $(\Delta W = W_1 - W_2)$. The participants of the test study can earn a maximum of $W_1 = 200$ points and $W_1 = 100$ points, which are converted to dollars at the end of the game. Further restrictions that differ from the termination in 2.2.1: The effort levels range from $\mu_i = 1$ to $\mu_i = 40$ (integer numbers) and the cost parameters depend on the effort level and are determined as follows: $C(\mu_i) = \frac{\mu_i^2}{c}$ with $c = 7$. The

luck component is "uniformly distributed over the interval $[-\varepsilon_i = -10; \varepsilon_i = 10]$." (Hannan, Towry, and Zhang 2011: 7). The probability of winning the tournament again is $P(\mu_i, \varepsilon_i)$ and therefore the expected payoff function for agent $i \in \{j, k\}$ is:

$$E[\pi_i] = W_2 + P(\mu_i, \varepsilon_i)\Delta W - C(\mu_i), \quad (3.28)$$

and the unique Nash-Equilibrium strategy after Bull et al. 1987 is as follows:

$$\mu^* = \frac{[\Delta W \cdot c]}{4 \cdot \varepsilon}. \quad (3.29)$$

Based on equation 3.29 the Nash-Equilibrium effort level is 17.5 while a Pareto-Optimal solution for the agents is to choose the minimum level of effort zero and therefore collude. With the above described model it is now possible to define the hypothesis that needs to be proofed:

H_1 : The agents' effort level does not change when they can mutually monitor each other.

The procedure and design of the tournament is fairly easy: The authors conducted a tournament in which "...dyads work under a tournament for points" and converted to dollar at the end of the game (Hannan, Towry, and Zhang 2011: 12). The experimental timeline is depicted and described in Figure 1. After each period the agents have the chance to communicate for 45 seconds in order to make arrangements. Then, agents choose an effort level that is influenced by the above describes convex cost structure and a random shock. After each round, the participant with the higher rank in the dyad wins prize W_1 second wins W_2 (in case of a tie the computer randomly decides). All participants know their own performance and rank at the end of each round. Furthermore, the agents in the mutual monitoring condition (perfect information) can also observe the performance and

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Periods				Periods				Periods				Periods			
Cycle 1				Cycle 2				Cycle 3				Cycle 4			

3.3.2 Experimental Results

Results of this tournament reject the hypothesis made. Note, the Nash-Equilibrium effort level is 17.5. Table 3 shows the results of the experimental study for both described scenarios. The average effort level in if monitoring is allowed is 22.95 at a significance level of 1%. In each of the four periods the effort level is higher than the NE level could predict. The contradiction of the hypothesis also confirms the theoretical results of Kräkel. Agents seem to be very predisposed regarding competition and mutual monitoring reinforces competition (cf. Hannan, Towry, and Zhang 2011: 17).

Mean (Std. Dev.)	Mutual Monitoring	
	No	Yes
Period 1 Effort	18.23 (4.19)	21.69 (7.31)
Period 2 Effort	21.69 (7.31)	23.75 (6.23)
Period 3 Effort	17.85 (7.91)	22.88 (8.67)
Period 4 Effort	18.03 (6.35)	22.95 (5.80)
Total Effort	18.73 (3.81)	22.95 (5.80)

Notes: Absolute t-values in parentheses.

Table 3: Regression Results of Mutual Monitoring

Source: Hannan, Towry, and Zhang 2011: 17, Table 2.

3.4 Summary

The first chapter has an unexpected outcome: the hypotheses of Backes-Gellner, Lazear, and Wolff, as well as the one from Hannan, Towry, and Zhang can be refuted. It appears obvious that horizontal collusion has a negative effect for the principals' output, but theory and empirical findings highlight the rejection of that hypothesis. In extent, empirical findings like the one from Hannan, Towry, and Zhang find evidence for the contrary; in static collusion it is not possible to find a stable collusive equilibrium. Same findings apply for the dynamic model with a fixed and known ending. However, the example of the supergame points out that stable collusive behavior is possible if agents prioritize present utility. Empirical findings support Kräkel's theory: Hannan, Towry, and Zhang examined rank-order tournaments with and without mutual monitoring. Results are clearly in favor of that agents prioritize competitive behavior rather than collusive and the effort level even increases when mutual monitoring is possible. The next chapter examines the risk-taking behavior of agents and the how this behavior impairs the rank-order tournament environment.

4 Risk-Taking Behavior

As previously mentioned, rank-order tournaments are subject to relative performance measurements and induce competition between the participants. Competition is not solely responsible for the choice of the effort level that determines the overall performance; it also leads to individual risk taking behavior under pressure (cf. Genakos and Pagliero (2012): 783). In the following, I briefly examine risk-taking behavior of agents in a rank-order tournament that "...can influence both the spread of distribution of output and the distribution mean." (Hvide 2002: 879). The essay *Tournament Rewards and Risk Taking* by Hvide (2002) examines such agent behavior. The theoretical approach is then reflected by an empirical study of Grund and Gürtler (2005), who analyze risk-taking in tournaments empirically. The work *An empirical study on risk-taking in tournaments* focusses on results in the German Soccer League.

4.1 Risk-Taking Model of Hvide

The model by Hvide is an extension of the rank-order tournament model of Lazear and Rosen and builds on chapter 2.2. The only differing assumptions in this paper are that the agents "...can influence both the spread of distribution of output and the distribution mean." (Hvide 2002: 879). In other words:

For example, CEOs can affect whether their firm has a safe or a risky research and development profile, which type of workers to employ, whether to enter emerging markets, in addition to deciding how hard to work themselves. And fund managers can choose the riskiness of their portfolio, in addition to choosing how much resources to spend on providing and analyzing relevant stock information.

(Hvide 2002: 879)

From theoretical literature one can say that two types of strategies, including effort and risk level, exist in the equilibrium: 1) when agents play high risk strate-

gies they chose consequently a low level of effort and vice versa 2) when agents play low risk strategies they chose consequently a higher level of effort (cf. Grund and Gürtler 2005: 547; cf. Hvide 2002: 879). The two possible outcomes can occur, while it is not obvious yet which strategy will be consistent with the equilibrium, because both variables (effort and risk) are endogenous.

4.2 Model Assumptions

An increase in risk implies an increase in the error term and therefore, the variance of ε_i . The implication for the output level is a mean-preserving spread of q_i . Assumptions from the original model in chapter two are adhered to, with the exception that the error term and its variance are chosen endogenously. Therefore, risk-taking is added. Hence, the variance of $\varepsilon_i = \eta_i^2$ and $\eta_i^2 = \sigma^2 + z_i^2$ with $\sigma > 0$ and $z_i \in R_+$, with σ is still the background noise and exogenous, z_i is endogenous and symbolizes the voluntary spread opportunity in the output distribution. No costs are associated with the adjustment of z_i and therefore uniformly zero. Concluding that, risk taking behavior has no direct impact on the utility of agent and the expected output and first best solutions remain unchanged by the implementation of this set of choice.

4.3 Risk-Taking & Lazy Behavior

In the following, I present the results of Hvide: In Proposition 1, Hvide proofed that "the unique equilibrium induces infinite variance and zero effort from both agents." (Hvide 2002: 883). The proof (to be found in Hvide 2002: 883-884) finds evidence for the intuitive assumption that an agent's high degree of risk simultaneously leads to lazy behavior, keeping in mind that this applies for a group where the agent with the highest output receives the highest reward. The participants in a tournament, where risk is a choice of the agents, is likely to increase the noise level in order to reduce the importance of effort. As a consequence, risk-taking behavior in a firm has a negative impact on the principal's output.

The robustness check of this attempt leads to the same result. Even if risk is bound to a certain level, agents choose to be risky and lazy: "Under risk aversion, the relative efficiency of tournaments versus piece rates is decreasing in the level of possible risk taking." (Hvide 2002: 887). The same problem also occurs when agents are facing adverse selection. Agents still make use of high-risk strategies in the equilibrium, if the asymmetric information gap is not too large. Again, the consequence is less effort (cf. Hvide 2002: 885-887).

4.4 The Mediocre Solution

The question now is how to prevent an equilibrium solution where agents are not "infinitely" simultaneously risky and lazy, in terms of effort. Hvide next examines the attempt of the "Mediocrity Puzzle". This solution does not seem to fit into the relative performance measurements, but from literature we know that mediocre solutions can be achieved (cf. Levine 1992 and Mui 1995). In 1994, Heinkel and Stoughton derived an optimal compensation scheme that replaced old reward schemes (where a manager with a high return was rewarded the most) by a mediocre solution. It has been implemented in order to solve the moral hazard problem. Skandia Fund Management (SFM) provides a more common example for an apparently mediocre solution. In 2000, SFM was in use of a compensation scheme that discriminated against outlying performance. A very low and a very high return on the manager's portfolios "...both yield to a lower reward from the principal than performances in the middle." (Hvide 2002: 878). Hvide's approach to prevent agents from choosing high-level risk-taking behavior is to give an appropriate incentive for a moderate output. Hence, agents are motivated to choose a moderate risk level, which then encourages them to work hard. The construction of the model is quite similar to the standard rank-order tournament structure, with any differences explained by the reward structure. The agent with the highest output does not win the tournament, rather the mediocre solution implements that the winner of the tournament is the one with an "...output closest

to a finite benchmark.” (Hvide 2002: 888). Proofed by Hvide in Proposition 3 (cf. Hvide 2002: 890), agents choose a lower level of risk when the moderate output is rewarded higher than a very large output. This then results in a high-level of effort, which is considered as hard working. This approach by Hvide explains the agents’ output regarding a given tournament prize structure and the possibility of risky strategies. Furthermore, an empirical study by Grund and Gürtler (2005) sheds light on whether the theoretical findings can be explained in practice.

4.5 Empirical Findings on Risk-Taking Behavior in Tournaments

Christian Grund and Oliver Gürtler (2005) explored field evidence of risk-taking behavior of the German Major League Soccer. So far, only a few essays empirically deal with risk-taking behavior in rank-order tournaments; Chevalier and Ellison (1997) are pioneers regarding empirical studies on this topic. Both examined the principal agent conflict between "...mutual fund investors and mutual fund companies." (Chevalier and Ellison 1997: 1167). As a result they discovered that portfolio managers increase the risk of the portfolio in case their performance is below average. The reason being, managers that are around the average performance return rates or even above, have a disproportionate positive effect on the investment inflow. In their research, Grund and Gürtler attempt to answer following question:

Q_2 : Are risk-taking strategies attractive for agents (coaches) in rank-order tournaments and do they make use of them?

4.6 Model Assumptions & Hypotheses

In this rank-order tournament study, coaches represent the role of agents. Rather unsuccessful coaches get fired and are likely to receive less payment than the successful coaches. Further, the risk-taking behavior can be measured through the formation of the team: a more offensive formation is considered to be more risky, vice versa a more defensive formation reflects a less risky strategy. Notice, that in this case, the coaches are responsible for the strategy, while the players are the ones that exert the effort. Consequently, a reduction in effort should be irrelevant. Incentives in a soccer game are as follows: the winning team receives three points, one point for a tie, and zero points for a loss. The number of goals only matters if two teams are ranked equal regarding the sum of points. Then, the difference of the goals scored and goals suffered will decide the final rank. These incentives in mind, the coaches face an incentive structure, as shown in Figure 2. The incentive structure simply shows the relationship between a loss, a tie, and a win. Intuitively, a coach that faces a loss will likely change to a riskier strategy while a coach that faces a win is more likely to change to a less risky strategy.

