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David Danz, Frank Hüber*
Dorothea Kübler**
Lydia Mechtenberg***
Julia Schmid*

* WZB Berlin, Germany
** Technische Universität Berlin, and IZA, and WZB, Germany
*** Universität Hamburg, Germany

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'I'll do it by myself as I knew it all along': On the failure of hindsight-biased principals to delegate optimally*

David Danz, Frank Hüber
WZB (Social Science Research Center Berlin), 10785 Berlin, Germany, david.danz@wzb.eu, frank.hueber@wzb.eu

Dorothea Kübler
Department of Experimental Economics, Technische Universität Berlin, and IZA, and WZB (Social Science Research Center Berlin), 10785 Berlin, Germany, dorothea.kuebler@wzb.eu

Lydia Mechtenberg
Department of Economics, University of Hamburg, 20146 Hamburg, Germany, lydia.mechtenberg@wiso.uni-hamburg.de

Julia Schmid
WZB (Social Science Research Center Berlin), 10785 Berlin, Germany, julia.schmid@wzb.eu

With the help of a simple model, we show that the hindsight bias can lead to inefficient delegation decisions. This prediction is tested experimentally. In an online experiment that was conducted during the FIFA World Cup 2010 participants were asked to predict a number of outcomes of the ongoing World Cup and had to recall their assessments after the outcomes had been realized. This served as a measure of the hindsight bias for each participant. The participants also had to make choices in a delegation game. Our data confirm that hindsight-biased subjects more frequently fail to delegate optimally than subjects whom we have classified as not hindsight biased.

Key words: hindsight bias, delegation, experiments
JEL classification numbers: C72, C91, D84

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1. Introduction

There is ample evidence that people fail to remember their past beliefs correctly. After having received new information affecting these beliefs, they tend to exaggerate the availability of their current information to their past selves. Hence, people are not surprised by new information as they think they knew it all along. This information projection of recalling one's past information state incorrectly is called the hindsight bias. Using a novel experimental design, we show how this behavioral bias affects delegation decisions in a systematic and predictable fashion. In a principal-agent relationship the hindsight bias has the paradoxical effect that additional information about the performance of the agent can increase the inefficiency of the principal's delegation decision.

Consider the following example in the context of medicine. After a tumor has been diagnosed, in hindsight 90 percent of lung cancers and 70 percent of breast cancers are observed on radiographs that had previously not been recognized (as indicated in a testimony by the radiologist Berlin 2003). Suppose now that the early radiograph is seen by a subordinate doctor who overlooks the tumor. Suppose further that after the tumor has been found, a superior who is informed about the diagnosis evaluates the subordinate's ability to diagnose cancer. A hindsight-biased superior might forget that she had not detected the tumor herself. As a consequence, she might underestimate the relative ability of the young doctor, compared to her own (Madarász 2012). This can induce the supervisor not to delegate further decisions to the subordinate doctor.

We propose a simple two-period model of a delegation game to demonstrate how the hindsight bias can result in incorrect evaluations of another person's relative ability and, in consequence, to suboptimal delegation decisions. In the game, a principal has to decide whether to delegate a decision to an agent after having received information about her ability at an interim stage. To delegate optimally, the principal needs to evaluate the agent's ability relative to her own. If the principal is hindsight biased, she accounts differently for the interim information than if she was rational. A principal's biased memory of her ex ante state of information toward the true outcome results in an irrationally high level of self-confidence and thus to inefficiently little delegation.[1]

[1] The interdependence of confidence issues and delegation decisions has been studied by Bénabou and Tirole (2002) and Bénabou and Tirole (2003). They show how principals act strategically in order to influence the agent's self-confidence and therefore his performance. Our focus, by contrast, is on how the principal's self-confidence affects her delegation decisions. For this, we do not need a conflict of interest between the principal and the agent. Hence, in our setting, the principal and the agent have the same payoffs from the project at hand and ex ante information is symmetric, so that no problem of moral hazard can occur.

Our experiment links the hindsight bias as a personal trait to a person's delegation decision. The experiment consists of two parts. First, in a prediction game each participant's ability to correctly remember her ex ante beliefs is measured. Then, participants take part in the delegation game based on the model. Having classified subjects as hindsight biased or rational according to the prediction task, we investigate their delegation decisions in the delegation game. Indeed, we find that subjects whom we categorize as hindsight biased delegate significantly less often than other subjects exactly in those situations where the hindsight bias should prevent delegation, as indicated by the model. In other situations where the hindsight bias should not affect the delegation decision, we find no significant difference between subjects whom we have classified as hindsight biased or rational. Thus, we are able to establish a causal link between the hindsight bias as a personal trait and suboptimal delegation decisions. To our knowledge, this is the first paper that documents a relationship between hindsight bias and delegation.

We contribute to two separate strands of the literature. First, our study relates to the literature on optimal delegation and on interim information in multi-period principal-agent relationships. In principle, receiving interim information in such relationships is considered useful for the principal in order to mitigate the problems of asymmetric ex ante information (Strausz 2006) and uncertainty (Dessein 2005). For instance, venture capital contracts should account for interim information about the agent: If the initial authority is with the entrepreneur, control rights can be shifted to the venture capitalist later on if unfavorable information about the entrepreneur's ability is released at intermediate stages (Chan et al. 1990). Empirically, the venture capitalist has the more control rights the more uncertain he is about the quality of the project or the entrepreneur's ability (Kaplan and Strömberg 2004). However, this literature presupposes that principals are fully rational and correctly account for all current and past information available to them when making their delegation decisions. If the principals are hindsight biased, receiving new information can distort their relative performance evaluation and hence lead to inefficient delegation decisions. This renders interim information less useful, or even harmful.

The decision as to whether to delegate control rights can be influenced by several factors, such as informational advantages of the agent, the principal's disutility from taking a decision perceived as unkind (Bartling and Fischbacher 2012), as well as the desire of the principal to create incentives for effort provision by the agent when there is a conflict of

interest (Aghion and Tirole 1997). An experimental test of the model by Aghion and Tirole (1997) has shown that agents respond to control rights more strongly than predicted with respect to their effort choice, i.e., they underexert effort relative to the equilibrium prediction without control and they overexert effort when they have the decision right. Although this profile of effort choices makes delegation relatively attractive for the principals, very often the majority of them retain control when they would have received higher returns by delegating authority. Fehr et al. (forthcoming) summarize: "We find a strong behavioral bias among principals to retain authority against their pecuniary interests and often to the disadvantage of both the principal and the agent.[...] Our results suggest that authority has non-pecuniary consequences that inhibit the reallocation of authority." This phenomenon is in line with the psychological findings on agents' desire for self-determination (Ryan and Deci 2000).

The second strand of literature to which our study contributes is work on the hindsight bias itself. All economic studies on the hindsight bias, including our own, build on psychological experiments by Fischhoff (1975), Fischhoff and Beyth (1975), and many others, summarized in the meta-analysis by Guilbault et al. (2004). The vast literature has demonstrated the bias in a number of very different contexts and designs. Our study is most closely related to two experiments that establish a relationship between information projection and economic behavior. In an asset market experiment, Camerer et al. (1989) show that compared to individual decisions the curse of knowledge is reduced by a market environment, but that it is not entirely eliminated. In another study on asset markets by Biais and Weber (2009), subjects were informed of the current prices of a number of assets and had to predict the price of these assets one week later. When asked to recall their prediction after being informed of the actual price, subjects underestimated their uncertainty. In a second experiment with investment bankers, the authors show that more hindsight-biased managers earn less money. The most comprehensive theoretical treatment of the projection bias is the model by Madarász (2012). It shows how optimal incentives need to be adjusted in the presence of agents prone to information projection in a number of different contexts.

In the following, we will first introduce the simple model of the delegation game. It allows us to derive hypotheses concerning the choices of fully rational Bayesian and hindsight-biased players. In Section 3, the experimental design is described, and in Section 4, we present the empirical results. Section 5 concludes with a discussion of the findings.

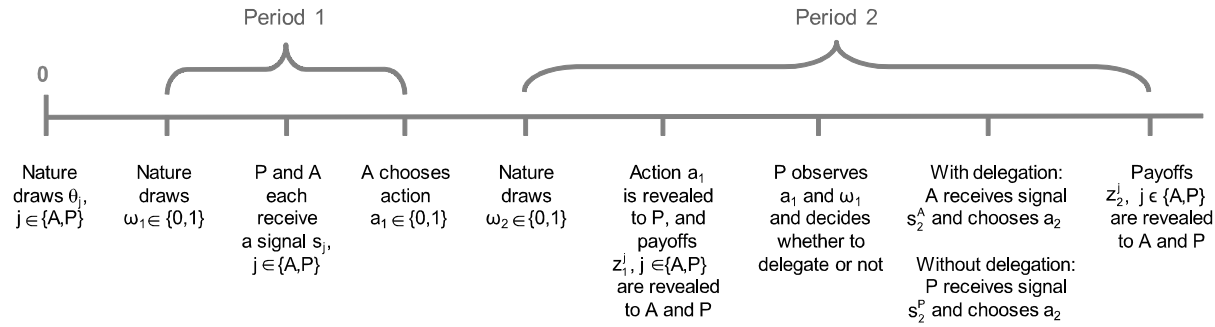

Figure 1 Timeline of the delegation game.

2. Principal-Agent Framework

We present a simple model to investigate under which conditions people who are prone to the hindsight bias take inefficient delegation decisions. For the hindsight bias to manifest itself, at least two periods are necessary. This two-period game is summarized in Figure 1.