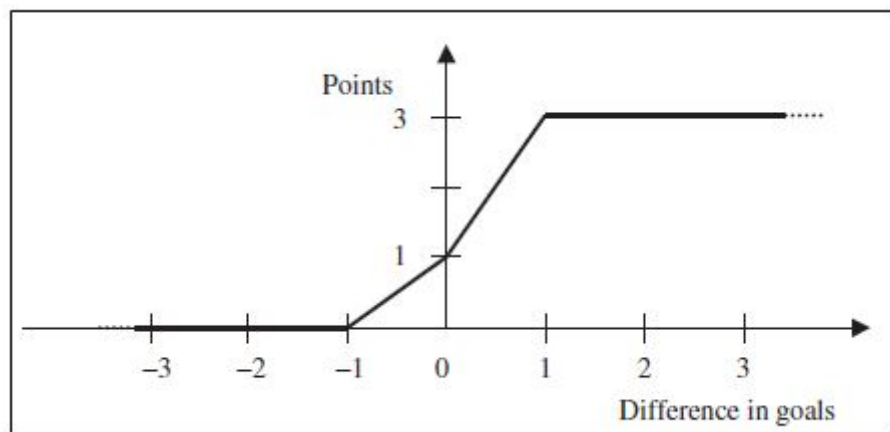


Figure 2: Incentive Structure of a Soccer Game

Source: Grund and Gürtler 2005: 458, Figure 1.

The main hypothesis to be examined is as follows:

H_2 : "The coach of a team leading (being behind) during a match should switch to a less risky (riskier) strategy."

(Grund and Gürtler 2005: 458)

4.7 Dataset

Exploring the dataset of the German Major Soccer League 2003/2004 should show if risk-taking agents are more successful than non-risk-taking agents. The dataset contains 306 matches and 18 teams. Coaches can freely choose their formation which consists of 11 players (including one goal keeper) and are allowed to substitute up to three players during the game. Here, a substitution obtains three different strategies:

1. Risk neutral: same tactical substitution
2. Risk-taking: a forward replaces a defender
3. Risk-averse: a defender replaces a forward

Risk-taking substitution has the initial incentive to increase the probability of winning, while a risk-averse substitution symbolizes a result protection. The dataset comes from a renowned soccer news provider, www.kicker.de.

4.8 Empirical Results

To analyze the hypothesis, the authors make use of a binary probit regression. This regression calculates the risk-taking behavior in regard to the difference in the number of goals. The latter describes the goals scored by a team minus the goals made of the opponent team. Table 4 shows the implicit results with an increase in the goal difference:

	Risk-taking substitutions	Risk-reducing substitutions
Goal difference	-0.230*** (8.84)	0.110*** (4.39)
Home match	0.109 (1.47)	-0.053 (0.70)
Difference in ranking	-0.012* (1.83)	0.008 (1.17)
Team dummies (18)	Yes	Yes
Pseudo R^2	0.080	0.050
Number of observations	1682	1682
Notes: Absolute t-values in parentheses.		
* and *** indicates significance at the 0.10 and 0.01 level.		

Table 4: Regression Results of Risk-Taking Behavior

Source: Grund and Gürtler 2005: 459, Table 1.

Thus, the risk-taking behavior decreases (-0.230) and the risk-reducing behavior increases (0.110) with the in number of goal. Both observations are significantly different from zero at a 1% level. Further, risky behavior is affected by the difference in the league ranking and whether the match was at home or not. Clearly, coaches aim to change their strategies during the game depending on the goal difference. Furthermore, it is still questionable whether risk-taking behavior is successful or not. Two types of measurements define whether the risk-taking substitution was successful or not:

1. Advancement in scores from time of the first substitution to the end of the game.
2. Advancement of received points which is determined as the difference of received scores at the end of the game minus the hypothetical points received at the time of the first substitution.

	Score advancement	Point advancement
Degree of risk-taking	-0.118*** (3.78)	-0.058*** (1.69)
Home match	0.442*** (5.16)	0.193** (2.07)
Difference in position	-0.010 (1.29)	-0.001 (0.12)
Team dummies (18)	Yes	Yes
Pseudo R^2	0.048	0.024
Number of observations	612	612

Notes: Absolute t-values in parentheses.

*, ** and *** indicates significance at the 0.10, 0.05 and 0.01 level.

Table 5: Regressions Results on Score and Point Advancement

Source: Grund and Gürtler 2005: 460, Table 4.

Again, the authors used a binary probit model to evaluate the outcome (output) of risk-taking behavior activities. The degree of risk-taking is correlated to the amount and kind of substitution. Grund and Gürtler revealed that coaches like to increase the riskiness of their strategy when their team is behind in the game. However, Table 5 demonstrates that this behavior is not crowned with success. A change to a more risky strategy has a significant negative effect on the score (-0.118) and point advancement (-0.058). Therefore, coaches seem to overestimate the effect of switching to a riskier strategy. Hence, as advice and in conclusion coaches are better off if they stick to their initial tactical formation: "Obviously, an increase in risk not only enhances the variance of the outcome distribution, but also decreases its mean." (Grund and Gürtler 2005: 461).

4.9 Summary

From Hvide we know that agents play high-risk strategies combined with a low level of effort. The victim, in this case, is the principal, as his output is negatively influenced by the riskiness of his agents. Similar findings can be observed in the essay of Grund and Gürtler: risk-taking approaches by the coaches do not lead to a higher score or received points. Here, the club seems to be the victim that suffers from the individual risky behavior of their coach. The mediocre solution, therefore, is a favorable approach for firms where risky strategies, paired with lazy effort, have a high influence on the overall output. The work of Genakos and Pagliero (2012), *Interim Rank, Risk Raking, and Performance in Dynamic Tournaments*, supports Hvide's results and suggest the mediocre solution. Both examined competitive weight lifting contests and found evidence that "... professional athletes take greater risks when ranked close enough to the first athlete but then revert to safer strategies when ranked lower." (Genakos and Pagliero 2012: 811). Additionally, performance suffers due to riskier strategies when athletes play at the top of the tournament while lower ranked agents play safer strategies. In my view, this knowledge supports the mediocre solution and firms should consider adapting this structure from Skandia Fund Management (SFM). The next chapter concentrates on Sabotage & Mobbing activities of agents and whether this behavior applies in rank-order tournaments.

5 Sabotage & Mobbing

As another objection in favoring rank-order tournaments, Harbring and Irlenbusch deduce that sabotage and mobbing are omnipresent when relative performance evaluation occurs. The cases of both Tonya Harding (Olympic Winter Games 1994 in Lillehammer) and presidential election campaigns, in which the candidates attempt to ruin the reputation of their opponents, are examples of sabotage. In the labor market, employees are actively destructive against one or more colleagues, therefore harming the performance of their companies (cf. Harbring and Irlenbusch 2011: 611). There are two ways of winning a contest: either the agent has to invest his or her maximum work effort or he or she tries to weaken his or her competitor's performance. The latter action of the agent is highly undesirable for the principal (cf. Kräkel 2012: 239). "Unfortunately, sabotage activities can hardly be observed or verified. For natural reasons, agents engaging in sabotage are very careful in hiding their activities." (Harbring and Irlenbusch 2011: 611). A fairly new attempt of Harbring and Irlenbusch observes the effort and sabotage behavior of agents in a laboratory experiment. The publication *Sabotage in Tournaments: Evidence from a Laboratory Experiment* from 2011 exposes that the agents' behavior depends highly on the wage spread. Harbring and Irlenbusch's earlier attempt in 2008 *How many winners are good to have? On tournaments with sabotage*, also focuses on sabotage activities and makes use of the same model approach. The following subchapters concentrate on the modeling of the authors and their results with respect to previous research from Harbring, Irlenbusch, Kräkel, and Selten: *Sabotage in Corporate Contests – An Experimental Analysis* (2007) and Garicano and Palacios-Huerta: *Sabotage in Tournaments: Making the Beautiful Game a Bit less Beautiful* (2005).

5.1 Sabotage Model by Harbring and Irlenbusch

In the style of Harbring and Irlenbusch, I make use of a simple rank-order tournament game and mainly refer to the raw model in 2.2. The tournament is composed of two stages and $n+1$ participants while N agents and one principal build the framework of this game. The principal chooses a remuneration level in the first stage and the agents chose their behavior in the second stage. The behavior contains two activities that the agents are able to choose simultaneously. Either the agents can exert productive effort and/or sabotage activities. Both activities improve their relative performance in the situation but differ in the outcome for the principal. The principal offers the sum of wages W (here prize pool) and the agents compete for them (in this case for the prize). The winner of the tournament can win prize W_1 and the $n-1$ losers receive prize W_2 (whereas $W_1 > W_2$). The tournament-prize-difference can be written (as in 2.2.2) as $\Delta W = W_1 - W_2$. The total sum is denoted as $W = nW_2 + \Delta W$ and equals the total wages paid by the principal. The agents have two sets of strategies (μ_i, s_i) . Agent i is able to invest effort μ_i and a sabotage activity of s_i . Sabotage activities reduce the produced output of each agent by one unit. The production function y_i is determined as follows:

$$q_i = \mu_i + \varepsilon_i - \sum_{i \rightarrow j} s_i, \quad (5.30)$$

whereas ε_i is uniformly distributed over the interval $[-\bar{\varepsilon}; +\bar{\varepsilon}]$ and describes the luck component which is beyond anyone's control. Furthermore, ε_i is independent and identically distributed for all agents. In 5.30, it is clearly visible that each sabotage activity affects the production function negatively by one unit. In addition, sabotage is costly for each agent, exerting effort as well. Both actions bear costs that are denoted by two symmetric and quadratic cost functions:

$$C_\mu(\mu_i) = \frac{\mu_i^2}{c_\mu} \quad C_s(s_i) = \frac{s_i^2}{c_s} \quad (5.31)$$

Similar to Harbring and Irlenbusch, I assume that "... all agents face the same cost function for productive effort and the sabotage activity and that this is in common knowledge" (Harbring and Irlenbusch 2008: 685). Equations 5.30 and 5.31 result in the following profit function in which $P(\mu_i, \mu_{-i}, s_i, s_{-i})$ denotes the probability of winning this tournament, while the others play their pair of strategies (μ_{-i}, s_{-i}) :

$$\begin{aligned} E[\pi(\mu_i, \mu_{-i}, s_i, s_{-i})] &= P(\mu_i, \mu_{-i}, s_i, s_{-i})W_1 + \\ &[1 - P(\mu_i, \mu_{-i}, s_i, s_{-i})]W_2 - C_\mu(\mu_i) - C_s(s_i) \end{aligned} \quad (5.32)$$

The payoff function 5.30 finally reduces to

$$E[\pi(\mu_i, \mu_{-i}, s_i, s_{-i})] = W_2 + P(\mu_i, \mu_{-i}, s_i, s_{-i})\Delta W - \frac{\mu_i^2}{c_\mu} - \frac{s_i^2}{c_s} \quad (5.33)$$

as the authors assume agents to be rational, risk neutral, money maximizing and with pure strategies that obtain an interior symmetric equilibrium. Furthermore, the agents need only to derive their FOCs, while the principal also strives to maximize his overhaul profit. The agents' behavior depends on the wage spread chosen by the principal. If the spread is 0 the agents have no incentive to either exert effort or exercise any sabotage activities. But, if the spread is positive ($\Delta W > 0$) agents' behavior follows the FOC:

$$\frac{\partial P(\mu_i, \mu_{-i}, s_i, s_{-i})}{\partial \mu_i} \Delta W = \frac{2\mu_i}{c_\mu} \quad (5.34)$$

$$\frac{\partial P(\mu_i, \mu_{-i}, s_i, s_{-i})}{\partial s_i} \Delta W = \frac{2s_i}{c_s} \quad (5.35)$$

Through a closer look at 5.34 and 5.35 and the given assumptions made regarding the distribution of the luck component and the production function, "...one can show that in a symmetric equilibrium the marginal probabilities of winning are constant..." (Harbring and Irlenbusch 2008: 687). The size of the interval $[-\bar{\epsilon}; +\bar{\epsilon}]$

is the only (exogenous) variable that draws a visible change to the probability function (Proof by Harbring and Irlenbusch 2008: Appendix in supplementary data). That is:

$$\frac{\partial P(\mu_i, \mu_{-i}, s_i, s_{-i})}{\partial s_i} = \frac{\partial P(\mu_i, \mu_{-i}, s_i, s_{-i})}{\partial \mu_i} = \frac{1}{\varepsilon} \quad (5.36)$$

Implementing this knowledge reduces the FOCs to

$$\frac{1}{2\bar{\varepsilon}}\Delta W = \frac{2\mu_i}{c_\mu} \text{ and } \frac{1}{2\bar{\varepsilon}}\Delta W = \frac{2s_i}{c_s} \quad (5.37)$$

and delivers following optimal effort and sabotage level of the equilibrium:

$$\mu^* = \frac{C_\mu \Delta W}{2\bar{\varepsilon}} \text{ and } s^* = \frac{C_s \Delta W}{2\bar{\varepsilon}} \quad (5.38)$$

An interior solutions only exists, when

$$\frac{\Delta W}{n} \geq C_\mu(\mu^*) + C_s(s^*) \quad (5.39)$$

guarantees that the costs are not higher than the expected profit.

The results in 5.38 confirm the theoretical findings from the raw model in 2.2.2 the effort level and sabotage activities depend on the wage spread and not on the total sum of the prize pool.

After the employment of the agents' production and profit functions, the principal maximizes his gains. The principal gets remunerated by the sum of the productive output of the agents:

$$E[\pi_p(\mu, s)] = \gamma[E(\sum_i q_i)] - \theta W \text{ with } W = nW_2 + \Delta W \quad (5.40)$$

$$E[\pi_p(\mu, s)] = \gamma(\sum_i \mu_i - (n-1)\sum_i s_i) - \theta W, \quad (5.41)$$

with $\gamma > 0$ representing the value of each produced unit by the agent. The parameter θ ($0 < \theta \leq 1$) symbolizes proportional costs of the wage sum that the principal suffers. Harbring and Irlenbusch argue that these costs may come from the implementation of the remuneration system: "One interpretation would be that the principal is a manager who implements the wage system and is rewarded in proportion to the output and the wage costs of his team." (Harbring and Irlenbusch 2011: 614). What remains is the expected payoff function in the symmetric equilibrium of the principal in dependence of the choice of the wage spread ΔW and the total sum of the prize pool W (sum of wages):

$$E[\pi_p(\mu^*, s^*)] = \frac{\gamma \Delta W n [C_\mu - (n-1)C_s]}{2\bar{\epsilon}} \quad (5.42)$$

Equation 5.42 shows as well that the wage sum remains unaffected in terms of the expected output for the principal. While exerting effort and sabotage both have a positive outcome for the agent, they have a different outcome for the principal. The principal is positively affected by the productive effort of the agent but negatively influenced by sabotage costs. A positive output for the principal can only be achieved if $C_\mu > (n-1)C_s$ (Note: here there are two identical cost functions). In reality, one may assume that the sabotage is more costly than exerting effort. Deconstructive activities in a working environment are more difficult to hide and to carry out in front of the colleague or the employer.

5.2 Experimental Results of the Model

The examined framework in 5.1 is only a one-shot tournament. In reality, principals or managers repeat promotion/remuneration tournaments in organizations. Harbring and Irlenbusch designed a laboratory rank-order tournament with three agents and one principal to find empirical evidence for their framework. In their first attempt, they simulate a one-shot tournament with four different prize spreads and a total prize pool that consists of $W \in \{300, 600\}$. Furthermore, the cost parameters are $C_\mu = 70$, $C_s = 20$, $\theta = 0.3$, $\gamma = 3$, $\bar{\epsilon} = 120$ and agents are allowed to choose from $\mu_i \in [0, \dots, 100]$ and $s_i \in [0, \dots, 50]$. Table 6 describes the possible allocations of wage contracts for the afore mentioned assumptions, while Table 7 next page shows the corresponding predictive results for the chosen parameters (cf. Harbring and Irlenbusch 2011: 615-616).

Prize spread ΔW	Low wage level $W=300$		High wage level $W=600$	
Fixed wages ΔW	100 for each agent		300 for each agent	
$\Delta W = 0$				
Tournament incentives:	2 loser prize W_2	1 winner prize W_1	2 loser prize W_2	1 winner prize W_1
$\Delta W = 48$	84	132	184	232
$\Delta W = 96$	68	164	168	264
$\Delta W = 144$	52	196	152	296
$\Delta W = 192$	36	228	136	328

Table 6: Possible Allocations of Wage Contracts

Source: Harbring and Irlenbusch 2011: 615, Table 1.

In the second attempt, Harbring and Irlenbusch conducted a computerized laboratory experiment with 336 students. Students were allowed to participate in only one session which consisted of 30 repetitions. As an appropriate incentive students got paid for each session in the amount of their final output after 30 repetitions. In order to obtain a more detailed observation, the authors differentiate between five treatments: baseline, chat, framing, and two treatments to

	Fixed Wages		Tournament Incentives		
Price spread ΔW	$\Delta W = 0$	$\Delta W = 48$	$\Delta W = 96$	$\Delta W = 144$	$\Delta W = 192$
Effort	0	14	28	42	56
Sabotage	0	4	8	12	16
Output	0	6	12	18	24

Note: The effort and sabotage equilibrium predictions are derived for one-shot tournaments assuming that agents are risk neutral and are only interested in maximizing their own payoff.

Table 7: Predictive Results in a One-Shot Tournament

Source: Harbring and Irlenbusch 2011: 615, Table 2.

check for robustness. The first three treatments only differ in value-laden terms, e.g. sabotage, agent, and principal are replaced by synonyms in the baseline scenario. Harbring and Irlenbusch attempt to test whether value-laden terms have an effect on the test subject. The chat scenario allows the test subjects to communicate with each other and framing describes the employment situation. Figure 3 shows the result for the baseline scenario. The other scenarios are similar and are found in the Appendix A.1. Apparently, it is visible that effort and sabotage activities increase with the prize spread for a fixed wage sum.

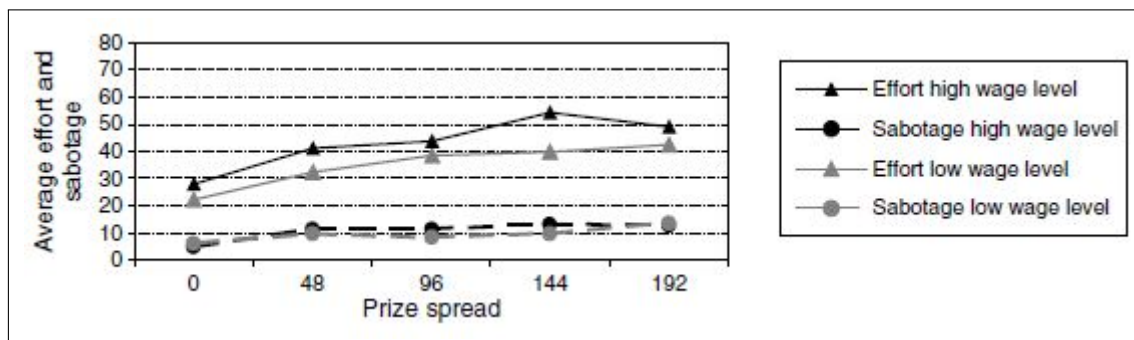


Figure 3: Average Effort and Sabotage

Source: Harbring and Irlenbusch 2011: 617, Figure 1.

As predicted in Table 7, effort and sabotage increase but, the regression output in Table 8 gives evidence that the increase is smaller than expected. Using gen-

eralized least square, Model (1) describes the individual effort and Model (2) the individual sabotage activities with $\Delta W = 0$ as the reference. Results for all spreads are highly significantly positive but smaller than anticipated in Table 7. As an example, effort and sabotage increase by 17.580 and 6.360, relative to fixed wages ($\Delta W = 0$) if the tournament prize spread is $\Delta W = 144$. Noteworthy, however, is the increase of effort and sabotage in the one-shot game, which is less than in the predicted model (resulting on a Wald Test). The regression table provides evidence and confirms the theoretical approach in 2.2.2 and 5.1:

Theoretical and empirical evidence has been found that proofs that “effort and sabotage increase with the prize spread.”

(Harbring and Irlenbusch 2011: 617).

Dependent Variable:	Effort (1)	Sabotage (2)	Output (3)	MC (4)
PS $\Delta W = 48$	7.149*** (2.480)	4.351*** (0.680)	-1.505 (2.360)	-0.229*** (0.078)
PS $\Delta W = 96$	13.430*** (2.490)	5.319*** (0.740)	2.802*** (2.420)	-0.147* (0.084)
PS $\Delta W = 144$	17.580*** (2.290)	6.360*** (1.130)	4.902* (2.640)	-0.132 (0.110)
PS $\Delta W = 192$	20.880*** (2.820)	8.153*** (1.180)	4.721 (3.100)	-0.212* (0.120)
Constant	27.730*** (2.340)	6.375*** (1.050)	14.940*** (2.700)	0.153 (0.110)

Note: Random effects GLS estimates on individuals with robust standard errors for groups are reported. Models (1) – (3) explain individual effort, sabotage, and output. *Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

Table 8: Regressions Results

Source: Harbring and Irlenbusch 2011: 618, Table 3.

A second finding of the regression indicates that the overhaul output for a given wage sum remains rather constant. Results are stated in regression (3) of Table 8 and visible for the baseline scenario in Figure 4 (all scenarios can be found in the Appendix Figure A.2). This result contradicts the predicted equilibrium results of Table 2.