First, nature draws the type θ^j of the principal (P) and of the agent (A), with $j \in \{P, A\}$. Both can be either a good type, $\overline{\theta}^j$, or a bad type, $\underline{\theta}^j$, and the type remains constant for the two periods. Types are drawn independently, and their prior probability of being a good type is r^P for the principal and r^A for the agent, respectively. Neither the principal nor the agent know their own type. At the beginning of each period $t \in \{1, 2\}$, nature draws the state of the world, $\omega_t \in \{0, 1\}$. States of the world are drawn independently across periods, and the two possible realizations, 0 and 1, are equally likely.

In the first period, the principal and the agent each receive a private signal s_1^j, $j \in \{P, A\}$, about the true state of the world. The quality of the signal, i.e., the probability ρ that the signal corresponds to the true state of the world, depends on the type θ^j of the player j. A good type $\overline{\theta}^j$ receives signals that are correct with probability $\overline{\rho}$ whereas a bad type's signals are only correct with probability $\underline{\rho}$, where $0.5 \leq \underline{\rho} < \overline{\rho} \leq 1$. After having observed his signal in the first period, the agent has to take an action $a_1 \in \{0, 1\}$. If this action corresponds to ω_1, both the agent and the principal receive a positive payoff z. If the action was incorrect, both receive zero payoffs.

At the beginning of the second period, the principal learns the agent's action a_1, and the true state of the world ω_1 that prevailed in the first period is revealed. The principal updates her belief about her own and the agent's type. Then, she decides whether she herself or the agent will make the next decision. If she opts for delegation, the agent will receive a private signal s_2^A about the state of the world $\omega_2 \in \{0, 1\}$ in the second period and

will choose an action $a_2 \in \{0,1\}$. If the principal decides herself, she receives a signal s_2^P about ω_2, and chooses an action $a_2 \in \{0,1\}$ herself. Both players again receive the positive payoff z, if a_2 turns out to correspond to ω_2, but zero otherwise. Then, the game ends.

Subjects derive a positive utility from being in control of their own situation. This has been found by psychologists and is stated as the theory of self-determination (Ryan and Deci 2000). The wish to retain decision rights and control over oneself is traced back to human desire and the need for autonomy, personal development, and self-regulation. Moreover, such an additional utility derived from the right to make decisions has also manifested itself in previous delegation experiments in economics (Fehr et al. forthcoming, Owens et al. 2012). To account for this, we introduce a variable $v \in \mathbb{R}^+$which denotes a psychic payoff from being in control. To account for unobserved heterogeneity of individuals, we assume that nature draws v at the beginning of the game for each player according to some continuous distribution $F(v)$, with $F'(v) > 0$. These psychic payoffs are drawn independently for all players.

Since we want to test whether hindsight-biased individuals delegate too little, we make delegation attractive for rational decision makers. In particular, we assume that the ex ante likelihood r^j of being a good type $\overline{\theta}^j$ is smaller for the principal than for the agent, $r^P < r^A < 1$. Hence, ex ante, the agent is better at predicting the true state of the world. Moreover, we assume that the principal's payoff from an action that matches the state of the world is lower if she does not delegate the decision, i.e. the payoff of a correct decision that she has taken herself is $z^{ND} = z - c$, with $c > 0$. The parameter c symbolizes opportunity costs in monetary terms. We assume that the principal has a per-period utility linear in the monetary payoff as well as in the non-pecuniary utility of self-determination, denoted by $U^D = z$ if she delegates the decision and by $U^{ND} = z^{ND} + v$ if she does not.[2] To solve the model, we will determine the probability that the principal delegates the second-period decision based on the parameters of the game and the distribution $F(.)$.

Finally, we turn to the delegation decision of a potentially hindsight-biased principal. A hindsight-biased principal will not remember in the second period that her signal was s_1^P in the first period. Her remembered signal is a weighted average of her past signal and the true state of the world that has been revealed in the meantime. Thus, she will believe

[2] Of course, also the agent potentially receives some utility of self-determination and the payoff. However, as we are only interested in the principal's delegation decision, we leave his utility aside.

that she saw $\widetilde{s}_1^P = s_1^P(1-\lambda) + \lambda\omega_1$, with $0 \leq \lambda \leq 1$. In the extreme case, when $\lambda = 1$, she will think that she received a signal $\widetilde{s}_1^P$ equal to the state of the world ω_1. As the state of the world and the signal realizations are binary, we restrict the analysis to the case of $\lambda = 1$ for the hindsight-biased and $\lambda = 0$ for the rational principal. Note that the hindsight bias can only affect the principal's posterior beliefs about her own type if the signal s_1^P contradicts the state of the world ω_1, because otherwise no distortion of the remembered signal is possible.

2.1. The delegation game

We apply the equilibrium concept of Perfect Bayesian Nash Equilibrium: Given their beliefs, all players make optimal decisions at all information sets; and they update their beliefs according to Bayes' rule whenever it is defined. The game has multiple equilibria, but for reasons of plausibility, we restrict attention to the (unique) pure-strategy equilibrium in which the agent always follows his signal in the first period, i.e., $s_1^A = a_1$. To derive this equilibrium, consider the principal's delegation decision, and assume that the agent followed his signal in $t = 1$. Four cases must be distinguished. In two cases, the principal's signal and the agent's action in the first period correspond, that is, they are both either 0 or 1. In the two other cases, the principal's signal and the agent's action in the first period contradict each other, i.e., the principal's signal is 0 and the agent's action is 1 or vice versa.

2.1.1. Case 1: $\omega_1 \neq s_1^P = s_1^A = a_1$

Suppose that both the principal and the agent have received an incorrect signal about the state of the world ω_1. Consider first the *rational* principal indicated by the subscript R. We calculate the critical value $\bar{v}_R$ of the utility from self-determination at which the rational principal is just indifferent between delegating and not delegating in period 2. Remember that the signal qualities of the agent and the principal in period 2 depend on their respective types:

$$\begin{aligned} &\Pr\left\{s_2^j = \omega_2 \mid \theta^j = \overline{\theta}^j\right\} = \overline{\rho} \text{ and} \\ &\Pr\left\{s_2^j = \omega_2 \mid \theta^j = \underline{\theta}^j\right\} = \underline{\rho} \text{ for } j \in \{A, P\}. \end{aligned} \tag{1}$$

Since both the agent and the principal obtained an incorrect signal in the first period, the principal's posterior belief about her own type is

$$\Pr\left\{\theta^P=\overline{\theta}^P \mid s_1^P\neq\omega_1\right\}=\frac{r^P\left(1-\overline{\rho}\right)}{r^P\left(1-\overline{\rho}\right)+\left(1-r^P\right)\left(1-\underline{\rho}\right)}, \tag{2}$$

while her posterior belief about the agent is given by

$$\Pr\left\{\theta^A=\overline{\theta}^A \mid s_1^A\neq\omega_1\right\}=\frac{r^A\left(1-\overline{\rho}\right)}{r^A\left(1-\overline{\rho}\right)+\left(1-r^A\right)\left(1-\underline{\rho}\right)}. \tag{3}$$

Thus, the principal's expected utility from *not delegating* (ND) in the second period amounts to

$$E\left(U_R^{ND}\right)=(z^{ND}+v)p_R^{ND}=(z-c+v)\,p_R^{ND},$$

with

$$p_R^{ND}\equiv\frac{r^P\left(1-\overline{\rho}\right)\overline{\rho}+\left(1-r^P\right)\left(1-\underline{\rho}\right)\underline{\rho}}{r^P\left(1-\overline{\rho}\right)+\left(1-r^P\right)\left(1-\underline{\rho}\right)}.$$

If, in contrast, the rational principal *delegates* (D), her expected payoff is

$$E\left(U_R^D\right)=zp_R^D,$$

where

$$p_R^D\equiv\frac{r^A\left(1-\overline{\rho}\right)\overline{\rho}+\left(1-r^A\right)\left(1-\underline{\rho}\right)\underline{\rho}}{r^A\left(1-\overline{\rho}\right)+\left(1-r^A\right)\left(1-\underline{\rho}\right)}.$$

We now define the critical value $\bar{v}_R$ to be that level of utility from self-determination at which the rational principal is indifferent between delegating and not delegating:

$$(z-c+\bar{v}_R)\,p_R^{ND}=zp_R^D. \tag{4}$$

The rational principal refrains from delegation if and only if her utility from self-determination exceeds $\bar{v}_R$.