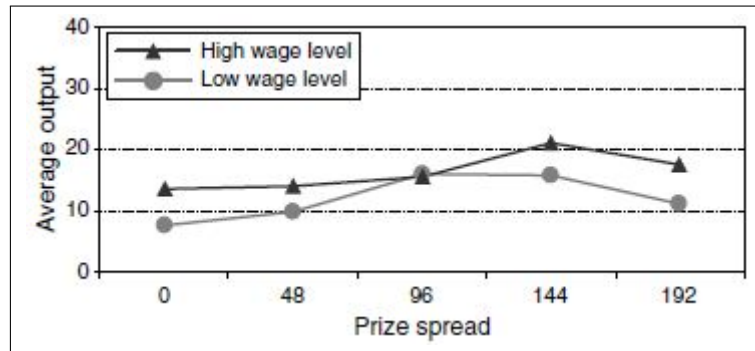


Figure 4: Average Output

Source: Harbring and Irlenbusch 2011: 619, Figure 2.

In order to understand the discrepancy, Harbring and Irlenbusch conducted regression (4). MC (4) regresses the marginal cost difference between effort and sabotage and measures the optimal relation of both for a fixed wage sum. A negative sign implies that sabotage is predominant; vice versa a positive sign implies a predominant effort behavior of the agents. Zero would imply a perfect mix of effort and sabotage due to money maximizing. All signs of the coefficients aside from the constant are negative. This demonstrates that an increase in the wage spread gives the agents a higher incentive to do sabotage and if the wages are fixed the difference of effort and sabotage costs is zero (cf. Harbring and Irlenbusch 2011: 613-618). In the following subchapters, I describe further findings and research on sabotage and mobbing activities and link them with the results of Harbring and Irlenbusch.

5.3 Further Research Findings

In this subchapter, I briefly highlight and compare the empirical findings of the work of Harbring, Irlenbusch, Kräkel, and Selten: *Sabotage in Corporate Contests – An Experimental Analysis* (2007) with Garicano and Palacios-Huerta: *Sabotage in Tournaments: Making the Beautiful Game a Bit less Beautiful* (2005).

5.3.1 Sabotage in Corporate Contests

The authors Harbring, Irlenbusch, Kräkel, and Selten in the following Harbring et. al., examined a similar approach in their paper *Sabotage in Corporate Contests – An Experimental Analysis* (2007) as explained in detail in 5.2. Harbring et. al. consider a two-stage tournament with three heterogeneous players having individual cost functions. Cost functions differ due to the ability of each agent. Agents can have a high or a low ability, whereas costs are low and high respectively. Ex-ante, low costs determine a favorite and high costs an underdog. At the first stage the agents choose a level (high or low) of sabotage simultaneously which are of common knowledge and increase the agents' cost functions (reduction of winning). The set of sabotage strategies contains four alternatives: 1) no sabotage at all, 2) and 3) sabotage only one player, or 4) sabotaging all players. At the second stage agents then chose their individual effort level. Harbring et. al. make use of a Tullcock contest (1980). Prizes are determined as in 5.2 with only one winner and two loser prizes (cf. Harbring, Irlenbusch, Kräkel, and Selten 2007: 370-371). The main research question in this case is: Will the agents individually harm each other in order to win the first prize? Four hypotheses complete the research question:

H_3 : Alliance – Underdogs harm each other less than the favorite.

H_4 : Resignation – The higher the proportion of favorite, the less the underdogs harm them.

H_5 : Battle of Giants – Favorites harm favorites more than underdogs.

H_6 : Superiority - The higher the proportion of favorite, the less the favorites harm the underdogs.

(cf. Harbring, Irlenbusch, Kräkel, and Selten 2007: 372-373)

The design of the contest is quite similar to the attempt in 5.2 regarding participation compensation and procedure. The authors designed three treatments in order to build one homogenous game and two games with different types of players. The experimental results are briefly summarized in Table 9:

	Theoretic predic.	Exp. results		Theoretic predic.	Exp. results	
	Sabotage	Sabotage exerted	Sabotage received	Effort	Avg. effort	Frequ. of Win.
Hom						
3 favorites	100%	48.00%	48.00%	79.37	122.98	33.33%
HetF						
2 favorites	100%	57.83%	55.33%	86.51	122.94	37.33%
1 underdog	100%	49.50%	54.50%	37.07	80.79	25.33%
HetU						
1 favorite	100%	49.83%	73.67%	89.04	126.97	43.33%
2 underdogs	100%	70.25%	58.33%	49.47	89.04	28.33%

Table 9: Aggregated Results

Source: Harbring, Irlenbusch, Kräkel and Selten 2007: 375, Table 2.

Obviously, sabotage is less likely in practice than theory predicts, taking a look at the sabotage level exerted in all three treatments: "Note that a situation where all subjects choose to sabotage each other occurs in only 12% of all contests at maximum." (Harbring, Irlenbusch, Kräkel, and Selten 2007: 375). On the other hand,

the average effort level in all three treatments in the contest modus is higher than in the theoretical prediction. The frequency of winning is the only parameter that is in line with the anticipated results. Favorites, on average, win the tournament. The development of sabotage over rounds is explained by Figure 5. The agents start in all three treatments with a lower level of sabotage and during the first ten rounds the sabotage activities increase and remain almost constant from the 20th round.

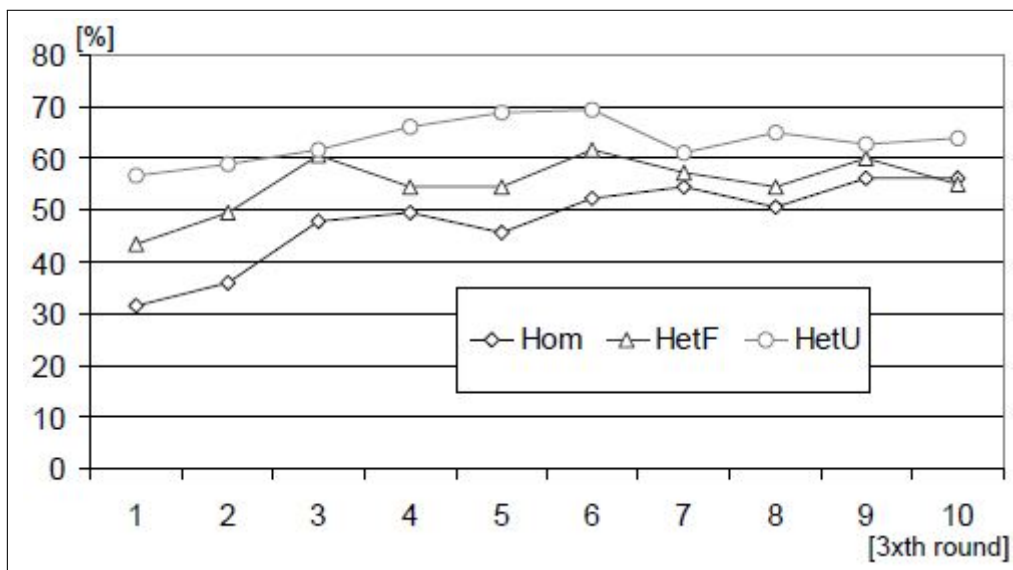


Figure 5: Sabotage Development over Rounds

Note: The data points represent averages over 3 rounds.

Source: Harbring, Irlenbusch, Kräkel, and Selten 2007: 375, Figure 2.

Testing the four hypotheses results in:

H_3 : Alliance – Underdogs harm each other less than the favorite.

= False, underdogs do not harm favorites less in HetU.

H_4 : Resignation – The higher the proportion of favorite, the less the underdogs harm them.

= True, underdogs in HetF sabotage less than in HetU.

- H_5 : Battle of Giants – Favorites harm favorites more than underdogs.
= True, HetF is the example that favorites harm favorites more than underdogs.
- H_6 : Superiority - The higher the proportion of favorite, the less the favorites harm the underdogs.
= False, there is no significant evidence that favorites harm underdogs in HetU larger than in HetF.
- (cf. Harbring, Irlenbusch, Kräkel, and Selten 2007: 377)

Comparing these results with the results of 5.2, one can say that heterogeneous agents' behavior is not as predictable as theory may argue. Agents are even able to create a Pareto-Superior outcome (cf. Harbring, Irlenbusch, Kräkel, and Selten 2007: 384). Commonly, they both come to the same result: that sabotage is overvalued in theoretical models and sabotage levels are lower in reality.

5.3.2 Sabotage in the Spanish National Soccer League

The last subchapter of sabotage and mobbing activities deals with a research attempt of Garciano and Palacios-Huerta (2005). This attempt differs from the last two approaches described in 5.2 and 5.3.1, which were laboratory studies with a focus on individual behavior. Both authors examined the incentive effect of sabotage in the Spanish National Soccer League in their paper: *Sabotage in Tournaments: Making the Beautiful Game a Bit Less Beautiful*. This paper focuses on the team sport of soccer. Therefore, the "... setting is a sports context." (Garciano and Palacios-Huerta 2005: 2). In 1994 the Fédération Internationale de Football Association (FIFA) implemented a new reward system in all soccer leagues worldwide. In the past, soccer teams in a national league competition could get two points for a win, one for tying, and zero points for a loss. The new implemented reward system guaranteed three points for a win instead of two, leaving everything else unchanged. The objective of the FIFA was to encourage teams to attack

and score more goals, making soccer more attractive. Sabotage, in this examination can, be seen as any effort to explicitly reduce the performance of the opponent team. The data set for the examination comes from the 94/95 full season (last 2-1-0 scheme) and 98/99 full season (new 3-1-0 scheme). The increase of one point per win can be seen as an increase in the tournament-prize-difference. As a control of the analysis of the dataset, the authors "... use data from the Spanish Cup competition La Copa..." (cf. Garicano and Palacios-Huerta 2005: 5). Briefly, the OLS model consists of four different types of players (goalkeeper, defender, midfielder or attacker) and two behavioral team actions. The two possible team actions consist of constructive and deconstructive behavior:

1. Constructive behavior is defined through the number of attackers, shots, shots on goal and corner kicks also named as "offensive play".
2. While deconstructive behavior, in this case of sabotage, is defined through the number of defenders, fouls, yellow and red cards named as "sabotage play". Further, extra time and substitutions and an additional set of other control variables complete the model.

The objective of the authors is to find experimental evidence that an increase in the tournament-prize-difference encourages teams to win. This can be achieved by either exerting more constructive effort or deconstructive behavior. The following hypotheses are in the focus of the consideration regarding an increase in the tournament-prize-difference:

H_7 : Offensive Play characteristics are increasing

H_8 : Sabotages Play activities are increasing

H_9 : More goals per game (FIFA)

The descriptive statistics in Table 10 support hypotheses 7 and 8 and report the difference in effort in offensive and sabotage play before and after incentive change.

The changes for the offensive play are all significantly positive at the 1% level and describe a positive incentive effect. Results for the sabotage play are similar and all significant at the 1% level as well. Fouls and yellow cards increase with the tournament-prize-difference and support the hypotheses 7 and 8. Results from the OLS regression confirm the descriptive statistics in Table 10 and are presented in Table 11 and 12.

Offensive Play				Sabotage Play			
	Before	After	Diff.		Before	After	Diff.
Att- ackers	2.08 (0.0244) N = 740	2.35 (0.0256) N = 760	0.274*** (0.0353)	Def- enders	4.05 (0.0286) N = 740	3.93 (0.03) N = 760	-0.122*** (0.0415)
Shots	6.19 (0.124) N = 734	6.80 (0.101) N = 760	0.619*** (0.16)	Fouls	16.20 (0.191) N = 734	17.49 (0.151) N = 760	1.290*** (0.243)
Shots on Goal	4.12 (0.0882) N = 760	4.75 (0.0775) N = 760	0.626*** (0.117)	Yellow Cards	2.33 (0.0549) N = 734	2.67 (0.0614) N = 760	0.338*** (0.0823)
Corner Kicks	5.29 (0.101) N = 734	5.94 (0.0885) N = 760	0.649*** (0.134)				

* denotes significant at the two-tailed 10% level, ** at 5%, and *** at 1%.

Table 10: Before and After Estimates

Source: Garicano and Palacios-Huerta 2005: 18, Table 1.

Offensive behavior finds evidence in the number of attackers. A 20% incentive change in forwards (column I in Table 11) speaks volumes. The offensive play in numbers of corner kicks, shots and shots on goal (columns IV - VI in Table 11) also supports the incentive positively by roughly 10% (although not all results are significant). Table 12 shows the results of a change in the level of sabotage. The

Explanatory Variable	Attackers		Offensive Index	
	(I) ...	... (IV)	(V)	(VI)
Incentive Change	0.413*** (0.098)	0.287** (0.133)	0.239 (0.151)	0.256* (0.142)
Cup Dummy	0.12 (0.0759)	-0.371*** (0.0937)	-0.43*** (0.107)	-0.388*** (0.104)
Year Effect	-0.139 (0.0914)	0.135 (0.12)	0.0647 (0.142)	0.139 (0.132)
Visitor Dummy			-0.478*** (0.0479)	-0.473*** (0.0472)
Own Budget			1.99E-5** (8.699E-6)	
Opponent's Budget			2.304E-5*** (8.643E-6)	
Intercept	2.08*** (0.0244)	-0.182*** (0.042)	-0.0252 (0.0591)	0.0691 (0.0522)
Include team fixed effects?	No	No	No	Yes
N	1698	1596	1568	1596
R ²	0.280	0.050	0.103	0.134

* denotes significant at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 11: Changes in the Level of Effort

Source: Garicano and Palacios-Huerta 2005: 18, Table 2.

number of fouls (column IV – VI) increases by about two per game. This is an increase of 12.5% from 16.2 to 18.2 per game at a representative significant level. Yellow cards, even if they are limited per player, increase (but not to a significant level) after the FIFA incentive changes by 10%. The main aim by the FIFA to implement the 3-1-0 scheme was to increase the number of goals per game. The regression on the output of the incentive change in Table 13 does not allow for an appropriate conclusion to confirm this. The value of the incentive change for three scenarios is not significant and close to zero.

Explanatory Variable	Fouls	Yellow Cards
	... (IV) ...	... (VII) ...
Incentive Change	1.99** (0.93)	0.23 (0.282)
Cup Dummy	1.17 (0.856)	0.33 (0.202)
Year Effect	-0.707 (0.897)	0.107 (0.27)
Intercept	16.2*** (0.191)	2.33*** (0.0549)
Include team fixed effects?	No	No
N	1596	1716
R ²	0.020	0.013

* denotes significant at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 12: Changes in the Level of Sabotage

Source: Garicano and Palacios-Huerta 2005: 19, Table 3.

Explanatory Variable	Goals Scored		
	(I)	(II)	(III)
Incentive Change	-0.0202 (0.169)	0.00187 (0.272)	0.011 (0.177)
Cup Dummy	6.629E-4 (0.11)	-0.126 (0.149)	-0.0169 (0.119)
Year Effect	0.0846 (0.158)	-0.154 (0.266)	0.108 (0.17)
Intercept	1.25*** (0.0443)	1.37*** (0.063)	1.5*** (0.0598)

* denotes significant at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 13: Changes in the Level of Goals Scored

Source: Garicano and Palacios-Huerta 2005: 20, Table 4.

5.4 Summary

Competition of agents stirs up envy and therefore stirs up sabotage activities. The reason for social envy is a purely subjective perception (cf. Kräkel 2010: 246-251 and cf. Akerlof 1976: 603). This chain reaction needs to be controlled by the principals. Nevertheless, to sum up the results, Habring and Irlenbusch's experimental evidence suggest that sabotage activities increase with the prize spread within a rank-order tournament, as well as effort that we already know from chapter 2. Unfortunately, sabotage activities are predominant in terms of the marginal cost difference between effort and sabotage, and therefore agents have a higher incentive for sabotage instead of exerting a higher effort level. Further experimental findings do not solely support the theoretical knowledge that sabotage stirs up problems and therefore might be overvalued. Harbring, Irlenbusch, Kräkel, and Selten come to the empirical result that in reality, agents can even create Pareto-Superior outcomes than predicted by theory. Aside from laboratory studies, chapter five also deals with sabotage activities through examination of a field study. Garicano and Palacios-Huerta observed the incentive effect of sabotage in the Spanish National League after the change to the 3-1-0 scheme, which indicates an increase in the prize spread. Here as well, effort, in terms of attackers, shots, and corner kicks, increases and sabotage play results in more fouls and yellow cards per game. Concluding, sabotage is present but the obvious negative effect on the principal (in terms of less output) is not significant enough to exclude rank-order tournament as an incentive performance scheme.

6 Presence of a Superstar

Lastly, a more modern problematic issue in the tournament theory describes the presence of a superstar. Sherwin Rosen defines the superstar effect in her pioneer work as follows:

The phenomenon of Superstars, wherein relatively small numbers of people earn enormous amounts of money and dominate the activities in which they engage, seems to be increasingly important in the modern world.

(Rosen 1981: 846)

The superstar effect describes the increase in the ability of the most skilled player or worker and the lower equilibrium of the competitor (low-ability player) that comes along with it (cf. Brown 2011: 5). Sherwin Rosen was the first to deal with this problematic issue in her paper *The Economics of Superstars* in 1981. Regrettably, the research seems to have stalled a little, and further remarkable research of this topic took a while. The most recent and known publications that discuss this theme are the work of Jennifer Brown (2011) in *Quitters Never Win: The (Adverse) Incentive Effects of Competing with Superstars* and Ryuichi Tanaka and Kazutoshi Ishino (2012) in *Testing the Incentive Effects in Tournaments with a Superstar*. In the following, I carefully examine the approach of Jennifer Brown. She proved the behavior of n-heterogeneous players competing for multiple prizes.

6.1 N-Heterogeneous Players and Multiple Prizes

Brown describes a contest with three participants and a prize pool W . The allocation key for the participants is as follows: the winner gets awarded by a fraction α which is greater than 0.5 of the total prize pool W . The second place receives $(1-\alpha)$ of W and the third place goes away empty-handed. In order to map the superstar behavior player 1 is λ -times ($\lambda > 1$) more talented than the other two identical players. Furthermore, Brown calculates the expected payoff function including the probabilities of winning a prize for all three players:

$$\pi_1 = \frac{\lambda x_1}{\lambda x_1 + x_2 + x_3} \left(\alpha + (1-\alpha) \left(\frac{x_2}{\lambda x_1 + x_3} + \frac{x_3}{\lambda x_1 + x_2} \right) \right) W - x_1 \quad (6.43)$$

$$\pi_2 = \frac{x_2}{\lambda x_1 + x_2 + x_3} \left(\alpha + (1-\alpha) \left(\frac{\lambda x_1}{x_2 + x_3} + \frac{x_3}{\lambda x_1 + x_2} \right) \right) W - x_2 \quad (6.44)$$

$$\pi_3 = \frac{x_3}{\lambda x_1 + x_2 + x_3} \left(\alpha + (1-\alpha) \left(\frac{\lambda x_1}{x_2 + x_3} + \frac{x_2}{\lambda x_1 + x_3} \right) \right) W - x_3 \quad (6.45)$$

The FOCs of the expected payoff functions is as follows:

$$\begin{aligned} \frac{\partial \pi_1}{\partial x_1} &= \frac{\lambda(x_2 + x_3)}{(\lambda x_1 + x_2 + x_3)^2} \left(\alpha + (1-\alpha) \left(\frac{x_2}{\lambda x_1 + x_3} + \frac{x_3}{\lambda x_1 + x_2} \right) \right) W \\ &\quad - \frac{x_1}{\lambda x_1 + x_2 + x_3} (1-\alpha) \left(\frac{x_2}{(\lambda x_1 + x_3)^2} + \frac{x_3}{(\lambda x_1 + x_2)^2} \right) W - 1 = 0 \end{aligned} \quad (6.46)$$

$$\begin{aligned} \frac{\partial \pi_2}{\partial x_2} &= \frac{\lambda x_1 + x_3}{(\lambda x_1 + x_2 + x_3)^2} \left(\alpha + (1-\alpha) \left(\frac{\lambda x_1}{x_2 + x_3} + \frac{x_3}{\lambda x_1 + x_2} \right) \right) W \\ &\quad - \frac{x_2}{\lambda x_1 + x_2 + x_3} (1-\alpha) \left(\frac{\lambda x_1}{(x_2 + x_3)^2} + \frac{x_3}{(\lambda x_1 + x_2)^2} \right) W - 1 = 0 \end{aligned} \quad (6.47)$$

$$\begin{aligned} \frac{\partial \pi_3}{\partial x_3} &= \frac{\lambda x_1 + x_2}{(\lambda x_1 + x_2 + x_3)^2} \left(\alpha + (1 - \alpha) \left(\frac{\lambda x_1}{x_2 + x_3} + \frac{x_2}{\lambda x_1 + x_3} \right) \right) W \\ &\quad - \frac{x_3}{\lambda x_1 + x_2 + x_3} (1 - \alpha) \left(\frac{x_2}{(x_2 + x_3)^2} + \frac{x_2}{(\lambda x_1 + x_3)^2} \right) W - 1 = 0 \end{aligned} \quad (6.48)$$

The similarity of equation 6.47 and 6.48 is clearly visible. Both equations lead to the equality $y = x_2 = x_3$. Inserting this equality in 6.46 and 6.47 leads to 6.49 and 6.50.

$$\begin{aligned} \frac{\partial \pi_1}{\partial x_1} &= \frac{2\lambda y}{(\lambda x_1 + 2y)^2} \left(\alpha + (1 - \alpha) \left(\frac{2y}{\lambda x_1 + y} \right) \right) W \\ &\quad - \frac{\lambda x_1}{\lambda x_1 + 2y} (1 - \alpha) \left(\frac{2\lambda y}{(\lambda x_1 + y)^2} \right) W - 1 = 0 \end{aligned} \quad (6.49)$$

$$\begin{aligned} \frac{\partial \pi_2}{\partial y} &= \frac{\lambda x_1 + y}{(\lambda x_1 + 2y)^2} \left(\alpha + (1 - \alpha) \left(\frac{\lambda x_1}{2y} + \frac{y}{(\lambda x_1 + y)} \right) \right) W \\ &\quad - \frac{y}{\lambda x_1 + 2y} (1 - \alpha) \left(\frac{\lambda x_1}{(2y)^2} + \frac{y}{(\lambda x_1 + y)^2} \right) W - 1 = 0 \end{aligned} \quad (6.50)$$