Consider now the *hindsight-biased* principal, indicated by the subscript H. Her posterior belief about the agent's type is rational and given by (3). But since she wrongly believes that she has received the correct signal in period 1 ($\widetilde{s}_1^P=\omega_1$), her posterior belief about her own type is irrationally optimistic, namely

$$\Pr\left\{\theta^P=\overline{\theta}^P \mid \widetilde{s}_1^P=\omega_1\right\}=\frac{r^P\overline{\rho}}{r^P\overline{\rho}+\left(1-r^P\right)\underline{\rho}}. \tag{5}$$

Therefore, her expected utility from *not delegating* amounts to:

$$E\left(U_H^{ND}\right)=(z-c+v)\,p_H^{ND}, \tag{6}$$

with

$$p_H^{ND} \equiv \frac{r^P \overline{\rho}^2 + \left(1 - r^P\right) \underline{\rho}^2}{r^P \overline{\rho} + \left(1 - r^P\right) \underline{\rho}}.$$

By contrast, if the hindsight-biased principal delegates, her expected payoff from delegation is the same as if she were rational, i.e., $E\left(U_H^D\right) = E\left(U_R^D\right) = zp_R^D$. Consequently, the hindsight-biased principal refrains from delegation if and only if her utility from self-determination exceeds the critical value $\bar{v}_H$ which is defined by the following equation:

$$\left(z - c + \bar{v}_H\right) p_H^{ND} = zp_R^D. \tag{7}$$

We now proceed to analyzing how the hindsight bias affects the principal's propensity to delegate. To do so, we compare the critical values at which the rational and the hindsight-biased principal are indifferent between delegating and not delegating. From (4) and (6), we can infer that

$$\left(z - c + \bar{v}_R\right) p_R^{ND} = \left(z - c + \bar{v}_H\right) p_H^{ND}. \tag{8}$$

Using simple algebra, one can show that p_R^{ND} is strictly smaller than p_H^{ND}. Consequently, (8) implies that $\bar{v}_R$ must be strictly greater than $\bar{v}_H$. Since $F'(v) > 0$, we formulate our first prediction:

Theoretical Prediction 1. *Let $\omega_1 \neq s_1^P = s_1^A = a_1$. Then, the probability of delegation is strictly lower for the hindsight-biased principal than for the rational principal.*

Intuitively, the hindsight-biased principal fails to recognize that she is less likely to be a good type compared to the agent when she received an incorrect signal and the agent chose the incorrect action. As a consequence, she believes that she is more likely than the agent to get a correct signal in the second period. A rational principal, in contrast, would recognize that her probability of being a good type is lower than the agent's probability if both received an incorrect signal. Therefore, the critical value of the utility from self-determination making it just optimal to delegate is lower for the hindsight-biased than for the rational principal.

We now proceed to analyzing the case in which both the principal and the agent receive a correct signal in the first period.

2.1.2. Case 2: $\omega_1 = s_1^P = s_1^A = a_1$

Suppose that both the principal and the agent received a correct signal about the state of the world in period 1. In this case, there is no scope for the hindsight bias to affect updated beliefs as the principal's signal was correct and, hence, her remembered signal does not differ from the actual one. Therefore, the hindsight-biased and the rational principal have precisely the same belief about their own type. In fact, this belief corresponds to the belief that the hindsight-biased principal holds about her own type in Case 1 in which she remembers having received a correct signal. Now, in Case 2, her period-1 signal was in fact correct leading to the same belief. The principal's belief about the agent's type is unaffected by a potential hindsight bias, i.e., the agent is good with probability $\frac{r^A\overline{\rho}}{r^A\overline{\rho}+(1-r^A)\underline{\rho}}$. Thus, in Case 2 the hindsight-biased principal always has the same expected utility as the rational principal from delegating or not delegating. Calculations analogous to those conducted in the analysis of Case 1 for the cutoff values $\bar{v}_H$ and $\bar{v}_R$ reveal that either principal (biased or not) refrains from delegation if and only if her utility from self-determination exceeds a cut-off value $\overline{\bar{v}}$ (without indices R and H as the value is identical), defined by the equation

$$\left(z - c + \overline{\bar{v}}\right) p_H^{ND} = z q^D, \tag{9}$$

with

$$q^D \equiv \frac{r^A\overline{\rho}^2 + \left(1 - r^A\right)\underline{\rho}^2}{r^A\overline{\rho} + \left(1 - r^A\right)\underline{\rho}}.$$

This provides us with our second prediction:

Theoretical Prediction 2. *Let $\omega_1 = s_1^P = s_1^A = a_1$. Then, the probability of delegation is the same for the hindsight-biased and for the rational principal.*

2.1.3. Case 3 and 4: $\omega_1 = s_1^P \neq s_1^A = a_1$ and $\omega_1 \neq s_1^P \neq s_1^A = a_1$

In the two remaining cases, the agent and the principal have received different signals in the first period. We do not discuss these cases in detail. They are, however, similar to the two cases analyzed above: As before, the hindsight bias affects the delegation probability if and only if the principal's signal in the first period was incorrect. Thus, the remaining two cases do not add any additional insights into how the hindsight bias affects the propensity to delegate. We therefore restrict attention to Case 1 and 2 and choose the experimental design accordingly (see Section 3.2).

2.1.4. Equilibrium analysis and hypotheses

So far, we have assumed that the agent always follows his signal in the first period. We now argue that this is indeed an equilibrium strategy. Consider the agent when he has just received his signal in the first period. At that moment, all he knows about his type is that he is, a priori, more likely than the principal to get the correct signal in any period. Thus, his expected second-period payoff increases in the probability of delegation, even if his utility from self-determination is zero. The probability of delegation, however, increases in the principal's posterior belief that the agent is a good type. (Note that this is true regardless of whether the principal is rational or hindsight-biased.) But given that, in the second period, the principal believes that the agent has followed his signal, the theoretical predictions above imply that the principal's trust in the agent will be highest if the agent chooses the action that matches the state of the world in period one. This, again, becomes more likely to be achieved if the agent follows his signal. The expected first-period payoff of the agent also increases in the probability of matching the state of the world and therefore in the probability with which the agent follows his signal. Consequently, the agent always strictly prefers to follow his signal, given that he is expected to do so. Note that any player who chooses the action in the second period has a strict incentive to follow his or her signal. We get

PROPOSITION 1. *The game has a Perfect Bayesian Nash Equilibrium in pure strategies in which the agent always follows his signal in the first period, the principal follows her signal in the second period if she does not delegate, and the agent follows his signal in the second period if the principal delegates. The principal refrains from delegation in Case* 1 *[Case* 2*] if and only if she is either rational and her utility from self-determination exceeds* $\bar{v}_R$ *[*$\overline{\bar{v}}$*] or if she is hindsight-biased and her utility from self-determination exceeds* $\bar{v}_H$ *[*$\overline{\bar{v}}$*].*

Note that this equilibrium is *not* unique: Consider a situation in which the principal believes that the agent always chooses the action that was *not* indicated by his signal in the first period, although the agent would follow his signal in the second period. Moreover, assume that the agent has infinite utility from self-determination. Then, all that the agent cares about in the first period is maximizing the likelihood of delegation. Thus, he wants to maximize the posterior belief of the principal that he, the agent, is a good type. Given the principal's beliefs, this is only possible if the agent does *not* follow his signal in the

first period, thereby justifying the principal's belief. It is possible to find parameters for which this is an equilibrium. However, this equilibrium is implausible because in reality, competence is rarely signaled by failures. Thus, we restrict attention to the equilibrium that is characterized by the above theoretical predictions.

From our theoretical predictions, we can derive the two main hypotheses that we test in the experiment:

HYPOTHESIS 1. *If both the agent and the principal receive an incorrect signal in the first period (Case 1), then the hindsight-biased principal is strictly less likely to delegate in the second period than the rational principal.*

HYPOTHESIS 2. *If both the agent and the principal receive a correct signal in the first period (Case 2), then the hindsight-biased principal is as likely to delegate in the second period as the rational principal.*

3. Experimental Implementation

3.1. Specification of the delegation game

The following parameter specification was implemented in our experimental design:

$$\begin{aligned} r^P = \frac{2}{5},\ r^A = \frac{1}{2}, \\ z = 75,\ c = 3, \\ \overline{\rho} = \frac{2}{3},\ \underline{\rho} = \frac{1}{2} \end{aligned}$$

If we evaluate the critical values $\bar{v}_R$, $\bar{v}_H$ and $\overline{\overline{v}}$ for this specification of the parameters, we can derive the expected utility of delegation and non-delegation.

Figure 2 depicts the expected difference in the utility of delegation vs. non-delegation $\Delta E(U) = E\left(U^D\right) - E\left(U^{ND}\right)$ for a rational and a hindsight-biased principal in Case 1 (left panel) and Case 2 (right panel). $\Delta E(U)$ depends on the principal's utility from self-determination, v. If $\Delta E(U) > 0$, the principal opts for delegation. The dashed lines depict the difference in utility for a rational principal, $E\left(U_R^D\right) - E\left(U_R^{ND}\right)$; the dotted lines represent this difference for a hindsight-biased principal, $E\left(U_H^D\right) - E\left(U_H^{ND}\right)$. In Case 1 (left panel) a rational principal chooses to delegate if $1.47 < v < 5.09$, whereas a hindsight-biased

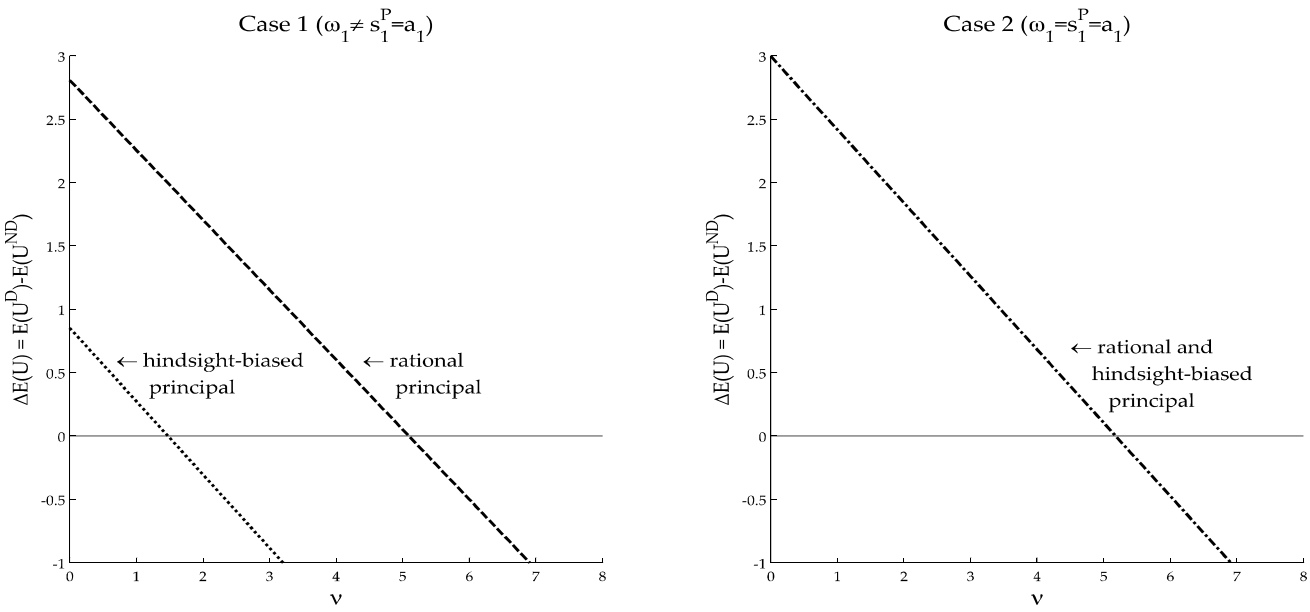

Figure 2 Difference between expected utility from delegation and non-delegation depending on utility from self-determination.

principal does not delegate for these values of v. In Case 2 (right panel) all principals opt for delegation if $v < 5.18$, no matter whether they are biased or not.[3]

Based on these findings, we state the following *Observations* that we can test in addition to the two hypotheses derived in the previous section:

Observations

(i) Rational principals show similar delegation rates in Case 1 and Case 2.

(ii) Hindsight-biased principals are less likely to delegate after both players receive incorrect signals (Case 1) than after correct signals (Case 2).

(iii) When comparing delegation rates in Case 2 and Case 1, hindsight-biased principals show a stronger decrease in delegation rates than rational principals.

3.2. Experimental Procedure

In order to identify the effects of the hindsight bias on delegation decisions, we conducted an online experiment during the FIFA World Cup 2010. The experiment consisted of two stages. In the first stage, participants had to answer a questionnaire and played the first

[3] Note that the parameters are chosen such that a principal with no utility from self-determination, $v = 0$, wants to delegate in Case 1 and Case 2, regardless of whether she is rational or hindsight-biased. Because we know that individuals derive non-pecuniary utility from having the right to decide, $v > 0$, we wanted to avoid a situation where principals almost never delegate the decision to the agent. Thus, we have chosen the parameters such that we can expect enough variation in delegation decisions across treatments.

part of the delegation game. This stage was conducted during the preliminary round of the FIFA World Cup 2010. The second stage consisted of another questionnaire and the second part of the delegation game, starting directly after the semi-finals of the World Cup (see Figure 3). The two-stage design was necessary to allow for a biased memory.

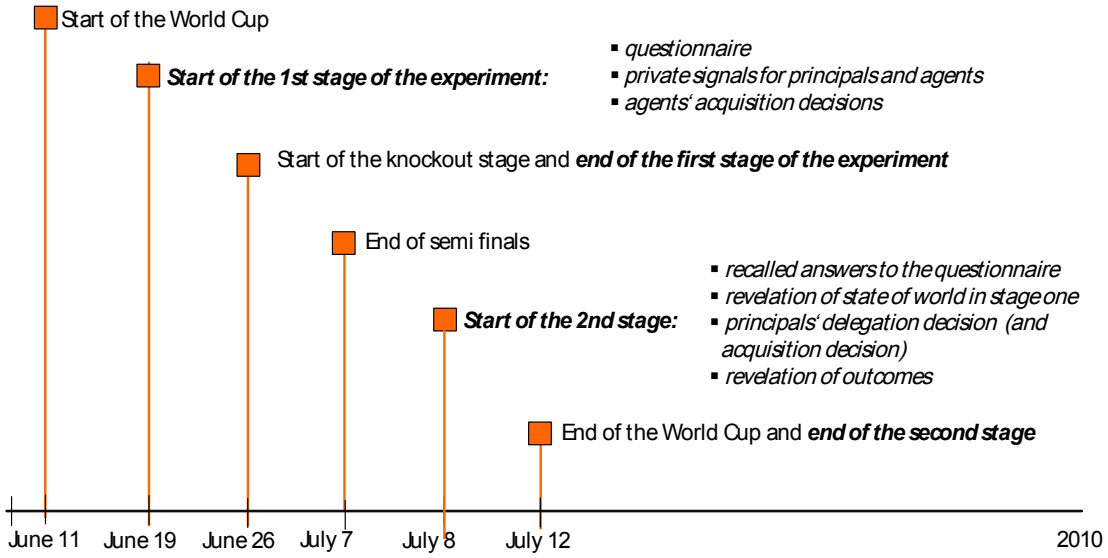

Figure 3 Timeline of the Experiment.

In order to measure a participant's hindsight bias we asked the following questions regarding outcomes of the ongoing championship during the preliminary round:

1. *"What is the likelihood of [nation] reaching the final of the World Cup 2010?"*
2. *"How many goals will be scored during the eighth-final, quarter-final and semi-final (within regular playing time, 14 matches overall)?"*

For the first question, which we will refer to as the 'finals task', we specified the nation to be Argentina, Spain, and Germany, respectively. We chose to ask this question for each of the three countries as we hoped that at least one of them would indeed reach the final, because previous studies have shown that the hindsight bias is stronger if a certain event turns out to be true than when it turns out not to be true (Fischhoff 1975, Slovic and Fischhoff 1977, Fischhoff and Beyth 1975).[4] The question concerning the number of goals

[4] We also added the question *"What is the likelihood of Italy dropping out before the semi-final of the World Cup 2010?"* to introduce some variation in the questions. However, already during the first stage of the experiment, it was already clear that Italy would not make it to the knock-out round. This rendered the question useless for our purposes. In addition, we asked participants about their relative certainty regarding the goals task and about their favorite team in the World Championship. We did not use these two questions for the analysis.

('goals task') provided us with a slightly different test for the hindsight bias not based on a binary outcome variable. About two weeks later, when the semi-finals were over and the second stage of our experiment started, the participants had to recall their answers to the questions above.[5] Before stating their answers, subjects were told the true outcome for each question. The order of the questions was different in this second questionnaire to prevent subjects from recalling their estimates simply due to their ordering. In order to incentivize participants at the first stage, we raffled five sets of two tickets for the "11-Freunde-WM-Quartier", a popular place in Berlin for the public viewing of World Cup matches. For the memory task at the second stage, we paid 100 Euro to the 10 subjects who best remembered their answers of stage one. It turned out that 14 subjects perfectly remembered their answers, and we decided to pay all of them 100 Euro.

In addition to answering the questionnaire, the participants played the delegation game described in section 2.1. The game was framed as the interaction between a manager (principal) and a coach (agent) of a soccer club in two subsequent seasons. In each period, a decision about the acquisition of a particular new player for the soccer club had to be taken. The state of the world in each season was the true talent of this new player. It is optimal to acquire a talented player, but an untalented player should not be acquired. The private signals of the principal and the agent were framed to be advice about the talent of the new player received through a (good or bad) personal talent scout. As in the model, the quality of the signal depended on the principal's and the agent's type. That is, with the parameters above, the talent scout advising the manager was good in 40% of cases ($r^P = 0.4$) and the scout advising the coach was good in 50% of cases ($r^A = 0.5$). A good talent scout gave a correct advice in two-thirds of cases ($\overline{\rho} = 2/3$) whereas a bad talent scout gave correct advice in only 50% of cases $\left(\underline{\rho} = 0.5\right)$. The talent scout of the manager and the coach, respectively, remained the same for the two periods of the game.

The first 24 participants of the experiment who logged in were assigned to be agents, and all other participants were principals. As our main interest is in the decisions of the principals, we replicated the decisions of the agents and matched them to the principals accordingly (e.g., the first agent was matched to principals with numbers 1, 25, 49, etc.). Upon logging in, the participants had to answer the questions regarding the World Cup,

[5] Before answering the questions, participants were informed that they would be approached again in about two weeks from then, without knowing what they would be have to do in the second stage.

read the instructions of the delegation game, and were informed of their role. Both the principals and the agents received their private signal, i.e., they were given an advice from their talent scout. Then, the agents had to make the decision whether or not to buy the new player for the team in this season. This decision was revealed to the principal they were matched to. The agents had to decide whether to acquire a new player for the second season after they had received a new signal about the new player's talent. While their decision for the first season was implemented for certain, the implementation of their decision for the second season depended on whether the principal had decided to delegate this decision to the agent in the second stage. Hence, we applied the strategy method for the agents' decision in order to avoid having to rely on their participation in the second stage.

About two weeks later at the second stage of the experiment, all participants who had completed the first stage, were asked to recall and write down their answers to the questions regarding the World Cup from the first stage. In addition, the principals had to complete the delegation game. First, they learned the state of the world in the first stage (i.e., whether the new player was talented or not). Further, the principals were reminded of the agent's decision, but not of their private signal in the first stage. The principals then had to decide whether or not to delegate the decision concerning the acquisition of a new player for the second season. If they decided to take the acquisition decision themselves, they received a signal about the talent of the second new soccer player. Then they were asked whether or not they wanted to buy this player. If they had delegated the decision to the agent, the (already elicited) decision of their agent was implemented. At the end of the second stage, all participants were informed about the true state of the world and the outcome of their decisions.