Solving both equations simultaneously provides the optimal equilibrium function. For given values of α it is now possible to illustrate the change in effort due to a given change in the ability factor λ . In Figure 6 on the next page, using three different values for α (under the restriction $\alpha > 0.5$), it is possible to illustrate the relationships between the relative ability, the effort of the non-superstar players and the given prize distribution. The first solution describes a tournament structure where the winner receives everything ($\alpha = 1$). The second set of solution awards the winner with 80% ($\alpha = 0.80$) and the third set with 60% ($\alpha = 0.60$) of the prize pool W . A look at Figure 6 shows that as the ability parameter λ increases, the slope with the alleged superstar decreases faster than the other three curves. Brown puts it succinctly: "That is, the adverse effort of increasing the superstar's ability is dampened by the existence of a consolation prize." (Brown

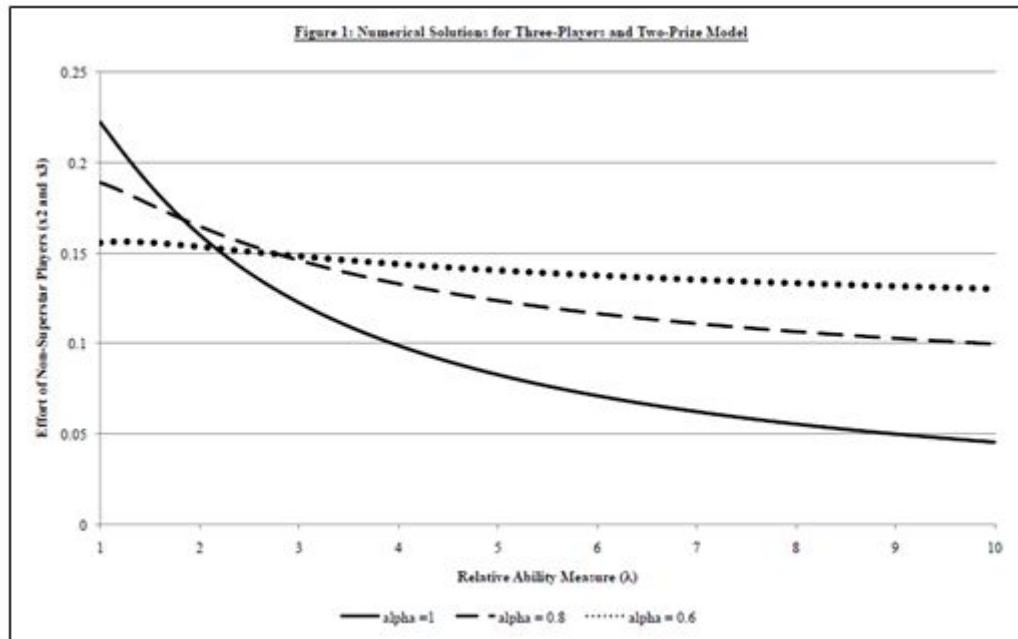


Figure 6: Numerical Solution for a Three-Player and Two-Prize Model

Source: Brown 2011: Figure 1.

2011: 988). Furthermore, if the asymmetry is small, weak players raise their effort with an increasing α while the effort of weaker players decreases with an increase in α when the asymmetry difference is higher. The curves in Figure 6 show that the superstar effect is larger for players with a high ability than for players with low abilities. This statement is confirmed by Szymanski and Valetti (2005) in their paper *Incentive effects of second prizes*, in which they examine the optimality of second prizes. They proved that the second prize can be an optimal solution (if the first prize is unattainable) in a three-person tournament with one superstar and two equally weak players. Proof of this consideration is briefly explained in their *Proposition 2* (cf. Szymanski and Valetti 2005: 474).

6.2 Empirical Evidence of the Superstar Effect

After conducting the proof in chapter 6.1, it is theoretically obvious that the presence of a superstar in a rank-order tournament has a negative impact on its competitors. Jennifer Brown and Ryuichi Tanaka with Kazutoshi Ishino show empirical evidence for the negative impact of superstars in golf tournaments. Kevin J. Boudreau et. al give an example for superstars in the economy.

6.2.1 Data from the PGA Tour

Jennifer Brown used golf data from 1999 to 2006 in order to prove the negative impact of Tiger Woods on his competitors. The dataset contains 269 PGA tournaments. In this example, there is a player who is λ -times more talented than the other participants and therefore called the superstar, or in this case, Tiger Woods. At the peak of his career in 2001 he "averaged nearly 9 strokes better than the average top-20 player." (Brown 2011: 991). Scores in Figure 7 of Tiger Woods are significantly lower than the average mean scores of the remaining top-20 players. For testing the superstar effect, Brown compares the scores in tournaments where Tiger Woods was present and scores in tournaments where he was absent. In Figure 8 it is already possible to see a tendency without prejudicing the outcome of her study. Browns results are based on the pioneer work of Ehrenberg and Bognanno (1990a and 1990b) who explained performance incentives by using golf data.

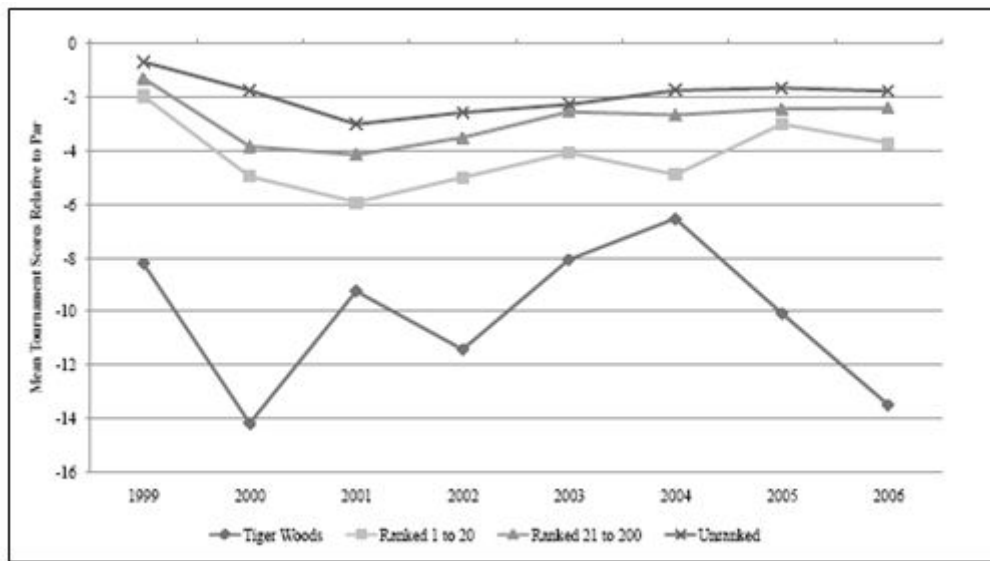


Figure 7: Average Scores (1999-2006) of Woods and Average Top-20 Players

Source: Brown 2011: Figure 2.

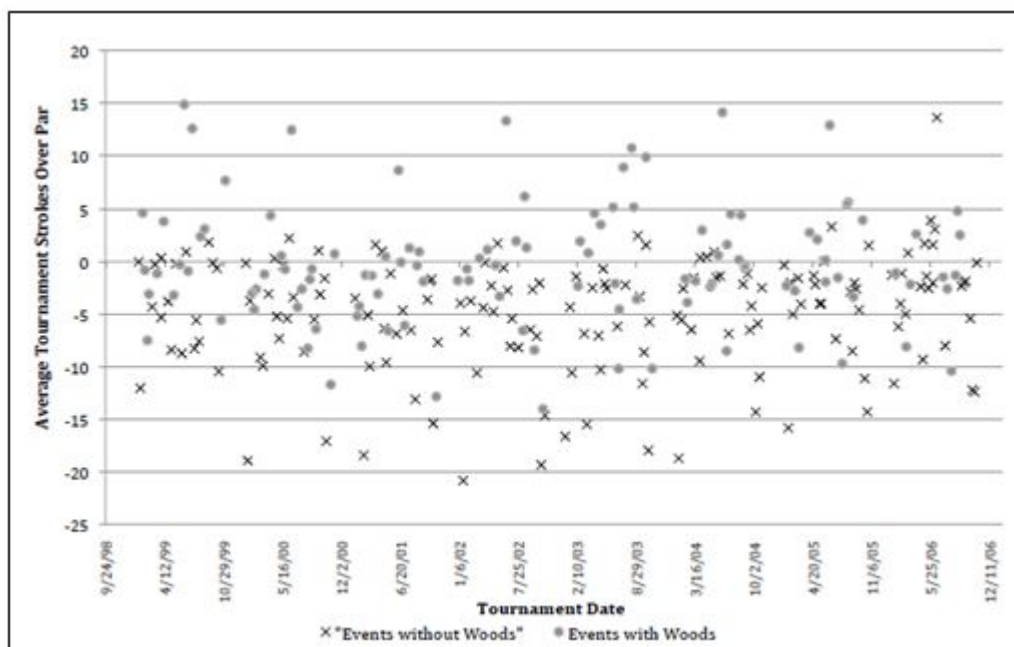


Figure 8: Average Tournament Strokes Over Par (except Woods)

Source: Brown 2011: Figure 3.

Brown's results are based on the previously mentioned pioneer work of Ehrenberg and Bognanno (1990a and 1990b) explained performance incentives by using golf data. Brown, however, is the first scientist who uses golf data to illustrate the effect of a superstar in regard to the field of competitors. Her main hypothesis that is to be tested is that:

H_{10} : In the presence of a superstar the performance of the other competitors is worse because they reduce their effort.

For testing this hypothesis Brown makes use of the following OLS model:

$$\begin{aligned} strokes_{i,j} = & \beta_j star_j * HRanked_i + \beta_2 star_j * LRanked_i + \beta_3 star_j * URanked_i \\ & + \alpha_1 HRanked_i + \alpha_2 LRanked_i + \gamma_0 + \gamma_1 X_i + \gamma_2 Y_j + \varepsilon_{ij} \end{aligned} \quad (6.51)$$

where $strokes_{i,j}$ symbolizes the score, either above or under par for player i in tournament j . The dummy variable $star_j$ takes the value 1 and if Tiger Woods is present and is considered for players with rankings H, L and U. Abbreviation H stands for players ranked in the top-20, L for top-21-200 golfers, and U for unranked players respectively. Ranking depends on the Official World Golf Ranking. The implementation of the X_i matrix reflects the influences of player-specific restrictions. Weather conditions, number of viewers, prize money and other event-specific restrictions are controlled by the Y_j matrix and ε_{ij} is the error term (cf. Brown 2011: 993). Table 14 gives significant evidence for the hypothesis H_1 . The superstar effect already occurs in the first round of regular and major tournaments. From regression 2.1, the top-20 golfers needed almost +0.6 strokes more than Tiger Woods, when he is present, in comparison to when he is not. The result is significant at a p-value of five percent. Golfers that make the cut after the second round may continue the last two rounds. In regression 2.3, overall results

of regular and major tournaments show an effect of 1.3 and 0.7 strokes for the top-20 golfers and top-21-200 golfers respectively. A notable result, because often just one stroke decides which player wins the tournament. A closer look at the unranked players shows that the superstar effect does not occur for them. Results are not significantly different from the results of Tiger Woods, if he is present. Reason for that is the flat prize distribution on the last ranks (see Appendix A.3). The difference between the 50th and the 51st rank is small. A shift in the position has just a marginal effect on the performance of the unranked golfers (cf. Brown 2011: 995-996).