In order to incentivize the participants in the delegation game, 10 randomly drawn subjects were paid according to their decisions in this game. A randomly drawn subject in the role of an agent received 75 Euro for a correct decision and nothing otherwise, both in stage one and two. For example, if the agent in the first stage decided to buy the player and this turned out to be the correct decision (i.e., the player was talented), the agent received 75 Euro. If the agent decided not to buy the player in the second stage and the player turned out not to be talented, the agent earned another 75 Euro. A randomly drawn subject in the role of the principal received 75 Euro for a correct decision of her matched agent in a stage one. In addition, this principal received 75 Euro for the second stage, if

she had delegated the decision to her matched agent and it was correct, whereas she only received 72 Euro for a correct decision if she had not delegated the decision to the agent but had decided herself. Together with the incentives from the memory task, participants could earn up to 250 Euro.

We recruited subjects via a call for participation in the sports section of the Berlin newspaper *Der Tagesspiegel* and from the subject pool of the experimental lab at Technical University Berlin using the recruiting tool ORSEE (Greiner 2004). In total 419 subjects participated in the experiment. After logging into the online experiment, subjects received instructions on their computer screen and were asked to read them carefully.[6]

As we used the decision of the agents for multiple principals, it was necessary for the underlying true state of the world to be the same for the agents and their matched principals. Thus, to keep things simple, we randomly drew the state of the world upfront for both periods and implemented this draw for all participants. The random draw determined that it was beneficial to buy the new soccer player in each season. Given these states of the world in periods 1 and 2, we determined the types of the principals and the agents as well as their signals according to the probabilities specified in Section 3.1. As we wanted to generate a large number of observations for Case 1 and Case 2, we matched the agents and the principals according to their signal realization in the first period whenever possible. This, of course, implies that the signal realizations of principals and agents are not independent unlike in the model.[7] However, as the subjects played the game only once, they were not able to draw any inferences concerning the dependence of the signals.

4. Results

In the following we will present our results along the lines of the predictions derived above.

4.1. Descriptive statistics of memory tasks

The distributions of the actual and the recalled predictions in the finals and the goals task are depicted in Figure 4.[8] Regarding the finals task, we had fortunately asked for one of the actual participants in the final, namely Spain. The average likelihood subjects assigned

[6] For the instructions (translated from German) see Appendix B.

[7] In fact, only five principals received private signals different from their matched agent signal in the first period. However, five agents did not follow their signal when making the acquisition decision in the first period. Hence, only 303 out of 395 principals received a signal in line with the observed action by the agent.

[8] Gaussian kernels are used for the density estimates. The selected bandwidths are 0.04 (panel A) and 1.8 (panel B).

ex ante to Spain's participation in the finals was 32.5%. After Spain was known to be participating in the finals, the subjects' average recalled likelihood assessment was 39.6%. A Wilcoxon signed-rank test confirms a significant shift in the distribution of recalled likelihood assessments toward the actual outcome ($p < 0.0001$). However, there is considerable heterogeneity on the individual level: 26.1% of the subjects are unbiased as they remember their prediction correctly, 51.1% of the subjects' behavior is in line with the hindsight bias as they report recalled predictions that are higher than their actual predictions, and a considerable fraction of 22.8% of the subjects report recalled predictions that are lower than they actually were. As these subjects behave neither in line with rational behavior nor with the hindsight bias, we refer to them as "unclassified" and report results regarding their behavior separately.[9]

For Argentina and Germany who did not reach the final, we did not observe any comparable effects of the hindsight bias.[10]

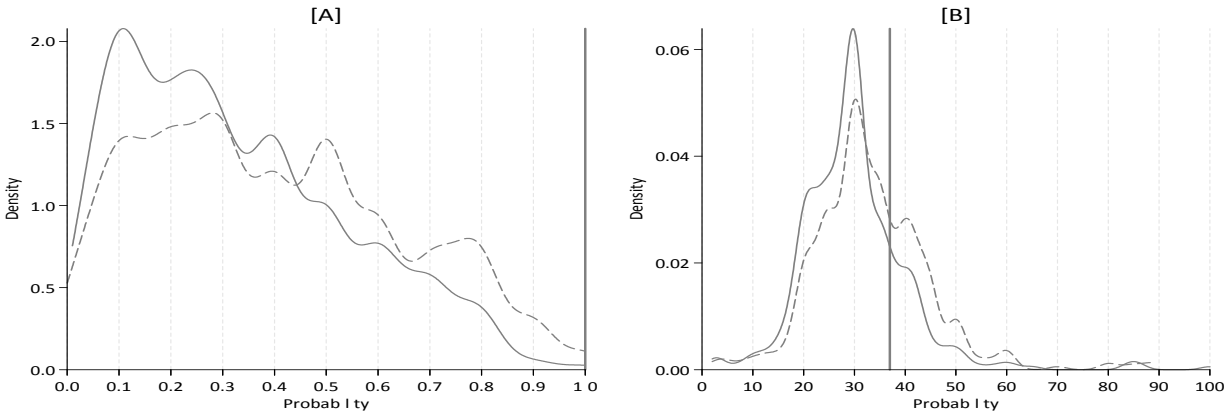

Figure 4 Kernel density estimates of actual predictions (solid lines) and recalled predictions (dashed lines) of Spain's likelihood of entering the final (panel A) and the number of goals (panel B). Solid vertical lines indicate the true values of the true outcomes (1 and 37 respectively).

A similar pattern is observed for the goals task. First note that 79.7% of the subjects underestimated the true number of goals shot during the eighth-, quarter- and semi final (37). In line with the hindsight bias, the mean of the recalled predictions (34.3) is larger

[9] Among the biased subjects the fraction of unclassified subjects is significantly lower than the fraction of hindsight-biased subjects (binomial test, $p < 0.0001$).

[10] For Argentina, the distributions of predictions and recalled predictions are virtually the same. For Germany, the recalled predictions are significantly higher than actual predictions on average although Germany failed to participate in the finals.

than the mean of the actual predictions (31.0). Again, a Wilcoxon signed-rank test indicates that this shift in the distributions is significant ($p < 0.0001$). On the individual level we find 22.5% rational subjects who remember their prediction accurately, 43.5% of the subjects behave in line with the hindsight bias as their recalled predictions are closer to the actual outcome of 37, and 33.9% cannot be classified as they behave contrary to either prediction.[11]

As we attempt to correlate the degree of hindsight biasedness as an individual characteristic with the choices in the delegation game, we assess the consistency of both measures. We find that both measures are significantly dependent[12]: About 50% of the subjects who remembered their prediction in the goals task correctly show some degree of hindsight bias in the finals task, while 73% of the subjects who take hindsight-biased decisions in the goals task are hindsight biased in the finals task as well. As the dependence between the two tasks is significant but not perfect, we introduce an additional classification of subjects based on both prediction tasks together. Here, we classify a subject as rational if and only if she remembered her predictions correctly in both tasks (9% of all subjects) and as hindsight biased if she was classified as hindsight biased in one of the tasks and as rational or hindsight biased in the other (41% of all subjects). Just as for the measure based on one of the tasks alone, we do not consider subjects with a biased recall that contradicts the hindsight bias.

Since we observe some extreme choices in both prediction tasks, we will also investigate the effect of outliers as a robustness check. For example, regarding the finals task one subject assessed Spain's likelihood of attending the finals as 3% in the first place and then recalled it as being 100% after Spain was known to be participating. Another subject estimated the number of goals scored during the eighth-, quarter- and semi-final to be 210 and remembered her prediction as being 60 after the true outcome of 37 was announced. Grubbs' test for outliers identifies four extreme observations that are relevant for our analysis.[13] Although we do not exclude theses observations in our main analysis below, we report on those instances where their deletion affects the results.

[11] Again, among the biased subjects the fraction of unclassified subjects is significantly lower than the fraction of hindsight-biased subjects (binomial test, $p = 0.0342$).

[12] We run a probit regression with a dummy indicating hindsight-biased behavior in the goals task as the dependent variable and a corresponding dummy for the finals task as the independent variable (unclassified subjects were excluded, standard errors were corrected for clusters on the individual level). A test of the finals task dummy against zero yields $p = 0.001$.

[13] A full list of the outliers in the prediction and memory tasks together with the corresponding delegation decisions can be found in Appendix A.1. Note that six of these 10 observations are classified as unexplained and are thus not

4.2. Effect of hindsight bias on delegation behavior

Out of 395 participants in the role of the principal, 303 were in a situation where their private signal corresponded to the agent's action (Case 1 and 2). Out of those, 229 (203) can be classified as being either rational or hindsight biased based on the finals task (goals task). As our model does not yield any predictions regarding unclassified subjects, these observations are excluded from the analysis. Based on the combination of both tasks, 150 subjects can be classified.

Table 1 gives an overview of the principals' delegation rates conditioned on their available information and their classification based on the (combined) tasks. First, we note that the delegation rates support our assumption that subjects derive a positive utility from self-determination, as delegation rates should be 100% without such a non-pecuniary utility both for rational and hindsight-biased principals.

Table 1 Delegation rates by task, principal's type and information.