Strokes relative to par for Tournament types:	2.1 first round regulars & majors	2.2 first round regulars regulars	2.3 tournament regulars & majors	2.4 tournament regulars regulars
Superstar Effect for Players:				
Ranked 1 to 20	0.596** (0.281)	0.535* (0.302)	1.358** (0.726)	0.996 (0.786)
Ranked 21 to 200	0.161 (0.113)	0.141 (0.117)	0.804*** (0.318)	0.672** (0.328)
Unranked	0.202 (0.126)	0.212 (0.131)	0.596 (0.396)	0.311 (0.400)
Other variable coefficients				
# of observations	34986	29167	18805	15651
R-squared	0.29	0.21	0.48	0.38

Note: All specifications include controls for players' rank, strength of the field, wind, rain and temperature, purse size, television viewership, tournament type, and course-player fixed effects. Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *, **, and *** represent statistical significance at p-values of 0.10, 0.05, and 0.01, respectively. "Major" events are the PGA Championship, US Open, British Open and Masters. Scores for Tiger Woods are excluded.

Table 14: Regressions Results: Scores in the Presence of Tiger Woods 1999-2006

Source: Brown 2011: Table 2.

To make those results significant, it is important to mention that the superstar effect only occurs when the superstar justifies his or her role as a favorite. After Jennifer Brown's calculations, this effect has been accountable for roughly \$6 million each year between 1999 and 2006 (cf. Brown 2011: 1003). Brown calculated Woods' earnings in the absence of the superstar effect: "How much would Tiger Wood's earnings have been reduced if all his competitors played as well as they did when he was not in the field?" (Brown 2011: 1003). As Table 1 shows, this change, on average, is worth one stroke. However, many tournaments would not have been influenced by this outcome. Recalculations come to the conclusion that Tiger Woods would have earned \$48.4 million instead of \$54.4 million during the observed period. For him, this would have been a reduction by more than 10%. In contrast, the earnings effect for his competitors would have not been so dramatic. Brown also simulated the new earnings distribution. Top-200 players earned on average \$3.4 million from 1999-2006. In fact, competitors would have earned approximately \$28,000 more in the whole period but such a small difference would not give them a serious incentive to exert more effort. This simulation provides evidence that the adverse superstar effect is large enough not to exert more costly efforts in order to gain a marginal payoff (cf. Brown 2011: 1003). Companies in the economy should be aware of this phenomenon, and hiring policies in organizations need to be cautious in hiring superstars. Internal competition is one of the major drives of incentives and therefore highly influenced by hiring policies. The overall performance in a company can suffer if the adverse superstar effect is not taken into account.

6.2.2 Data from the Japan Golf Tour

A fairly new publication by Tanaka and Ishino from July 2012, *Testing the incentive effects in tournaments with a superstar*, supports the work of Brown. Their research manifests the previous findings on golf related results which I sum up in the following before having a closer look on economical findings. The basic rules and

prize structure of the Japanese Golf Tour do not differ much from similar tours in the US. The share of prize marginally increases with a higher ranking. As well, the lower the ranking, the flatter the prize distribution. Concluding, *ceteris paribus* thing are comparable with the attempt of Brown, except for Tiger Woods. Tiger Woods was replaced by Masahi Ozaki, who is considered the superstar of the Japanese Golf Tour. Ranked as a member of the top-10 golf players worldwide "for almost 200 weeks between 1989 and 1998" (Tanaka and Ishino 2012: 396), he fits the superstar figure very well. Not only is his overall performance outstanding, but Mashi "Jumbo" Ozaki, was the leading prize pool winner in Japan 12 times. His annual average income amounted to 200 million yen per year and was far above the income of his competitors (cf. Tanaka and Ishino 2012: 395-396). The theoretical framework is based on the work of Stein (2002) and Szymanski with Valetti (2005). The econometric model is derived from Brown and measures the total score in relation to the presence of the superstar, the prize pool, and tournament specific characteristics. Tanaka and Ishino used panel data from the major events of the Japan Golf Tour during 1994 to 1996.

Average score	1994	1995	1996
Exempt	1.31	0.90	0.66
s.d.	6.49	6.66	6.35
Nonexempt	4.50	3.59	3.97
s.d.	6.33	6.09	5.86
Jumbo Ozaki	-11.06	-9.35	-8.82
s.d.	5.88	5.21	7.95

Average score is the average strokes to the par of cut and non-cut players. For mean differences average scores with and without a superstar, we test the null hypothesis of no difference against the two-sided alternative. For the share of exempt players, all differences are statistically significantly different from zero at 1% level.

Table 15: Average Scores on the Japan Golf Tour 1994-1996

Source: Tanaka and Ishino 2012: 398, Table 2.

A part of the descriptive statistics Table 15 shows the outstanding performance of Ozaki in relation to his opponents. While Ozaki scored, on average, 9.74 below par between 1994-1996, the exempt players scored on average 0.96 strokes above par during the same period. Results for Ozaki and the exempt players are significant at a level of 1%, thus the outstanding superstar performance is obvious. Table 16 presents the examination results. The superstar effect accounts for 0.34 additional strokes in the first round, and a total of 1.2 strokes for the other players. These results are significant at a 5% level. Columns two and four indicate results that distinguish between the presences of Ozaki and exemption players. The adverse effect that Brown found evidence for also applies to the Japan Golf Tour. The results are in a similar range as on the PGA Tour. To conclude, the presence of a superstar participating in a golf tournament accounts for one stroke for the whole tournament (cf. Tanaka and Ishino 2012: 399-402). Concluding, the thesis of effort reduction of competitors competing with a superstar holds. Both papers show distinctive evidence for the superstar effect.

Dependent variable: score	First round	First round	Total	Total
Superstar	0.343**	0.311**	1.207***	0.863**
s.e.	0.144	0.157	0.346	0.384
Exemption		-0.020		-0.252
s.e.		0.136		0.334
Superstar · exemption		0.074		0.594**
s.e.		0.114		0.286
Total prize	-0.189**	-0.190***	-0.693***	-0.695***
s.e.	0.080	0.080	0.191	0.190

Player fixed effects are removed by demeaning both dependent and independent variables. Year and course dummies are included. Standard errors are robust to clustering by player id. *Represent statistical significance at p-values of 10%. **Represent statistical significance at p-values of 5%. ***Represent statistical significance at p-values of 1%.

Table 16: Examination Results for the First Round on the Japan Golf Tour

Source: Tanaka and Ishino 2012: 400, Table 4.

6.3 Summary

The superstar effect describes a person who outperforms in a field of competitors competing for a prize or a promotion. The superstar excels in the workplace and outshines his competitors who therefore suffer from the superstar's superiority. Jennifer Brown recently examined this effect using sports data and the example of Tiger Woods. Supported by the analytical theory, players, or agents, decrease their effort level with the increase of superiority of the superstar. In other words, when the superstar's performance is high, the level of effort of the players in the field decreases. Figure 6 depicts the theoretical outcome very well. Brown's results in her field study of Tiger Woods on the PGA tour gives important insights for agents' possible behavior in companies who also have a "high flyer" in their team. Further research into the real economy would be of interest for human resource managers in order to prevent the effort deterioration of their employees. One recent attempt by Boudreau, Helfat, Lakhani, and Menietti, examines the superstar effect in a company called Coder Inc. Their forthcoming essay *Field Evidence on Individual Behavior & Performance in Rank-Order Tournaments* "...demonstrates that individuals in tournament-type contests perform less well on average in the presence of larger number of competitors in total and superstars." (Boudreau et. al. 2012: 1). Economic proof of this superstar effect could change the recruitment process and the mix of teams in companies significantly. Furthermore, a closer look on "...the optimality of second prizes" (Szymanski and Valetti 2005:467), a research attempt by Szymanski and Valetti (2005) could solve or at least diminish this problematic nature.

7 Conclusion

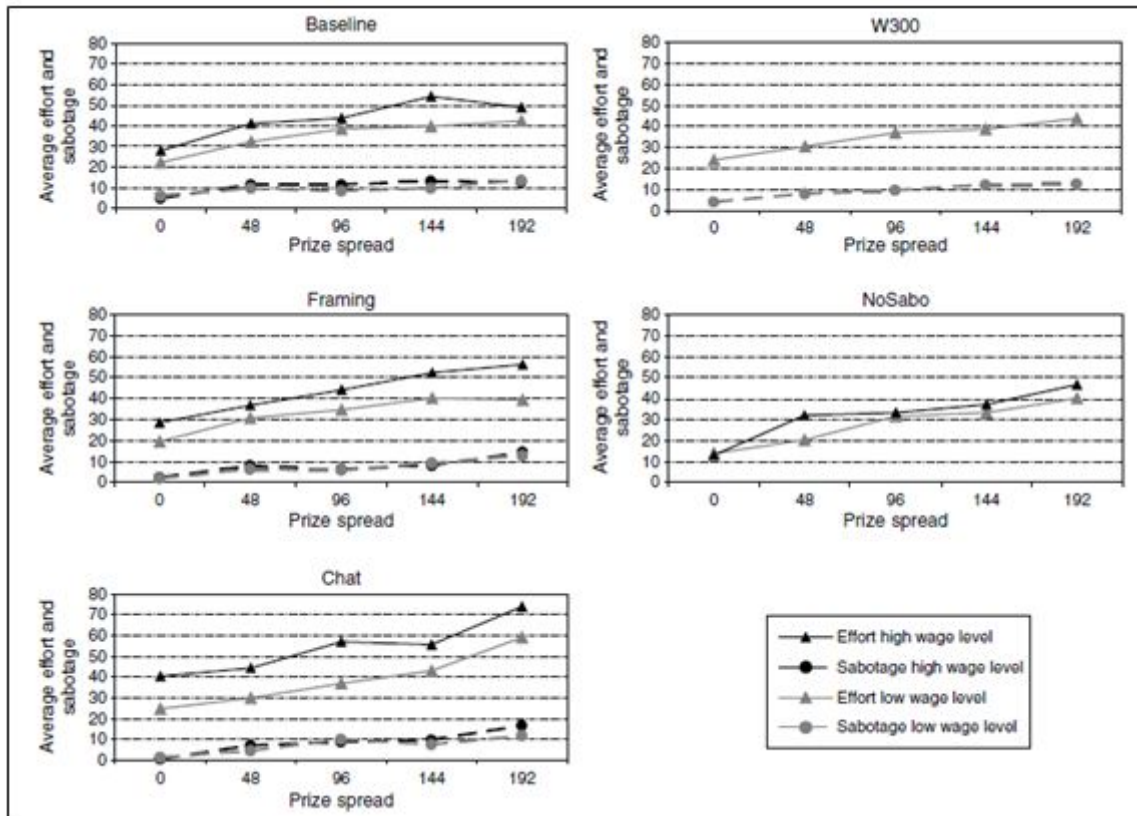
Lazear and Rosen were the first to use game theoretical application in their pioneer work to explain Principal-Agent-Theory in the explicit case of rank-order tournaments. The crucial principal, according to this research, is that the employment of labor increases with the prize spread. So far so good, but rank-order tournaments also have negative effects regarding the principal and his output. Companies have to consider negatively correlated characteristics of agents in the tournament theory such as the four problem areas examined in this thesis: Teamwork & Horizontal Collusion, Risk-Taking Behavior, Sabotage & Mobbing, and the Presence of a Superstar. Results of some problem areas are surprising and some confirm the initial hypotheses made at the beginning of this essay. It would seem that disadvantages, such as horizontal collusion and sabotage, should negatively affect the principal's output. Horizontal agreements within rank-order tournaments are commonly considered in the literature to negatively affect the output due to effort reduction by the agents. Theoretical findings by Kräkel and experimental results by Hannan, Towry, and Zhang refute this hypothesis. Agents prioritize competitive behavior rather than collusion in rank-order tournaments. Collusion is not considered to remain stable or static in games or dynamic tournament simulations, except agents' natural behavior is strictly time driven with high preferences for the present. In his work *Collusion in homogenous and heterogeneous tournaments*, Gürtler supports this outcome and additionally shows that heterogeneous tournaments are superior to homogenous tournaments and also prevent a potential collusion in the so-called supergame. I found a similar outcome in the case of sabotage activities. Sabotage behaves similar to effort and increases along with prize spread. A laboratory study by Harbring and Irlenbusch (2011) finds evidence that sabotage activities are predominant and that an increase in the price spreads leads to more sabotage. Contrary, studies of Harbring, Irlenbusch, Kräkel, and Selten (2007) conclude that, even in the presence of sabotage, agents choose on average an even higher effort level and cre-