	Finals task (n=229)		Goals task (n=203)		Combined (n=150)	
Information	Rational	Biased	Rational	Biased	Rational	Biased
Case 1 ($\omega_1 \neq s_1^P = a_1$)	66.7% ($\frac{24}{36}$)	55.2% ($\frac{37}{67}$)	75.9% ($\frac{22}{29}$)	55.4% ($\frac{36}{65}$)	81.8% ($\frac{9}{11}$)	55.9% ($\frac{33}{59}$)
Case 2 ($\omega_1 = s_1^P = a_1$)	71.8% ($\frac{28}{39}$)	70.1% ($\frac{61}{87}$)	67.4% ($\frac{29}{43}$)	66.7% ($\frac{44}{66}$)	60.0% ($\frac{9}{15}$)	76.9% ($\frac{50}{65}$)

In line with *Hypothesis 1*, the table shows that irrespective of the method of categorizing subjects as hindsight biased or rational, the delegation rates are lower for hindsight-biased principals than for rational principals in situations where the principal and the agent both received incorrect signals (Case 1). Furthermore, in line with *Hypothesis 2*, the table reveals that the delegation rates for rational and hindsight-biased subjects are very similar when the agent's decision coincides with the state of the world (Case 2) except for the combined categorization. Regarding the comparisons across cases as stated in *Observations (i)*, *(ii)*, and *(iii)*, we find that the differences in the delegation rates of rational principals are not directed in a systematic manner across categorization methods. We interpret this as weak support for *Observation (i)* as we would expect – if anything – a very small decrease when moving from Case 2 to Case 1. The results are very clear concerning *Observation (ii)*

relevant for our main results. Although the Shapiro-Wilk tests reject normality for the distributions of the differences between recalled and actual predictions for both tasks (which could be due to the outliers besides non-normality of the population), Grubbs' test is applied in order to employ a nonarbitrary criterion for the exclusion of apparently extreme observations.

as hindsight-biased principals show lower delegation rates in Case 1 compared to Case 2 for each classification method. Finally, note that these decreases in delegation rates when moving from Case 2 to Case 1 are always larger for hindsight-biased than for rational principals, just as predicted by *Observation (iii)*.

In order to test the hypotheses, we employ probit regressions for each classification with the principals' probability to delegate as the dependent variable and a constant, a dummy variable for Case 1, a dummy variable for principals classified as hindsight biased and an interaction of both dummies as independent variables.[14] Table 2 shows Wald tests of the differences between delegation rates obtained by proper transformations of the estimated coefficients.[15]

Table 2 Differences in delegation rates by type and information of principals.

		Finals task	Goals task	Both tasks
Hypothesis 1:	$\pi_H^1 - \pi_R^1 < 0$	-0.114	**-0.205****	**-0.259****
Hypothesis 2:	$\pi_H^2 - \pi_R^2 = 0$	**-0.017**	**-0.008**	**0.169**
Observation (i):	$\Delta_R := \pi_R^1 - \pi_R^2 \approx 0$	**-0.051**	**0.084**	**0.218**
Observation (ii):	$\Delta_H := \pi_H^1 - \pi_H^2 < 0$	**-0.149****	**-0.113***	**-0.210*****
Observation (iii):	$\Delta_H - \Delta_R < 0$	-0.098	**-0.197***	**-0.428****

Note: Bold values represent results in line with our hypothesis. π_l^k denotes the delegation rates with $k \in \{1, 2\}$ for case 1 and case 2 and $l \in \{R, H\}$ for rational and hindsight-biased principals respectively. The p-values are based on Wald tests: $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

The first row in the table lends support to *Hypothesis 1*. In Case 1, hindsight-biased principals delegate less often than rational principals (significant for the goals-task classification and the combined classification). Furthermore, in line with *Hypothesis 2*, the second row of the table indicates that irrespective of the classification of subjects, there is no significant difference between the delegation rates of rational and hindsight-biased principals in Case 2.

Also regarding the comparisons across cases formulated in *Observations (i),(ii),* and *(iii)*, we find support for our theoretical predictions. First, independent of the categorization method, we find that the delegation rates of rational principals are not significantly different

[14] Appendix A.2 reports the estimated coefficients and standard errors for each categorization.

[15] Tests are one-sided for directed hypotheses (*Hypothesis 1*, and *Observation (ii)* and *(iii)*) and two-sided for undirected hypotheses (*Hypothesis 2* and *Observation (i)*). Appendix A.3 gives further details and reports results for the data without outliers.

between the two cases. Second, hindsight–biased principals exhibit a decreased propensity to delegate when they face a situation where the agent's decision contradicts the state of the world compared to situations where the agent's decision and the state of the world coincide (significant for the finals-task classification and the combined classification; marginally significant for the goals-task classification). Finally, in line with *Observation (iii)*, we find that hindsight-biased principals show a stronger reduction in delegation rates than rational principals when moving from Case 2 to Case 1 (significant for the combined classification and marginally significant for the goals-task classification).

Our results are robust with respect to the exclusion of outliers (for the detailed analysis see Appendix A.3). We finally note that irrespective of the classification method the unclassified subjects show no significant differences in behavior between Case 1 and Case 2.[16]

5. Discussion

Using a novel experimental design, we show that the hindsight bias can lead to suboptimal delegation decisions. The hindsight bias plays a role when an economic actor has imprecise information about the state of the world. Then, once the true state of the world is revealed, hindsight-biased principals fail to remember their early assessment. Thus, in a principal-agent relationship the principal's confidence in herself relative to the agent is not correctly updated. Hindsight-biased principals are frequently too self-confident and therefore delegate too little, compared to rational principals. This finding sheds new light on an established result in the principal-agent literature, namely that interim information in a multi-period principal-agent relationship can mitigate distortions that originate in asymmetric ex ante information or ex ante uncertainty. Our paper shows that this result holds true for rational but not necessarily for hindsight-biased principals. In particular, our results suggest that hindsight-biased principals (e.g., managers, doctors or venture capitalists) can become even worse at evaluating the relative ability of their agents when interim information is released relative to no interim information.

[16] Regarding the comparison of all four cases there is one significant difference (out of 18 comparisons): Subjects who are unclassified with respect to the finals task have significantly higher delegation rates in the cases with $\omega_1 \neq s_1^P = a_1$ $(68.6\%, n = 35)$ than in the cases with $\omega_1 = s_1^P \neq a_1$ $(33.3\%, n = 9)$. Excluding the outliers renders the difference insignificant.

As we have identified a specific source of the inability to delegate optimally, the question arises as to which management instruments can be used to counteract the bias. Documenting the principal's information at certain points in time can alleviate the effects of her biased memory. For example, a manager could be forced to document evaluations of his subordinates' decisions before she knows whether these decisions turned out to be right or not; or a venture capitalist could document his early assessment of the entrepreneur and his venture.

On the other hand, providing the principal with interim information about the performance of the agent creates inefficiencies when the principal is hindsight biased. Thus, more monitoring or subjective evaluations within firms can be counterproductive for optimal delegation decisions.

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Appendix

A. Supplemental Tables

A.1. Observations classified as outliers by Grubbs' maximum normed residual test.

Task	ID	Prediction	Remembered Prediction	Difference	Explained by rational behavior or hindsight bias	Decision to delegate
Finals	91	100	0	-100	unexplained	yes
	382	3	100	97	hindsight bias	no
Goals	40	31	5	-26	unexplained	yes
	135	60	89	-29	unexplained	no
	148	2	30	28	hindsight bias	yes
	157	210	60	150	hindsight bias	yes
	209	30	120	-76	unexplained	no
	263	36	86	-48	unexplained	yes
	360	40	70	-30	unexplained	no
	381	10	37	27	hindsight bias	no

A.2. Probit regressions of principal's type and information on delegation rate.

	Propensity to delegate		
	Finals task	Goals task	Combined
Constant	0.577	0.452	0.253
	(0.213)	(0.198)	(0.327)
Case 1	−0.146	0.250	0.655
	(0.304)	(0.323)	(0.549)
Hindsight-biased	−0.049	−0.021	0.483
	(0.256)	(0.255)	(0.370)
Case 1*Hindsight-biased	−0.250	−0.545	−1.242
	(0.368)	(0.393)	(0.598)
n	229	203	150
$\log L$	−145.25	−129.85	−90.9
$\chi^2_{(3)}$	4.58	4.33	7.73

Note: Values in brackets represent standard errors.

A.3. Estimated effects of principals' information and type on delegation rates.

	Testing hypotheses		Finals task		Goals task		Combined	
	H_0	H_1	incl. outliers	w/o outliers	incl. outliers	w/o outliers	incl. outliers	w/o outliers
Hypothesis 1: $\pi_H^1 < \pi_R^1$	$\pi_H^1 - \pi_R^1 = 0$	$\pi_H^1 - \pi_R^1 < 0$	-0.114	-0.147	-0.205	-0.226	-0.259	-0.266
			(0.125)	(0.070)	(0.021)	(0.013)	(0.026)	(0.023)
Hypothesis 2: $\pi_H^2 = \pi_R^2$	$\pi_H^2 - \pi_R^2 = 0$	$\pi_H^2 - \pi_R^2 \neq 0$	-0.017	0.000	-0.008	0.003	0.169	0.169
			(0.847)	(0.997)	(0.933)	(0.978)	(0.216)	(0.216)
Observation (i): $\pi_R^1 \approx \pi_R^2$	$\Delta_R := \pi_R^1 - \pi_R^2 = 0$	$\pi_R^1 - \pi_R^2 \neq 0$	-0.051	-0.032	0.084	0.084	0.218	0.218
			(0.630)	(0.762)	(0.431)	(0.431)	(0.204)	(0.204)
Observation (ii): $\pi_H^1 < \pi_H^2$	$\Delta_H := \pi_H^1 - \pi_H^2 = 0$	$\pi_H^1 - \pi_H^2 < 0$	-0.149	-0.179	-0.113	-0.145	-0.210	-0.218
			(0.028)	(0.011)	(0.091)	(0.046)	(0.006)	(0.005)
Observation (iii): $\Delta_H < \Delta_R$	$\Delta_H - \Delta_R = 0$	$\Delta_H - \Delta_R < 0$	-0.098	-0.147	-0.197	-0.229	-0.428	-0.436
			(0.230)	(0.134)	(0.074)	(0.048)	(0.012)	(0.011)

Note: π_l^k denotes the delegation rates with $k \in \{1, 2\}$ for case 1 and case 2 and $l \in \{R, H\}$ for rational and hindsight-biased principals respectively. The values in brackets correspond to p-values obtained by Wald tests of the non-linear restrictions given in column "H_0". For example, given the estimated parameters in Table A.2, *Observation (i)* is tested by the restriction $\pi_R^1 = \pi_R^2$ with $\widehat{\pi}_R^2 = \Phi(\widehat{b}_{const})$ and $\widehat{\pi}_H^1 = \Phi(\widehat{b}_{const} + \widehat{b}_{Case1})$ where $\Phi(\cdot)$ denotes the standard normal cdf.