ate a Pareto-Superior outcome. This leads to the result that, to a certain extent, sabotage is overvalued in theory and further research is needed to find an invariable result. Field evidence findings would be a particularly further help for companies to set up efficient tournaments. As long as the theory and practice contradict one another, an implementation of sabotage-free rank-order tournaments seems to be impossible. Even clearer are the results of the risk-taking behavior of agents and the superstar phenomenon. How is it possible to prevent agents from choosing risky strategies? Risk-taking behavior leads to an effort reduction and, on average, less output for the principal in a tournament where the highest output receives the first prize. Hvide's solution proposes an implementation of a mediocre solution: a compensation scheme that rewards agents who achieve a benchmark level set by the principal. The last findings concentrate on the superstar phenomenon, a situation in which a single agent, whose average performance is out of reach for the other participants, dominates a rank-order tournament. This "high flyer" stands alone and has a positive outcome for the principal, but negatively affects the other participants and their effort level. Brown (2011) examined data from the PGA tour with Tiger Woods as the superstar. In the presence of a superstar (in this case, Tiger Woods), players did not exert more effort in the tournament, as the payoff is very low. This implication and example of the superstar is relevant for the process of hiring new employees in a company. In conclusion, the four problems discussed in this essay could be individually avoided through the actions of the principal, or are simply not of prime importance, such as the problem of horizontal collusion. Risk-taking can be eliminated by mediocre scheme compensation and superstars need to be assessed and placed with agents of an equal performance level. Finally, sabotage in rank-order tournaments is a phenomenon that still needs to be further discussed and researched. Any results on the effect of sabotage are not clear or understandable for economic implementation. Tournament theory is a dynamic process in which the main problem that hinders principals is that of a Moral Hazard, something which is uniquely embedded in each human being.

Appendix

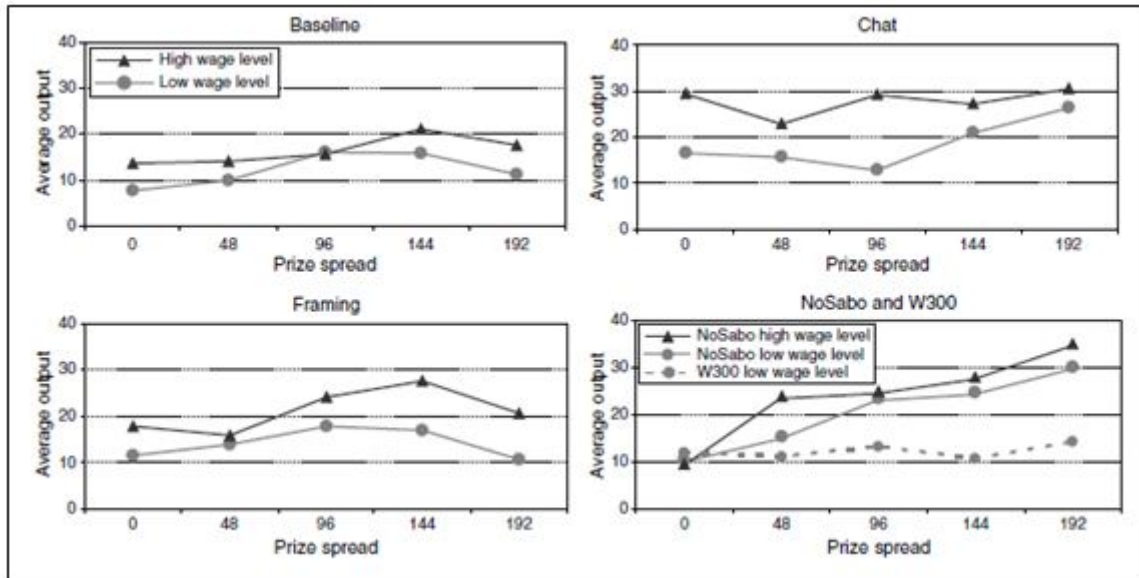
A.1 Average Effort and Sabotage by Treatment

Source: Harbring and Irlenbusch 2011: 617, Figure 1.



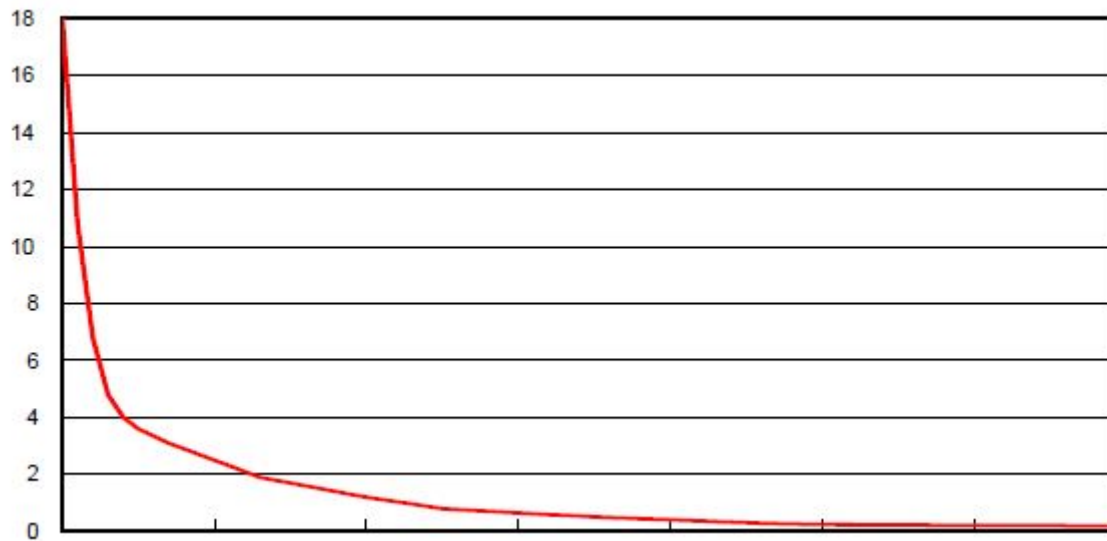
A.2 Average Output

Source: Harbring and Irlenbusch 2011: 619, Figure 2.



A.3 Prize Money Distribution in the PGA Tournaments

Source: Frick and Simmons 2007:3, Figure 2.



A.4 Curriculum Vitae

Personal Data

Name: Stefan Rethmeier
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Education

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February 13, 2013

A.5 Abstract English

Abstract

This thesis examines the problem areas of rank-order tournaments and explicitly focuses on the four following issues: Teamwork & Horizontal Collusion, Risk-Taking Behavior, Sabotage & Mobbing, and the Presence of a Superstar. Moreover, this essay is a comprehensive extension of the pioneer work of Lazear and Rosen's (1981) and their work *Rank-Order Tournaments as Optimum Labor Contracts* concentrating on its potential negative characteristics. After a brief introduction into the tournament theory and the model of Lazear and Rosen, the afore mentioned problem areas will be discussed and examined using research results and publications of leading researchers in the field of rank-order tournaments. Results help companies to implement more efficient rank-order tournaments in order to prevent deterioration of effort levels of the participants. I proof that horizontal collusion is, in practice, unstable, and that sabotage activities can also result in higher effort levels. Although risky behavior of agents appears to be the most common problem for principals, superstars in rank-order tournaments can also lead to a decline in the effort level of participants. Therefore, tournaments become less effective and can be inefficient for principals.

A.6 Abstract German

Abstract

Ausgangspunkt dieser Thesis sind die vier wesentlichen Problemfelder von relativen Leistungsturnieren: Teamwork & Horizontale Kollusion, Risikoverhalten, Sabotage & Mobbing und das Superstar-Phänomen. Aufbauend auf die Pionierarbeit von Lazear und Rosen (1981) und dem Werk Rank-Order Tournaments as Optimum Labor Contracts konzentriert sich meine Thesis auf die Gefahren, die durch die Implementierung von relativen Leistungsturnieren entstehen können. Nach einer Einführung und Darstellung der Modellierung von Lazear und Rosen werden im Weiteren die vier zumeist vorherrschenden Problematiken beschrieben und mit Hilfe von einschlägigen Publikationen diskutiert. Experimentelle Forschungsergebnisse runden die jeweiligen Kapitel dabei ab und belegen oder widersprechen die theoretischen Modelle. Die aggregierten Ergebnisse helfen Unternehmen bei der Implementierung von effizienten relativen Leistungsturnieren, wobei der potentielle Leistungsverfall der Turnierteilnehmer im Vordergrund steht. Theorie und Studien belegen, dass horizontale Kollusion in Theorie und Praxis nicht stabil sind und Sabotageaktivitäten durchaus auch zu einem höherem Leistungslevel führen können. Dagegen ist das Risikoverhalten von Turnierteilnehmern das mitunter gravierendste Problem für die Unternehmen und führt zum Leistungsverfall der Teilnehmer und zu geringerem Output für die Unternehmung. Ein eher neu thematisiertes Phänomen, aber historisch fest verankert, ist die Problematik von Überfliegern, so genannten Superstars, in Unternehmen. Der Output relative Leistungsturniere leidet enorm unter diesem Phänomen und führt zur Leistungsineffizienzen auf Seiten der anderen Teilnehmer.

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