B. Instructions

B.1. Instructions for the agents: Round 1

Thank you for participating in our survey and the following little game!

Information regarding participation and lottery:

Among all participants we will raffle

> **5 x 2 cards for the 11-Friends-World Cup**
> on June 26, 2010, at 1 p.m.

We will contact you again on July 8 to conduct another survey and finish the game.

Then you will have the chance to win between 75 and 250 Euro. If you are among the winners, we will contact you separately and transfer your earnings to your account.

Please answer the following seven questions:

1. Likelihood of Germany reaching the final of the World Cup 2010? (Please give a percentage between 0 to 100.)

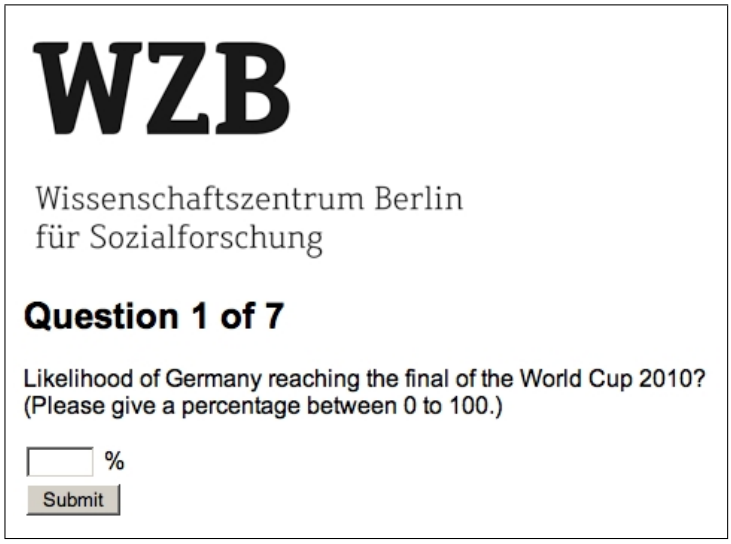

Figure B.1 How questions were presented to the participants, e.g. question 1.

2. What is the likelihood Spain reaches the final of the World Cup 2010? (Please give a percentage.)
3. What is the likelihood Argentina reaches the final of the World Cup 2010? (Please give a percentage.)
4. What is the likelihood Italy drops out **before** the semi-final? (Please give a percentage.)
5. How many goals will be scored within the regular playing time (90 min.) during the eighth-final, quarter-final and semi-final (14 matches overall)?
6. Suppose there are 100 people (including yourself) who – just like you – have just guessed how many goals will be scored during the eighth-final, quarter-final and semi-final. These estimations can be ranked so that the best estimation is first ranked. On which rank do you think you are with your estimate? Is your estimation between

- rank 1 and 10,
- rank 11 and 20,
- rank 21 and 30,
- rank 31 and 40,
- rank 41 and 50,
- rank 51 and 60,
- rank 61 and 70,
- rank 71 and 80,
- rank 81 and 90,
- rank 91 and 100?

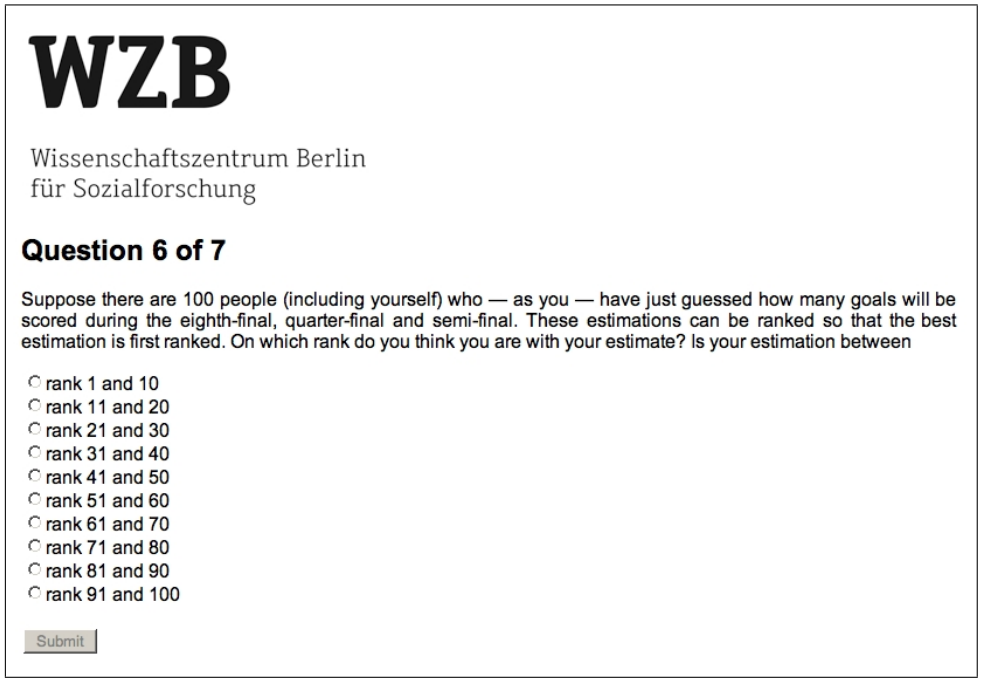

Figure B.2 Determining the participants' degree of overconfidence.

7. Which team is your personal favorite for winning the World Cup 2010?

Thank you for answering the previous questions.
Please read the following instructions very carefully and make the decisions you are asked for. You can win a considerable amount of money for it. On July 11, we will hold a raffle for all participants of the game and will draw 10 winners. If you are among the winners you will earn 75 Euro for each correct decision!

Imagine the following situation in which you will either take the role of the coach or of the manager:
During this season the coach and the manager of the soccer club "SC World-Champion" have to decide whether or not to buy a talented young player named Lion Elmess.

If the player evolves into a good player during the season, it is advantageous to have him as a member of the team. If the player doesn't evolve into a good player, it is not advantageous to have him as a member of the team. A young player evolves into a good player in half the cases.

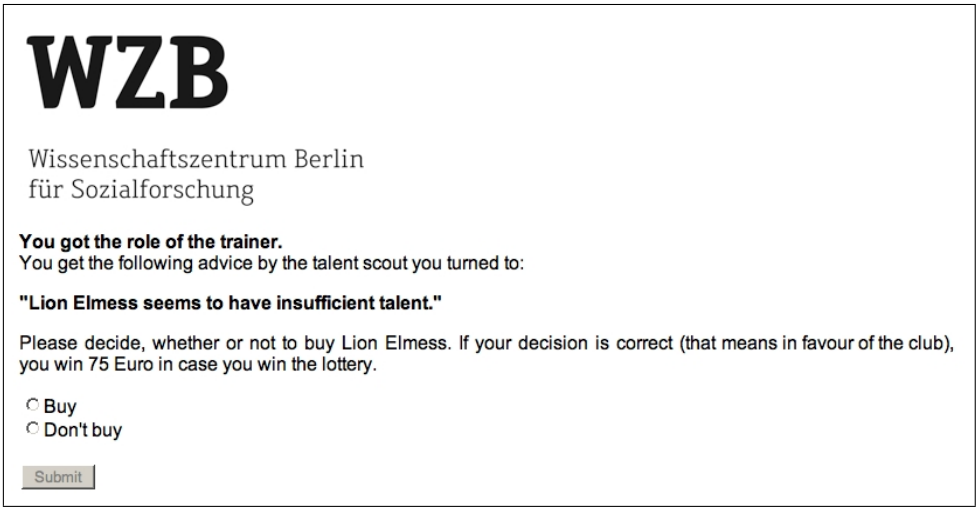

Figure B.3 First decision task of the agents in stage one.

To guide their decision, both the coach and the manager turn to a talent scout. A talent scout can be of a good or bad type. The coach as well as the manager cannot recognize the type of the talent scout. But the trainer turns to a good talent scout in five out of 10 cases (50 percent) while the manager turns to a good talent scout in only four out of 10 cases (40 percent) and in six out of 10 cases a bad type.

What distinguishes a good talent scout from a bad one?

The advice of a good talent scout is correct in two-thirds of cases. That is, in two out of three cases the young player evolves into a good player if a good talent scout rated him as a good player. In the same way, a young talent evolves into a bad player if a good talent scout rated him as a bad player.

In contrast, a bad talent scout can't predict the development of a young player that well. He is correct only in half the cases. If a bad talent scout rated a young player as a good player, he is correct only in one of two cases. In the same way, a young player nevertheless evolves into a good player even if a bad talent scout rated him as a bad player.

By pressing "Next" you will either get the role of the coach or the role of the manager and will have to make your decision.

You are in the role of the coach.

You are given the following advice by the talent scout you turned to:

["Lion Elmess seems to have great talent."]

["Lion Elmess seems to have insufficient talent."]

Please decide whether or not to buy Lion Elmess. If your decision is correct (that means in favor of the club), you win 75 Euro if you win the lottery.

[Buy]

[Don't buy]

You will find out whether [your acquisition] turned out to be a good decision at the end of the season in three weeks.

You will find out whether [your decision not to buy Lion Elmess] turned out to be a good decision at the end of the season in three weeks.

Before the start of the next season (in three weeks), both the trainer and manager have to decide again whether or not to buy a young player named Lukas Hashüpfer.

Concerning the quality of the talent scout and the player's feasible talent, the same assumptions as for the decision regarding Lion Elmess hold.

In three weeks the manager has to decide whether she will leave the decision of whether or not to buy Lukas Hashüpfer to you or whether she will take it herself.

For practical reasons we ask you to now take the decision whether or not to buy Lukas Hashüpfer in the event of the manager leaving the decision to you. Again, you get 75 Euro should you win the lottery and if your decision is correct.

Again, you ask your talent scout for her advice. It is the same talent scout you already asked with regard to Lion Elmess. You get the following advice by your talent scout:

["Lukas Hashüpfer seems to have great talent."]
["Lukas Hashüpfer seems to have insufficient talent."]

Please decide now, whether or not to buy Lukas Hashüpfer for the next season:
[Buy]
[Don't buy]

You will find out whether [your acquisition] turned out to be a good decision in three weeks.

You will find out whether [your decision not to buy Lukas Hashüpfer] turned out to be a good decision in three weeks.

Thank you for participating!

We will contact you again on July 8 by email. Then you will get the chance to win between 75 and 250 Euro. If you are drawn for the tickets for the 11-Friends-World Cup, we will contact you on June 26.

B.2. Instructions for the agents: Round 2

Thank you for participating in the second stage of our survey and the following little game.

Information regarding participation and lottery:
Among the participants who complete the second stage of our game, we will inform those of you who have won between 72 and 250 Euro. We will explain later on how you can win the prize.

During the first stage three weeks ago, you were asked to state the likelihood of certain events in the course of the ongoing championship. You are now asked to remember your stated likelihoods in this first stage as precisely as you can.

The 10 participants who best remember their stated likelihoods in stage one will earn 100 Euro each. Only those participants who completed the entire second stage (including the game) will be considered.

Argentina did not reach the final of the World Cup 2010.

1. What likelihood for Argentina reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage between 0 to 100.)

During the eighth-final, quarter-final and semi-final 37 goals were scored (within regular playing time).

2. In the last survey, how many goals did you predict would be scored during the eighth-final, quarter-final and semi-final?

Germany did not reach the final of the World Cup 2010.

3. What likelihood for Germany reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

Spain did reach the final of the World Cup 2010.

4. What likelihood for Spain reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

Italy was eliminated during the preliminary round and therefore did not reach the semi-final.

5. What likelihood for Italy being eliminated before the semi-final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

(This question will not be taken into account because the outcome was already known within the first stage of the survey.)

Three weeks ago you were given the role of the coach of the club SC World-Champion. As the coach, you had to decide whether or not to buy the young talents Lion Elmess and Lukas Hashüpfer. You will now find out whether your decisions turned out to be good or bad.

Three weeks ago you decided [to buy Lion Elmess].
Congratulations, the acquisition of Lion Elmess turned out to be a good one. Lion Elmess was a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

Three weeks ago you decided [not to buy Lion Elmess].
Unfortunately, this decision was a bad one and Lion Elmess turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Furthermore, you decided [to buy Lukas Hashüpfer] three weeks ago.

Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team this season. You will get 75 Euro in the event of your winning the lottery.

Furthermore, you decided [not to buy Lukas Hashüpfer] three weeks ago.

Unfortunately, this decision was bad and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Thank you for participating!

We will contact you again if your name is drawn in the raffle on July 13. Should you have any further questions, do not hesitate to contact us.

B.3. Instructions for the principals: Round 1

The instructions for the principals were exactly the same as for the agents, until they learned their role in the delegation game:

You are in the role of the manager.

You are given the following advice by the talent scout you turned to:
"Lion Elmess seems to have great talent."
"Lion Elmess seems to have insufficient talent."

Please enter the advice you got in the following form.

Lion Elmess seems to have [Entry] talent.

For this season you will have to leave the decision whether or not to buy Lion Elmess to your coach. In the meantime, your coach was also given advice by her talent scout and took the following decision: [Decision]

You have to wait until the season is over in order to find out whether your coach's decision turned out to be good. The season lasts until July 8. On that date we will contact you again and inform you as to whether Lion Elmess evolved as a good or bad player, that is, whether your coach's decision to buy or not buy Lion Elmess turned out to be good. If the decision turns out to be good, you will win 75 Euro in the event that you win the lottery.

Before the start of the next season (in three weeks), both the trainer and the manager have to decide again whether or not to buy a young player named Lukas Hashüpfer. Concerning the quality of the talent scout and the player's feasible talent, the same assumptions hold as for the decision regarding Lion Elmess.

We will then ask you to decide, who – your coach or you yourself – will take the decision on Lukas Hashüpfer.

Please keep in mind that you only take part in the lottery if you complete both parts of the game.

Thank you for participating!

We will contact you again on July 8 by email. Then you will get the chance to win between 75 and 250 Euro. If you are drawn for the tickets for the 11-Friends-World Cup, we will contact you on June 26.

Instructions for the principals: Round 2
Thank you for participating in the second stage of our survey and the following little game.

Information regarding participation and lottery:
Among the participants who completed the second stage of our game, we will inform those of you who have won between 72 and 250 Euro. We will explain later on how you can win the prize.

During the first stage three weeks ago, you were asked to state the likelihood of certain events in the course of the ongoing championship. You are now asked to remember your stated likelihoods in stage one as precisely as you can.

[...] Again, the way the principals' remembered predictions were elicited was the same as for the agents.

Please remember the situation with regard to the first stage. You were given the role of the manager of the club SC World-Champion:
Your coach had to decide whether or not to buy the talented player Lion Elmess. You will now find out whether her decision turned out to be a good or bad decision.

For the next season a decision has to be taken as to whether or not to buy another talented young player named Lukas Hashüpfer. You have to decide whether you will leave this decision to your coach or whether you will take it yourself.

Basically, you are once again facing the following decision about the acquisition of a new player:

If the player evolves into a good player during the season, it is advantageous to have him as a member of the team. If the player doesn't evolve into a good player, it is not advantageous to have him as a member of the team. A young player evolves into a good player in half the cases.

To guide their decision, both your coach and you as the manager turn to a talent scout. A talent scout can be of good or bad type. The coach as well as the manager cannot recognize the type of the talent scout. But the trainer turns to a good talent scout in five out of 10 cases (50 percent) while the manager turns to a good talent scout in only four out of 10 cases (40 percent) and in six out of 10 cases a bad type.

What distinguishes a good talent scout from a bad one?
The advice of a good talent scout is correct in two-thirds of cases. That is, in two out of three cases the young player evolves into a good player if a good talent scout rated him as a good player. In the same way, a young talent evolves into a bad player if a good talent scout rated him as a bad player.

In contrast, a bad talent scout can't predict the development of a young player that well. He is correct in only half the cases. If a bad talent scout rated a young player as a good player, he is correct only in one of two cases. In the same way, a young player nevertheless evolves into a good player even if a bad talent scout rated him as a bad player.

By pressing "Next" you will find out your coach's decision in the last season (stage one) regarding Lion Elmess.

The coach's decision in the last season

After you and your coach turned to a talent scout last season, your coach decided to buy Lion Elmess. The acquisition of Lion Elmess turned out to be a good one. Lion Elmess was a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

After you and your coach turned to a talent scout last season, your coach decided not to buy Lion Elmess. Unfortunately, this decision was a bad one and Lion Elmess turned out to have a great deal talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Decision for the next season

For the next season, the decision whether or not to buy Lukas Hashüpfer has to be taken. You can take this decision on your own or leave it to your coach. If you take it on your own, the same talent scout you turned to last season will give you advice. If you leave the decision to your coach, she will also turn to the same talent scout as last season.

If you take the decision on your own and your decision is a good one, you will earn **72 Euro** in the event of your winning the lottery.

If you leave the decision to your coach again and her decision is a good one, you will earn **75 Euro** if you win the lottery.

If your decision or the decision of your coach turns out to be bad you won't earn any money.

☐ [I will take the decision regarding the acquisition of Lukas Hashüpfer on my own.]

☐ [I will leave the decision regarding the acquisition of Lukas Hashüpfer to my coach.]

You have decided to take the decision regarding Lukas Hashüpfer on your own.

You are given the following advice by your talent scout:

"Lukas Hashüpfer seems to have insufficient talent."

"Lukas Hashüpfer seems to have a great deal of talent."

Please decide now whether or not to buy Lukas Hashüpfer for the next season. If your decision is a good one, you will earn 72 Euro in the event you win the lottery.

[Buy]

[Don't buy]

Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team. In the event that you win the lottery, you will receive 72 Euro.

Unfortunately, this decision was a bad one and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event that you win the lottery.

You have decided to leave the decision regarding Lukas Hashüpfer to your coach.

Your coach decided to buy Lukas Hashüpfer. Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

Your coach decided not to buy Lukas Hashüpfer. Unfortunately, this decision was a bad one and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Please enter the advice you were given by your talent scout regarding Lion Elmess in stage one.

☐ "Lion Elmess seems to have great talent."
☐ "Lion Elmess seems to have insufficient talent."

Thank you for participating!

We will contact you again if your name is drawn in the lottery on July 13. Should you have any further questions, do not hesitate to contact us.

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SFB 649, Spandauer Straße 1, D-10178 Berlin
http://sfb649.wiwi.hu-berlin.de

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